THE MOSQUITOES OF THE SOUTH PACIFIC

(*Diptera, Culicidae*)

VOLUME I

By JOHN N. BELKIN

Illustrations by Charles L. Hogue

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1962

University of California Press
Berkeley and Los Angeles
Cambridge University Press
London, England

Library of Congress Catalog Card Number: 62-11490
Printed in the United States of America
Designed by Howard Bezanson

Date of Issue: July 18, 1962

TO THE MEMORY OF
Robert Matheson
INSPIRATIONAL TEACHER AND MENTOR
UNDER WHOSE GUIDANCE THIS
STUDY WAS STARTED

AND TO
MY WIFE, *Lorraine,*
WHOSE INTEREST, ENCOURAGEMENT, AND UNDERSTANDING
MADE POSSIBLE THE COMPLETION
OF THIS WORK

PREFACE

The South Pacific as used here comprises all the islands east of the Bismarck Archipelago, New Guinea, Australia, and Tasmania to Easter Island and Sala y Gomez, and from the equator south to the subantarctic islands of New Zealand and Macquarie Island. The mosquito fauna of this area has never been studied as a unit; its components have been only very briefly and partially covered in a synopsis of the adult mosquitoes of the Australasian region (Edwards, 1924), a check list of the Culicidae of the Australian region (Taylor, 1934), an atlas of the mosquito larvae of the Australasian region (Lee, 1944*a*), keys to the adult mosquitoes of the Australasian region (Knight, Bohart, and Bohart, 1944), a list of distributions (Iyengar, 1955), a study of mosquitoes and freshwater ecology (Laird, 1956), and an annotated bibliography (Iyengar, 1956). The remaining rather voluminous literature on the mosquitoes of the South Pacific consists of scattered descriptions of species, restricted geographical and taxonomic papers, and miscellaneous ecological and epidemiological studies.

Prior to World War II little systematic collecting of mosquitoes had been done in the South Pacific, but the fauna of the Solomons (Paine and Edwards, 1929), New Hebrides (Buxton and Hopkins, 1927), New Caledonia (Williams, 1943), Fiji (Paine, 1935, 1943), Samoa (Buxton and Hopkins, 1927; Edwards, 1928*b*), Tonga (Buxton and Hopkins, 1927), and New Zealand (Graham, 1929, 1939) had been sampled. Scattered records were also available for some other islands. A great deal of interest was aroused in the mosquito fauna of the area during the Allied occupation of the South Pacific in World War II in connection with the control of mosquito-borne diseases. Several score entomologists and their assistants in malaria survey or epidemiological units of the Allied armed services collected material through much of the area, particularly in the Solomons and New Hebrides. Probably several hundred thousand specimens of all stages of mosquitoes were collected during this period; of these, over 100,000 specimens are preserved in institutional or private collections. Following this burst of activity, interest in the area subsided at the end of the war but did not lapse completely. In recent years there has been a renewal of activity in the area through the efforts of the South Pacific Commission, its member nations, the University of California Pacific Tropic Diseases Project, and private individuals.

The purpose of the present work is to describe and illustrate in some detail all the species of mosquitoes of the South Pacific, to provide keys to these species, to bring together all the readily available information on the bionomics, disease relations, and distribution, and to attempt to analyze the mosquito fauna of the area in the light of our present knowledge. I began my studies on the mosquitoes of the South Pacific while engaged in malaria control activities on Guadalcanal, and my original intent was to monograph the mosquitoes of the Solomons. It soon became evident that the existing fauna of the Solomons was markedly different from that of the rest of the South Pacific, and I became interested in the entire area and in the problem of the derivation of the mosquito fauna of the South Pacific as a whole. The present work is the first step toward the goal of understanding this mosquito fauna. It is entirely preliminary in nature and largely descriptive. Much of the area is still very poorly collected and many of the species are not adequately known. I have tried to present the results of this study as objectively as possible and have emphasized graphic presentation of data to provide a ready comparative basis for future work. Although I originally planned to publish reviews of groups as their study was completed, I soon found that availability of additional material and experience gained from the study of different groups made piece-meal study and publication undesirable. The resulting delay in publication is more than compensated for, I believe, by a more uniform treatment and a greater ease of comparison.

In spite of the fragmentary nature of the data, I have made an attempt to analyze the mosquito fauna of the South Pacific and to make some inferences and speculations regarding its origin and development. Repeated patterns of speciation and distribution in the mosquitoes of the South Pacific are evident even at this stage of our knowledge. Some of these appear to be correlated with ecological, geological, and bathymetric data available for the South Pacific. I have no doubt that other interpretations of the data can be made; I have therefore attempted to present graphic summaries of all pertinent information to enable others to form and test their own hypotheses.

A word of justification is perhaps needed for the inclusion in this work of a section entitled "Material and Methods." First, this section explains the realiability of the verbal and graphic data presented here. Second, even the simplest techniques in collecting, rearing, preserving, and mounting are frequently neglected and few of them are mentioned in faunal works in sufficient detail to be useful to the field worker.

Although the present work raises more questions than it answers, I hope it will serve as a stimulus to further research not only on the mosquitoes of the South Pacific but also on other organisms of this area. Few areas of the world offer better or equal opportunities for investigations in all fields of biology, particularly for the study of evolution in nature. Few organisms are better subjects than mosquitoes for nearly all types of investigations in nature or in the laboratory. Opportunities for research on the mosquitoes of the South Pacific are unlimited; the following suggestions do not by any means exhaust the possibilities. Much remains to be done in the accumulation of data on the composition and distribution of the mosquito fauna through intensive surveys on every island group and on isolated islands. In many forms the associations of the adults and immature stages are presumptive only, or one or more stages are unknown. Detailed morphological studies, both descriptive and comparative, are much needed in all stages to provide sound criteria for determining relationships of species. No group has been intensively studied, and no attempt has been made to investigate thoroughly infraspecific variation in any species. Experimental hybridization and cytogenetic studies are much needed to resolve speciation problems in all groups. It is not even beyond the realm of possibility to attempt experimental speciation in nature on some isolated island in the area. The bionomics of all species are extremely poorly known or completely unknown, and much remains to be done on the epidemiology of mosquito-borne diseases in the South Pacific. Of great interest is the possibility of using some species of mosquitoes as indicators of the migrations of Polynesians.

Many individuals have contributed directly or indirectly to this study. I have been fortunate to be able to carry on the bulk of the work in a most stimulating intellectual environment at the University of California, Los Angeles, and have benefited immensely from association and discussions with colleagues in various related disciplines: Carl Epling, F. Harlan Lewis, Mildred E. Mathias, and Henry J. Thompson of the Department of Botany; Daniel I. Axelrod of the Department of Geology; Clarence E. Palmer of the Institute of Geophysics; John F. Kessel and Marietta Voge of the Department of Infectious Diseases; George A. Bartholomew, Nicholas E. Collias, Raymond B. Cowles, Waldo H. Furgason, Donald Heyneman, Thomas R. Howell, and Boyd W. Walker of the Department of Zoology; and Carl L. Hubbs of the Scripps Institution of Oceanography, University of California, La Jolla.

I have been most fortunate also in having a group of unusually capable assistants who have taken a personal interest in this study. Charles L. Hogue prepared all the original illustrations, made many slide mounts, and assisted me in innumerable ways in all phases of this study; I am much indebted to him for many suggestions and corrections. William A. McDonald, Yoshiaki Hokama, Harry E. Andersen, Robert X. Schick, and William D. Pratt assisted me in various ways, chiefly in the preparation and recording of the material. To Kay Metzner and Aiko Schick I am indebted for a most efficient typing of the first draft of the manuscript, and to Lucy F. Stockwell of the University of California Press for her painstaking editorial work.

To fellow culicidologists Elizabeth N. Marks, Peter F. Mattingly, and Alan Stone I am grateful for innumerable favors throughout this study. I wish to thank also the following institutions and individuals for the loan or gift of material as well as other assistance: Plant Diseases Division, DSIR, Auckland, New Zealand; Bernice P. Bishop Museum; Brigham Young University; British Museum

(Nat. Hist.); Chicago Natural History Museum; Department of Entomology, Cornell University; School of Hygiene and Public Health, Johns Hopkins University; Department of Entomology, University of Kansas; London School of Hygiene and Tropical Medicine; Department of Entomology and Economic Zoology, University of Minnesota; Entomology Division, DSIR, Nelson, New Zealand; Department of Entomology, University of Queensland; School of Public Health and Tropical Medicine, University of Sydney; U.S. National Museum; U.S. Naval Medical School; Division of Biological Sciences, University of Utah; Walter Reed Army Institute of Research; Dominion Museum, Wellington, New Zealand; J. v. d. Assem; D. E. Beck; C. O. Berg; R. M. Bohart; D. D. Bonnet; J. Bonne-Wepster; R. K. Bowman; E. S. Brown; C. R. Bruck; G. F. Burnett; S. J. Carpenter; H. Chapman; J. de Beaux; R. K. Dell; L. J. Dumbleton; J. G. Franclemont; A. R. Gaufin; E. S. Gourlay; J. L. Gressitt; A. B. Gurney; R. A. Harrison; H. Hoogstraal; M. O. T. Iyengar; W. R. Kellem; J. F. Kessel; W. V. King; K. L. Knight; J. Laffoon; M. Laird; D. J. Lee; H. N. March; H. E. Milliron; A. R. Mills; J. H. Paullus; J. Rageau; W. A. Robinson; L. Rosen; L. E. Rozeboom; R. J. Schlosser; C. B. Symes; Sione Tapa.

This study and its publication were made possible largely by grants from the National Science Foundation (NSF, G–1769, 3382, 6490); it is a pleasure to acknowledge this support. I also wish to thank the administrative staff of the University of California College of Agriculture and the California Agricultural Experiment Station for allowing me time to conduct these studies.

University of California, Los Angeles J. N. B.
January, 1960

CONTENTS

GENERAL CONSIDERATIONS

SYSTEMATIC TREATMENT

General Considerations

INTRODUCTION

The South Pacific remains to this day one of the least known and one of the least disturbed regions of the world in spite of the romantic appeal of some of the area to Europeans, the unscrupulous exploitation of some of its natural resources in the nineteenth century, and the extensive military operations during World War II. Only New Zealand, a few isolated islands, and, to a lesser degree, New Caledonia and Fiji have been affected to some extent by modern civilization.

Much has been written about the South Pacific, but the present knowledge of the area is extremely fragmentary and often very inaccurate. Even the exact geographic position of many islands is not known and many of the current navigational charts are based on fragmentary data obtained fifty to seventy-five years ago, or even earlier. The geology of the islands, the ocean floor, and the flora and fauna of the area are poorly known. No special general survey of the South Pacific and its biota has ever been made; if one were attempted at this time, it would do little except emphasize the lack of reliable data.

Although it may seem at first glance that the present knowledge of the mosquitoes of the South Pacific is quite extensive, this is far from correct, as will be evident in the discussions to follow. Nowhere in the area has the mosquito fauna been thoroughly studied. The majority of the collections have been confined to the immediate vicinity of settlements, practically no collecting has been done in the interior of any of the islands, and no collections at all are available for many islands. It is probable, therefore, that we know at present only a fraction of the existing mosquito fauna of the area, possibly less than 50 per cent of the species. The affinities of the known species are uncertain in many instances and their geographic relationships are difficult to determine since the mosquito fauna of the adjacent areas is even more poorly known than that of the South Pacific.

In spite of the fact that all the data are incomplete or even fragmentary, an attempt is made here to analyze briefly the mosquito fauna of the South Pacific and, whenever possible, to make inferences to its origins, history, and evolution. It is not my intent in this preliminary study to support or refute various theories as to the geological and biotic history of the South Pacific but rather to examine the mosquito fauna on its own merits. The available data can be interpreted in several ways in many instances where correlation is not possible. Therefore, it is very probable that many of the inferences presented here will not stand up when gaps in our knowledge are filled. The data on which the inferences are based will be found in the Systematic Treatment under individual species and groups. They have been summarized on charts (figs. 1-17), but it must be remembered that in this process a great deal of interpretation has been introduced, particularly in the determination of the affinities of species.

THE ENVIRONMENT

Only the very general features of the South Pacific as they pertain to the mosquito fauna can be briefly described here or elsewhere in this work. The area is so vast, varied, and complex that each island group would require a separate and extensive treatment impossible to undertake in a publication such as this. Unfortunately, the available information on the South Pacific is widely scattered and the only general survey is not available to the public. There is no general bibliography for the area, and I have made no attempt to prepare one for the study; many references can be found, however, in the publications of the Bernice P. Bishop Museum dealing with parts of the area.

GEOGRAPHY.—The South Pacific area (fig. 22) as considered here comprises several hundred islands and innumerable islets with a total land area of about 142,600 square miles lying in the South Pacific Ocean from the equator to about 55°30′ S. latitude (a distance of over 3,700 miles) and from about 154°30′ E. longitude to about 105°30′ W. longitude (a distance of about 6,500 miles from NW. to SE.). It is difficult to measure the total area of the South Pacific containing islands, but a conservative estimate would be about 12,000,000 to 13,000,000 square miles. The vastness of this area cannot be appreciated without comparison: it is exceeded among continental areas only by Asia, is slightly larger than Africa, and is considerably larger than North America (including islands). The land area in the South Pacific is only about 1.2 per cent of the total area. Since more than 70 per cent of the land is in New Zealand, land forms less than 0.5 per cent of the total area over most of the South Pacific, less than 0.05 per cent in the eastern part. Again to compare: the total land area of the South Pacific is about 90 per cent that of California and slightly less than that of Montana.

The majority of the islands of the South Pacific lie between the equator and the Tropic of Capricorn; only New Zealand and the islands to the south—Lord Howe, Norfolk, the Kermadec group, part of the Austral group, Oeno, Pitcairn, Henderson, Ducie, Easter, and Sala y Gomez—lie south of the tropic. The islands south of New Zealand are frequently referred to as the subantarctic islands.

The islands of the South Pacific are generally arranged in more or less complex groups, arcs, chains, or lines. Only a few are isolated, but in the majority of such instances the presence of reefs or shallows in their vicinity suggests the existence of more extensive land masses in the past (fig. 21). The various island groups are shown on the general map of the South Pacific (fig. 22) and the major individual islands on the sectional maps (figs. 23-27). The individual islands are extremely varied; in size they range from South Island of New Zealand, with an area of 58,093 square miles, to tiny coral or rocky islets less than an acre in area; the maximum elevations vary from over 12,000 feet in New Zealand and over 10,000 feet in the Solomons to barely above sea level in some coral atolls and rocky islets.

GEOLOGY.—The geology of the area is poorly known except for New Zealand and, to a lesser extent, New Caledonia and Fiji. No extensive sedimentary rocks have been described except from the above-mentioned islands, the remaining islands being primarily volcanic, coral, or a combination of the two. Recent volcanic activity and major earthquakes have been recorded in the Solomons, Santa Cruz, Banks, New Hebrides, Samoa, Tonga, Kermadec, and New Zealand.

Geologists generally separate the area into a continental border area and an ocean basin area, delimited by the andesite line which roughly follows the contour of the 3,000 meter depth in the western part of the area, as shown on the bathymetric chart (fig. 21). Thus Nauru, Ocean, Gilbert, Ellice, Samoa, and Niue, and all islands to the east and north of these, would fall into ocean basin area; all islands west and south of these would be in the continental border area. On islands of the continental border area, andesites (igneous rocks rich in silica) are common, while basalts, oceanites, and other igneous rocks poor in silica predominate in volcanic islands of the ocean basin area. Some geologists and biologists hold that at least part of the continental border area was an extensive continental mass (Melanesian continent) at one time in the past and that it was submerged except for the isolated island groups as we see them today. The majority of geologists and biologists are of the opinion that no continental masses have ever existed in the ocean basin area, but some biologists have postulated the existence of a mid-Pacific continent to account for the presence of some organisms on islands in this area.

The geological age of the islands as they exist today is difficult to determine, but it is generally regarded that, except for New Zealand, Fiji, and New Caledonia, the majority of the islands are relatively young, Tertiary or post-Tertiary. Even if this is correct, it does not preclude the existence of older, now extinct, islands in the same general area, represented now by submerged seamounts, guyots, and plateaus.

OCEANOGRAPHY.—Some general information is available on the topography and geology of the ocean floor of the South Pacific area (Menard, 1959), but in spite of recent surveys by the Swedish Deep Sea, the Galathea, and the Scripps Institution of Oceanograhy expeditions, details are lacking for most of the area and the existing data are not available to the public. The most up-to-date generally available large scale charts are found in the Times Atlas of the World (vols. 1 and 5). A very generalized and rough bathymetric chart is presented here for orientation purposes (fig. **21**).

It can be seen from this chart that the continental border area (see above) is characterized by extensive submarine areas less than 3,000 meters in depth separated completely or incompletely by deeper basins. The shallower areas are in the form of complex ridges, rises, and plateaus, on some of which are located the existing islands. In every island group except New Zealand, some of the islands or subgroups of islands are separated from each other by depths of over 1,000 meters and the areas within the 1,000 meter line are only moderately extensive. On the other hand, New Zealand is located on a very extensive area of less than 1,000 meters in depth which includes all the surrounding islands except the Bounty, Antipodes, and Macquarie Islands. The Macquarie group is on a separate ridge which connects with Antarctica. The basins all have depths of over 5,000 meters except the Coral Sea proper, the narrow Norfolk Island trough, and the small Three Kings Basin northwest of New Zealand. Several of the basins contain deep trenches, notably (1) the New Britain trench between New Britain and Bougainville in the Solomons Sea, with a depth of 9,140 meters in the Planet Deep, (2) the New Hebrides trench between the Hebrides and the Loyalties in the New Hebrides Basin, with a maximum recorded depth of 7,660 meters, and (3) the Torres trench between the Solomons and the Santa Cruz–New Hebrides ridge in the Santa Cruz Basin, with a maximum recorded depth of 6,061 meters.

The ocean basin area is characterized by relatively small areas less than 3,000 meters in depth and by very extensive basins of over 5,000 meters in its western and northern portions. The majority of the individual islands in almost every group in this area are separated from each other by depths of over 1,000 meters, and areas of less than this depth are very small indeed. In the western part is the very large South Western Pacific Basin, which along its boundary with the continental border area has two of the deepest known trenches in the world: the Tonga trench, with the Horizon Deep of 10,633 meters, and the Kermadec trench, with the Galathea Deep of 9,994 meters. Elsewhere, however, the South Western Pacific Basin is less than 6,000 meters in depth except between Samoa and Tonga (7,023 m.) and southeast of Niue (6,041 m.). The northern basins in the South Pacific are less than 6,000 meters in depth except for 7,316 meters in the Hilgard Deep east of Canton Island and 6,584 meters southwest of Vostock and Flint Islands (Southern Line Islands). Elsewhere in the ocean basin area, only small basins of over 5,000 meters in depth are found in or encroach upon the South Pacific area, with the greatest recorded depth of 6,045 meters in a small basin between the Society and Austral (Tubuai) Islands. The eastern part of the area has a number of relatively large areas less than 3,000 meters in depth on the South Eastern Pacific Plateau and along the Pacific Antarctic ridge but only a few restricted areas less than 1,000 meters in depth and only a few scattered islands.

In the greater part of the tropical South Pacific, the surface waters of the ocean move in a general westerly direction, due west along the South Equatorial current but shifting southwestward and even southward below 10° S. and in varied directions in the vicinity of island groups. There is no easterly equatorial counter current in the South Pacific tropics, the waters of the South Equatorial current splitting into two principal currents in the vicinity of the Solomons, Bismarcks, and New Guinea. In the southern winter the northern component is strong and supplies the bulk of the easterly Equatorial Counter Current which lies north of the equator. In the southern summer the southern component is strongest and supplies the East Australian current which flows southward and, under the influence of the westerly winds, shifts eastward toward New Zealand. It then joins the very strong west wind drift which flows constantly throughout the year in a general easterly direction but shifts northeastward toward the coast of South America.

CLIMATE.—As would be expected in an area encompassing such a wide range of latitude, the climate of the South Pacific is quite varied but is generally equable on all the islands, tropical, subtropical, temperate, or subantarctic. Brief notes on the temperature, rainfall, and seasonal changes in various parts of the areas are given below under the treatment of the mosquito fauna. It must be remembered that these data have been gathered at a few stations largely at or near sea level and that marked departures can be expected on the larger high islands. The greater part of the area is under the influence of the southeast trade winds, but their effect diminishes toward the northwest where the "monsoons" penetrate into the Solomons. The doldrums have a pronounced influence in the southern summer as far south and east as the New Hebrides, northern Fiji, Samoa, and the Northern Cook Islands. The gales and hurricanes of the South Pacific are not as violent as the typhoons of the northwest Pacific but they do a great deal of damage to some low islands and atolls. In general they originate along a line at about 10° S. latitude from the Coral Sea to the Society Islands and sweep southward or southeastward to about 30° S., affecting chiefly New Caledonia, New Hebrides, the Fiji-Tonga-Samoa areas, and, to a lesser extent, the western and southern parts of the Eastern Polynesian area.

ISLAND TYPES.—The islands of the South Pacific are extremely varied in physical features because of differences in geological origin and history and climate. Their topography, hydrography, and soils are very important factors in the mosquito fauna since they determine the ground water habitats available for mosquito breeding as well as the type and amount of vegetation; the latter in turn affects the mosquito fauna (see Flora). On this basis the islands of the South Pacific fall into three principal types: (1) the high igneous and sedimentary islands, (2) the elevated coral islands, and (3) the low coral islands and atolls.

The high islands are very diverse in character, ranging from sheer single volcanic cones (some with a caldera lake) to large complex islands, such as New Caledonia and the islands of New Zealand. In general they are well watered and have a complex topography and a considerable amount of soil which supports a vegetation that is often luxuriant. Streams are numerous and standing fresh water is usually present in lagoons, ponds, lakes, swamps, and sometimes marshes on more or less strongly developed flat coastal areas. These islands vary in age, of course, and show these features in varying degrees. Within the tropics such islands usually have extensive marginal coral reefs and frequently show evidence of elevated coral terraces. Breeding sites available for mosquitoes on such islands are usually numerous and diverse.

Elevated coral islands such as Rennell and Bellona are usually at least 200 feet above sea level. Although the coral rock is porous and no streams are present, freshwater springs or pools are found in depressions, caves, or in the cliffs at or below sea level. A thin red soil is found on such islands at least in pockets, and the vegetation is usually extensive and varied and may even include endemic species. In some instances (Rennell), the original atoll lagoon of the raised island may be transformed into a freshwater lake whose bottom is well above sea level. Such raised coral islands may have suitable freshwater habitats for mosquitoes.

The low-lying coral atolls as well as coral islands elevated less than approximately 200 feet usually have little or no fresh water but may have small pools of brackish water at sea level. The native vegetation is largely of the strand type, and introduced plants are generally limited to salt-tolerant species. Thus mosquito habitats are very limited; native ground pool species are restricted to those tolerant of brackish water; plant-breeding forms are usually absent on isolated islands.

FLORA.—A survey of the land flora of the South Pacific is beyond the scope of this work. Remarks will be confined here to some features of the vegetation which are important insofar as they provide habitats for mosquitoes. Vegetation affects mosquitoes in two principal ways: (1) it affords cover and protection to resting adult mosquitoes, and (2) it provides habitats for the development of the immature stages. The latter is very important on tropical islands of the South Pacific (see Bionomics and Dispersal). The most important species are (1) various woody plants which develop more or less extensive rotholes in which rainwater collects, (2) plants with large leaves, fronds, fruits, and so on which collect rainwater when fallen on the ground, and (3) plants with water-collecting leaf axils or pitchers. Native plants of most of these types are widely distributed in the tropical South Pacific and the introduction of others, such as cultivated aroids and the coconut, has increased the available habitats for some species of mosquitoes. The leaf axil and pitcher plant environments appear to be particularly conducive to the isolation of populations and speciation.

FAUNA.—A survey of the land and freshwater fauna of the South Pacific is also beyond the scope of this work. Only the vertebrates will be mentioned here since they may play a very important part in the completion of the life cycle of some biting mosquitoes by providing a source for the blood meal of the females. Native flightless mammals are known only from the Solomons (1 species of *Phalanger* and 3 genera of rats); many rats of the *concolor* or *exulans* group occur even on remote islands but these were probably spread by the natives and are not truly indigenous. Bats extend east to Samoa and south to New Zealand and are frequently numerous. Birds are numerous throughout the area and probably served as the chief source of blood for mosquitoes before the advent of man. They are the best-known organisms in the South Pacific (Mayr, 1931——, 1945). Reptiles are not numerous but one or more species extend east to Tonga and south to New Zealand. Amphibians are very few, represented only in the Solomons, Fiji, and New Zealand by native species of frogs.

HUMAN POPULATIONS.—Man and his activities are almost everywhere a potent factor in modifying the environment utilized by mosquitoes. In the South Pacific, human populations have affected the mosquito fauna but probably to a lesser extent than almost anywhere else in the world except the subpolar and other marginal areas. This is probably owing to a large extent to the insular nature of the area, its vastness, the difficulties of travel, and the remoteness of the South Pacific from major centers of population.

At the present time the human population of the South Pacific is roughly estimated at about 3,335,000. This figure gives a density of population of the order of 23 or 24 per square mile of land area, not markedly different from that of the world as a whole. However, the population is very unevenly distributed, with over 2,300,000 in the New Zealand area, about 625,000 in the Fiji-Tonga-Samoa area, and about 410,000 in all the rest of the South Pacific. Furthermore, within each of these areas the population density is very uneven and some islands are completely uninhabited.

For our purposes the human population of the South Pacific is divided into two groups: (1) the recent adventive populations of Europeans, Indians, Chinese, and other Asiatics (about 2,430,000), and (2) the earlier native populations of Polynesians, Melanesians, and Micronesians (about 905,000). The Europeans are numerically dominant only in the New Zealand area (2,150,000) but small numbers are found also in New Caledonia, the Society Islands, and Fiji; the other recent adventive populations are found chiefly in the tropical areas, Indians (200,000) being dominant in Fiji, and the others being represented by small numbers in all the major trading centers. The native populations consist of approximately 465,000 Polynesians (chiefly in New Zealand, Samoa, Tonga, and Eastern Polynesia), about 417,000 Melanesians (chiefly in the Solomons, New Hebrides, New Caledonia, and Fiji), and about 23,000 Micronesians primarily in the Southern Gilbert, Nauru, and Ocean Islands. It is difficult to distinguish clearly among the various native races as there has been a considerable amount of interbreeding among them as well as with some adventives, particularly between Polynesians and Europeans. In general, none of the native races altered the original environment to a marked degree as they did not engage in major agricultural pursuits. However, the Polynesians, in the course of their extensive travels and in association with cultivated plants which accompanied them, were apparently responsible for the spread of some indigenous species of mosquitoes within circumscribed areas (see Mosquitoes and Human Migrations).

The earliest inhabitants of the area are the Melanesians, a term used here in a broad sense to denote all the races of the "negroid" group found in the South Pacific. The time of their arrival in the South Pacific is quite uncertain, but presumably it occurred many thousands of years ago with several different stocks successively streaming from the west through New Guinea. Apparently the Melanesians did not migrate eastward beyond Fiji and southward beyond New Caledonia. At the present time the Melanesian populations in the South Pacific appear to be barely holding their own except in Fiji and New Caledonia, where they have increased considerably in recent years.

Much more is known about the history of the Polynesians, who are of the "caucasoid" group, but the time of their arrival in the South Pacific is not definitely known and divergent views are held as to their place of origin and the route or routes followed by them from the west on their way to the South Pacific. The ancestors of the present Polynesians began to occupy the South Pacific much later than the Melanesians; perhaps the first stream arrived about the beginning of the Christian era. By the time of the discovery of the South Pacific islands by Europeans, the Polynesians had reached and colonized almost every inhabitable island in the South Pacific east of Fiji, all the way to Easter Island, and had also established colonies in the Melanesian area to the west. With the aid of Polynesian legends, traditions, and extensive genealogies, as well as inferences from the distribution of physical characters and cultural and linguistic features, it has been possible to reconstruct with some degree of accuracy the routes of the Polynesian migrations within the South Pacific. However, many points of controversy still exist, particularly with respect to the original centers of dispersal within the area. At the present time the Polynesian populations in the South Pacific are in general on the increase and in several instances appear to have surpassed the numbers estimated to have been present in the early nineteenth century.

The Micronesians do not constitute an important element of the native population in the South Pacific as they are chiefly confined to the Southern Gilbert, Nauru, and Ocean Islands. This racial group is not as distinct as the Melanesian and the Polynesian. Its origin is uncertain, but some anthropologists believe that the Micronesians came primarily from Southeast Asia or Indonesia either in separate streams or possibly in the wake of the Polynesians. There appears to be considerable admixture of Micronesian features in some marginal Polynesian populations. In recent years there has been considerable relocation of Micronesians within the South Pacific.

The South Pacific islands were completely unknown to the Europeans until the latter half of the sixteenth century when Mendana first explored the Solomon islands (1568). In the following 200 years numerous explorers visited the South Pacific and a number of islands were discovered, but it was not until the voyages of Cook (1769–1779) that the area was thoroughly explored, widespread interest was aroused, and missionary and commercial penetration began. Prior to this time it is very unlikely that the fauna and flora of the area had been disturbed to any noticeable degree by the Europeans. On the other hand, during the period of exploitation, particularly after colonization of Australia (1788) and New Zealand (1840), the great increase in the sea traffic probably resulted not only in spreading some of the biota within the area but also in the introduction of exotic species, particularly the domestic and quasi-domestic forms. The early sailing vessels may have been especially important in this respect, since they usually had open stores of water on board which could be used for mosquito breeding. In spite of all the attempts to exploit the South Pacific, up to the present the only significant modifications of the environment have occurred in New Zealand, Fiji, New Caledonia, and a few scattered places elsewhere—especially on phosphate islands. The rather widespread coconut plantations through the tropical part do not appear to have affected the native mosquito fauna unfavorably; rather, they seem to have provided additional breeding sites for both ground pool- and plant-breeding forms. Similarly, the extensive occupation of the area by troops, as well as the military operations in the Solomons during World War II, apparently have had little permanent unfavorable effects on the environment or the mosquito fauna.

THE MOSQUITO FAUNA

ENTIRE SOUTH PACIFIC

The known mosquito fauna of the entire South Pacific area (figs. **1-5**) consists of 189 species, including 23 forms which are not named because of insufficient knowledge. A number of additional nominal species have been reported but these records are based on misidentifications, on erroneously labeled material, and on clerical errors; references to these will be found in the index as well as in the discussions of the fauna of the island groups from which the species have been reported. The mosquito fauna of the South Pacific cannot be said to be well known (although collections have been made on all the island groups except the Southern Gilbert, Phoenix, and Line Islands and on many individual islands); this fact is borne out by the absence of records on the charts of the regional faunal areas of the South Pacific (figs. **6-12**). The majority of the collections have been made in the vicinity of settlements, and attention has been centered on species closely associated with man and suspected as disease vectors. Practically nothing is known of the mosquito fauna of the interior of even the best-known islands and little attention has been paid to nonbiting forms and their immature stages. It seems probable, therefore, that we now know only a fraction of the existing mosquito fauna of the area—possibly less than 50 per cent of the species. Only a little over two-thirds of the known species (134) are represented by all stages (female, male, larva, pupa) and only 110 forms, chiefly from the Solomons, New Hebrides, and Fiji, have been reared individually so that the associations of the stages are certain.

Among the 189 known species there are 6 that have been either definitely or probably introduced into the area by man: the ubiquitous *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*Stegomyia*) *aegypti* introduced through commerce by Europeans; *Toxorhynchites brevipalpis*, *T. splendens*, and *T. inornatus* introduced recently for the control of container-breeding mosquitoes in Fiji and Samoa; and probably *Aedes* (*Stegomyia*) *marshallensis*, which, while as yet not collected in the South Pacific, is probably present in the Southern Gilbert Islands where it has been probably spread by natives ultimately from the Eastern Caroline Islands. In addition, *Aedes* (*Finlaya*) *notoscriptus* is in part, and possibly entirely, an introduction through commerce from Australia. It is possible also that several other species have been spread by natives into the area but, because of insufficient knowledge, all these species, as well as *notoscriptus*, are regarded provisionally as indigenous to the South Pacific area.

The indigenous mosquito fauna of the South Pacific consists then of 183 species. It is not only an extensive one but also a well-balanced one, the species belonging to 21 genera in 14 tribes. All 3 subfamilies are represented, although unevenly: (1) the Dixinae by 9 species in 4 genera and 2 tribes, (2) the Culicinae by 171 species in 15 genera and 10 tribes (5 of the genera being represented by a total of 27 subgenera so that at least 37 subgeneric entities are known in this subfamily), and (3) the Chaoborinae by 3 species in 2 genera and 2 tribes. The unequal representation of the subfamilies is in part owing to the relatively much poorer knowledge of the Dixinae and Chaoborinae, but it appears that these subfamilies are in general not as well represented as the Culicinae in the present-day fauna throughout the world. In the better known subfamily Culicinae, all the tribes that I recognize from the world (see Systematic Treatment) are represented except the Orthopodomyiini and Toxorhynchitini, and all the genera known from the Old World (23) are represented except the widespread *Orthopodomyia* and *Toxorhynchites* and the localized *Eretmapodites*, *Zeugnomyia*, *Udaya*, *Ayurakitia*, *Heizmannia*, and *Topomyia*. Of the 183 indigenous species, 155 (85 per cent) are either definitely or probably endemic to the area; only 28 (15 per cent) are definitely not endemic.

The endemism in the South Pacific mosquito fauna is not confined to the specific level. There are 3 endemic genera (*Neodixa, Opifex, Maorigoeldia*), at least 1 endemic subgenus (*Levua* in *Aedes*), and at least 10 endemic species groups (*colocasiae* and *painei* in *Uranotaenia; atriceps* in *Culex* (*Culex*) and *femineus* in *Culex* (*Mochthogenes*); *tenuipalpis* in *Mansonia* (*Coquillettidia*); *subalbirostris* in *Aedes* (*Ochlerotatus*); *purpuratus* in *Tripteroides* (*T.*) and *floridensis* and *caledonicus* in *Tripteroides* (*Rachionotomyia*); and *novaezealandiae* in *Corethrella*). Some of these species groups are so strikingly marked that they may have to be raised to subgeneric rank; in addition there are numerous endemic species complexes or subgroups. A very striking feature of the South Pacific mosquito fauna is the great development of the subgenus *Lophoceraomyia* in *Culex* (23 forms) and the subgenera *Finlaya* (24 forms) and *Stegomyia* (20 forms) in *Aedes*. In the latter 2 subgenera the *kochi* group (17 forms) and the *scutellaris* group (17 forms) respectively are better represented than anywhere else in the world. In the number of forms, the mosquito fauna of the South Pacific is comparable to that of the Nearctic region but has a much greater representation of genera and tribes and a great deal more endemism.

The affinities of the individual species comprising the indigenous mosquito fauna of the South Pacific have been determined only by inference from a comparison of external characters of the adult and the immature stages (particularly larvae). Many difficulties have been encountered because of the relatively poor knowledge of the mosquito fauna of the Papuan, Australian, and Indomalayan areas, as well as other faunal areas, and the very inadequate knowledge of some groups, particularly the Dixinae and Chaoborinae. A comparison of the mosquito fauna of the South Pacific with that of the rest of the world is presented on charts of the analysis of the mosquito fauna (figs. 13-17). This comparison is carried down to the level of species groups, subgroups, and complexes whenever possible. The detailed information on the groups is presented in the systematic section while the charts show only the world distributions of the various taxa and the number of species represented in the various island groups or isolated islands of the South Pacific which possess endemic or probably endemic species. It can be seen from these charts that there are marked differences in the representation of the various groups both within the South Pacific area and in the rest of the world. The mosquito fauna of the South Pacific is not a uniform modern derivative of the Papuan or Australian fauna, as believed by some investigators, but consists of various elements, some of which are not represented at all in adjacent areas. Furthermore there is a very striking differentiation of the fauna within the South Pacific area itself. An analysis of the affinities of the South Pacific fauna on a numerical basis will not be attempted here; it would be misleading and would tend to obscure the complex nature of the fauna by emphasizing the most recent elements represented chiefly in the western part (Solomons). It is quite clear from the charts that much of the South Pacific mosquito fauna has a common element with the Papuan–N. Australian area and with the Indomalayan and Oriental areas. It is also evident that other affinities are with S. Australia–Tasmania and even with the Ethiopian, Malagasy, Palaearctic, Nearctic, and Patagonia–S. Chile areas. There is no indication whatever of affinities with the Neotropical area except on the tribal, generic, and subgeneric levels. An attempt to explain how this complex fauna was developed is made in the section on the history of the fauna.

The nonendemic indigenous element of 28 species is a complex one and presents several interesting features, particularly in regional differences: (1) 13 species occur only in the Solomons area (*Bironella hollandi, Anopheles punctulatus, A. koliensis, Uranotaenia lateralis, Culex* (*C.*) *squamosus, C.* (*Lutzia*) *halifaxii, C.* (*Culiciomyia*) *papuensis, C.* (*Cul.*) *fragilis, C.* (*Cul.*) *pullus, Aedes* (*E.*) *imprimens, A.* (*Aedim.*) *alboscutellatus, A.* (*L.*) *dasyorrhus,* and *A.* (*S.*) *albolineatus*); even this group is complex, some of the forms occurring elsewhere only in a part of the Papuan area, others extending to N. Australia, the Indomalayan area, and some even to the Oriental as can be seen on the charts. (2) The Papuan *Armigeres breinli* occurs only in the Solomons and the Santa Cruz groups. (3) Two Papuan and N. Australian species, *Anopheles farauti* and *Aedes* (*V.*) *lineatus,* occur in the Solomons, Santa Cruz, and New Hebrides groups. (4) *Aedeomyia catasticta,* which has been reported from the Oriental, Indomalayan, Papuan, and N. Australian areas, is known only from the Solomon Islands and Fiji. (5) The Australian *Culex* (*C.*) *starckeae* and *Mansonia* (*C.*) *xanthogaster* are known only from New Caledonia and the New

Hebrides. (6) Three species occur only on New Caledonia: *Culex* (*C.*) *bitaeniorhynchus* has been reported throughout the Old World tropics, *Aedes* (*M.*) *alternans* is known from the Papuan and Australian areas, and *Culex* (*C.*) *australicus* is South Australian. (7) *Aedes* (*F.*) *notoscriptus* occurs on New Caledonia and New Zealand; it is known elsewhere from the Papuan and Australian areas and is probably introduced to New Zealand and possibly in part to New Caledonia. (8) *Aedes* (*H.*) *australis* from S. Australia and Tasmania is known only from Lord Howe and Norfolk Islands. (9) Three species are widespread in the South Pacific: *Culex* (*C.*) *annulirostris* is known everywhere in the South Pacific except the New Zealand area and is widespread elsewhere from the Indomalayan to S. Australia–Tasmanian areas; *Culex* (*C.*) *sitiens* and *Aedes* (*O.*) *vigilax* are known everywhere in the South Pacific except the New Zealand area and Eastern Polynesia and are widespread in the Old World tropics. (10) *Aedes* (*Aedimorphus*) *nocturnus* is known from New Caledonia, New Hebrides, the Fiji-Tonga-Samoa area, and the western islands of Eastern Polynesia; the distribution of this form is very peculiar (figs. **295, 296**) and suggests that *nocturnus* has been spread at least in part by natives and perhaps was even introduced into the South Pacific area.

The differences in distribution of these nonendemic species suggest that they have dispersed into the area at different times and along different routes. It is possible that some of these species dispersed very long ago and have not differentiated locally because from time to time there have been interchanges between the various populations. The majority of these forms are apparently salt tolerant and may be able to cross relatively large ocean barriers or be transported by man. This does not appear to be true, however, for the majority of species restricted to the Solomons area.

The endemic element of 155 species (85 per cent) is the most interesting and significant one in the mosquito fauna of the South Pacific. The degree of endemism may appear surprising, but it is real and is likely to be even greater when the fauna is more thoroughly studied. As indicated above, the differentiation of the endemic elements varies from a generic to a specific level. About half the endemic forms are from the Solomons; many of these do not appear to be strongly differentiated from their congeners outside the area and may therefore be regarded as subspecies by some workers. However, since differences are evident usually in all stages in these forms and are quite constant, these forms are considered as full species. Although in general the most highly differentiated species are found on the southern and eastern periphery of the South Pacific area and the less differentiated to the west, there are strongly differentiated forms in the west in the Solomons as well as the New Hebrides.

There is marked regional endemism within the South Pacific area. This is not confined to island groups or areas but is evident also on individual isolated islands (figs. **6-17**) and even within islands of a group. The 155 species endemic to the area are distributed as follows: (1) the Solomons area (including Rennell and Bellona) with 81 exclusive endemic species; (2) the Fiji-Tonga-Samoa area with 23 exclusive endemic species; (3) the New Zealand area (including Lord Howe) with 20 exclusive endemic species; (4) the Santa Cruz–New Hebrides area with 15 exclusive endemic species; (5) the New Caledonia area with 9 exclusive endemic species; (6) Eastern Polynesia with 5 exclusive endemic species; (7) the remaining 2 species endemic to the area as a whole are shared as follows: *Uranotaenia barnesi* between the Solomons and the Santa Cruz–New Hebrides areas and *Tripteroides* (*Rachionotomyia*) *melanesiensis* between the New Caledonia and the Santa Cruz–New Hebrides areas. A number of species originally apparently endemic to one area or group seem to have been spread by natives outside the area; they are still considered endemic to the original area. This is true of *polynesiensis*, *hebrideus*, and *varuae* in the *scutellaris* group of *Aedes* (*Stegomyia*) and of *oceanicus* and *hollingsheadi* in the *kochi* group of *Aedes* (*Finlaya*).

The individual endemic species of the South Pacific cannot be considered in detail here; the reader is referred to the charts, to the discussion of the six faunal areas of the South Pacific, and to the systematic section. The majority, if not all, of the endemic species in the South Pacific seem to be more primitive than their apparent relatives in adjoining areas; some of them, especially in New Zealand, are either the most primitive or among the most primitive existing species of their respective phylads anywhere in the world. The determination of whether a species or a character exhibits a primitive or derived condition is most difficult and involves a strong subjective element of interpretation except when good fossil material is at hand. The very meager paleontological evidence available for mosquitoes (Edwards, 1923*b*; Statz, 1944) is of no help in this respect, but I believe that a careful comparison of all stages (particularly the larvae) of members of a mosquito phylad with each other and with related phylads usually shows the evolutionary trend in a group or character. For example, it seems clear that members of the *scutellaris* group (*pseudoscutellaris* subgroup) present in the Fiji-Tonga-Samoa area are more primitive than and cannot be derived from those which occur in the Solomons, since the larvae of the former have a complete anal saddle and a strongly developed ventral brush while the larvae of the latter have these reduced. The tendency toward reduction of both characters from the condition found in primitive ground pool-breeders is evident in other treehole-breeding groups of *Aedes* (*Stegomyia*) and in many other genera. However, adaptive specialization of some features is a common phenomenon in primitive forms; this fact introduces many complications. It seems quite clear, in spite of these difficulties, that none of the endemic species in the South Pacific can be derived from their nearest relatives to the west and that, within the South Pacific area itself, the most primitive species of a given phylad occur on the periphery of the area and these in turn cannot be derived from the living species nearer to the west. Therefore, the endemic element of the South Pacific mosquito fauna seems to be composed of relicts of various ages, the most ancient and primitive being found in New Zealand, Eastern Polynesia, and the Fiji-Tonga-Samoa areas but others being preserved as well in some of the areas farther west.

A very interesting and, I believe, significant feature of some of the endemic species or groups of the South Pacific is that their only known relatives are found, not in the adjoining areas, but in isolated localities in the Indomalayan, Oriental, Malagasy, Ethiopian, Palaearctic, Nearctic, and Patagonia–S. Chile regions. In some such instances, relatives are also found in the S. Australia–Tasmania area. It is possible, of course, that these affinities and distributions are not real and that future collecting will reveal the presence of these groups in intermediate areas. However, the present picture is that of the classical disjunct distribution of ancient relict groups in other animals and plants. Some of the groups which show this are (1) the Dixinae, with affinities in S. Australia–Tasmania and Patagonia–S. Chile; (2) the *colocasiae* section of *Uranotaenia*, with affinities in Borneo and the Malagasy and Ethiopian regions; (3) the *wysockii* section of *Uranotaenia*, with affinities in the Indomalayan and Oriental areas; (4) to some extent the *trifilatus* subgroup of *Culex* (*Culex*), with affinities chiefly in the Ethiopian and Palaearctic areas but also apparently with a relict species in the Papuan area; (5) the remarkable *atriceps* group of *Culex* (*Culex*), with affinities in the Ethiopian area; (6) the *pseudomelaconia* group of *Culex* (*Neoculex*), itself represented in Australia and Tasmania, with affinities in the Ethiopian and Palaearctic (Mediterranean) areas; (7) *tonnoiri* of the subgenus *Climacura* of *Culiseta*, which is known only in the S. Australia–Tasmania and Nearctic areas; and (8) many others as noted on the charts (figs. 13-17). Several of the groups in New Zealand have no known relatives anywhere in the world. Even in groups which are represented in the Papuan–N. Australian area, the South Pacific forms frequently show closer resemblance to forms in the Indomalayan area, as, for example, in the *kochi* group of *Aedes* (*Finlaya*) and some members of the *Anisocheleomyia* section of *Uranotaenia*.

REGIONAL DIFFERENTIATION

As indicated in the previous section, the mosquito fauna of the South Pacific shows strong regional differentiation both in endemic and nonendemic elements. Solely on the basis of similarities and differences in the faunal elements, I have subdivided the South Pacific into six faunal areas. After this subdivision was made, a remarkable correlation was found between the faunal areas (fig. 19) and the submarine features of the South Pacific (fig. 21). The possible significance of this correlation, and a tentative explanation of the faunal differentiation, are discussed below in the section on the history of the fauna.

The mosquito faunal areas of the South Pacific appear to be basically natural units but, on geographical grounds, they also include adjacent isolated islands without indigenous fauna; some of the latter probably do not belong in the areas to which they are appended but are considered here for convenience only. The faunal areas of the immense South Pacific differ from each other in various degrees as to environmental features; they are often complex and may show internal differentiation and local endemism. These features are discussed in some detail for each of the areas in separate sections on the following pages. The composition of the faunas and the distribution and affinities of the individual species are shown on charts for each area (figs. 6-12); all the faunas, subdivided to island groups or individual islands possessing endemic species, are compared on a series of charts (figs. 13-17) on the level of species groups or complexes or larger units when adequate data are not available. The last chart (fig. 17) presents a numerical summary of species represented in each of the island groups or isolated islands with endemic species. It will be noted that the total number of endemic species for the entire South Pacific (155) is greater than the sum of endemic species in the subdivisions (148). This is owing to the fact that 7 species endemic to the entire area are shared by the subdivisions: *Aedes* (*F.*) *albilabris, Aedes* (*S.*) *gurneyi*, and *Tripteroides* (*R.*) *solomonis* by the Solomons and Rennell-Bellona, *Uranotaenia barnesi* by the Solomons, Rennell-Bellona, and the New Hebrides, *Aedes* (*S.*) *hebrideus* by Rennell-Bellona, Santa Cruz, and New Hebrides, *Tripteroides* (*R.*) *melanesiensis* by Santa Cruz, New Hebrides, and New Caledonia, and *Mansonia* (*C.*) *fijiensis* by Fiji and Samoa.

NEW ZEALAND AREA

Figs. 6, 7, 19, 27

ENTIRE AREA.—The New Zealand area (figs. 19, 27) comprises (1) New Zealand proper (North, South, Stewart, and several smaller islands) together with the Chatham, Auckland, and Campbell Islands, which all lie within the same 1,000 meter submarine rise with New Zealand proper; (2) the isolated islands of Bounty and Antipodes, each on a separate restricted 1,000 meter rise, roughly between Chatham and Campbell Islands; (3) the isolated Kermadec group on the Kermadec submarine ridge between New Zealand and the Tonga Islands; (4) the Macquarie group of islands southwest of New Zealand, located on a separate submarine ridge connected to Antarctica; (5) the isolated Norfolk Island and a few adjoining islets on the submarine ridge between New Zealand and New Caledonia; and (6) the isolated Lord Howe Island and several nearby islets on the western edge of the submarine ridge between New Zealand and the Chesterfield group west of New Caledonia. This area makes up the bulk of the land area of the South Pacific, about 103,800 square miles or over 72 per cent, and contains the greater part of the population, over 2,300,000 or about 70 per cent, of which about 150,000 are Maoris (Polynesians) and the remainder largely Europeans.

Mosquitoes have been reported only from North and South Islands of New Zealand proper and from Auckland, Kermadec, Norfolk, and Lord Howe Islands. Only 23 species are definitely known at present and 2 of these are not named because of insufficient knowledge; in addition, several other species have been reported, probably erroneously, from New Zealand proper (see below). The very limited faunas of Norfolk and Lord Howe (1 endemic species) have 1 species in common with Australia and are very markedly different from the rest of the area, which has a unique, wholly endemic fauna (except for 2 introductions). The fauna of the New Zealand area as a whole has been summarized on charts (figs. 6, 7) together with that of New Caledonia to emphasize the great differences between the mosquito faunas of the two areas.

It is very unfortunate that the mosquito fauna of this most significant area is so poorly known. I have seen less material from this area than from any other; the material is poor and largely composed of females (figs. 1-5). The immature stages of native species are either totally unknown or very poorly known, and the associations with the adults are presumptive only since no individual rearings have been made for any species. Males of several species are also unknown.

The desirability of a thorough knowledge of the mosquito fauna of this area from the standpoint of composition, distribution, and detailed knowledge of the individual species cannot be overemphasized. Such information would be of paramount importance in interpreting the morphology and phylogeny of the Culicidae and their zoögeography, since even the fragmentary knowledge we now possess indicates that the majority of species inhabiting this area are the most primitive mosquito relicts found anywhere, comparable in interest and importance to *Sphenodon* among the vertebrates and probably, in at least some species, contemporary with it in isolation.

NEW ZEALAND PROPER.—New Zealand proper is too well known to require description here. The two main islands, North Island and South Island, comprise the bulk of the land of the entire New Zealand area and support almost its entire population. In general, the climate of New Zealand is temperate and markedly different from that of the tropical South Pacific, but it is very equable everywhere and is semitropical in the North Auckland Peninsula, which is within the mangrove belt. The winters in New Zealand are, on the whole, slightly warmer than those in Italy. Ground frost is frequent everywhere except in the subtropical part; the air temperature also falls below the freezing point on the low ground, frequently on South Island and sometimes on North Island, but seldom on its coast. The recorded absolute extremes of temperature and the mean annual days of ground frost at Auckland are 90°, 32° F. and 1 day, at Wellington 88°, 29° F. and 29 days, and at Christchurch 96°, 19° F. and 21 days. Annual rainfall varies from about 14 inches to over 200 inches (probably as high as 300). On South Island the rainfall is fairly evenly distributed throughout the year, but on North Island winter is the rainiest season. In the highlands of South Island extensive permanent snow fields lie above 7,000 feet and feed many large glaciers. Elsewhere on South Island a considerable amount of snow falls; it is not rare even on the coast where, however, it does not remain for more than one or two days. The highlands of North Island also have much snow in the winter, but there is only one small permanent snow field with a few short glaciers. Elsewhere on North Island snow is rare, and it is never found on the coast. The topography and hydrography of New Zealand are extremely varied; all types of ground water habitats are available for mosquitoes. The native vegetation is quite extensive and varied and includes species which should be suitable for plant-breeding mosquitoes; apparently no attempt has been made to study these. The two main islands are so large that the rather extensive exploitation, development, and cultivation and the introduction of numerous exotic plants and animals in all probability have not affected adversely the native mosquito fauna. As far as I can determine, no major attempts at mosquito control have been undertaken for extensive periods except in the vicinity of large cities, chiefly Auckland, and largely against domestic forms.

Our present knowledge of the mosquito fauna of New Zealand is extremely meager, the few surveys and studies having been limited chiefly to the conspicuous biting species present in the vicinity of the major centers of population. In spite of this, the known fauna (figs. **6, 7**) is of extreme interest since it is quite unique, almost wholly endemic, and quite harmonious. A total of 21 species is definitely known from New Zealand proper, but 1 of these is doubtfully distinct and is not named (*Culex* (*C.*) sp. 2). In addition 3 other species have been reported by Graham (1939:211, 213). *Anopheles maculipennis* was recorded on the basis of 2 live females taken at Auckland on ships from the East Indies. Since this species does not occur in the East Indies, it is possible that the specimens in question were some species of the subgenus *Anopheles* from Australia. I suspect, however, that they may have been *Culiseta tonnoiri,* which has superficially similar wing markings and occurs in Auckland although it was not recorded by Graham. The record of *Culex annulirostris* found breeding at Auckland in the hold of a ship from Suva, and subsequently in a barrel on the waterfront, is not beyond the realm of possibility, since this species may be dispersed elsewhere in the South Pacific in this manner; however, Graham's identifications of immature stages are not reliable and no further collections of *annulirostris* have been made. *Aedes vexans* (presumably *nocturnus*) was reported on the basis of a single collection of larvae "found in a tin of water jammed among rocks just above high tide at Russell" (North Auckland Peninsula). It is most unlikely that this was in fact *nocturnus* simply on the basis of habitat, but it is possible that the species in question is an unrecognized native or introduced *Aedes.* There is also a possibility that a native species of plant-breeding *Aedes* superficially similar to *notoscriptus* occurs in New Zealand (see *notoscriptus*). I have heard reports from New Zealanders that a small dark mosquito is a vicious biter in the North Auckland Peninsula; this description does not fit any known species.

Of the 21 known species of mosquitoes, 2 are definitely or probably introduced. The ubiquitous *Culex* (*C.*) *quinquefasciatus* is definitely introduced and is known only from the Auckland area. *Aedes* (*Finlaya*) *notoscriptus* also appears to have been introduced into New Zealand and is known definitely only from Auckland, Whangarei, and Nelson City. The remaining 19 species are considered here to be native and all are endemic to New Zealand proper except that *Opifex fuscus* and *Culex* (*C.*) *pervigilans* are apparently present in the Kermadec Islands (see below). It has been suggested in the past that *pervigilans* is an introduced form, identical with or derived from *torrentium* of Europe, which could have been introduced on sailing vessels (whaling) during the nineteenth century. This does not seem probable but the problem cannot be resolved without further study; for the present I consider this form to be indigenous to New Zealand.

The known native mosquito fauna of New Zealand proper is a well-balanced one. All 3 subfamilies are represented: the Dixinae by 2 tribes, 3 genera, and 8 species; the Culicinae by 5 tribes, 6 genera, and 9 species; and the Chaoborinae by 1 species. Only primitive groups are represented. In this connection it is of interest to note that the Anophelini, Uranotaeniini, and Toxorhynchitini, which are widespread groups usually regarded as among the most primitive Culicinae, have not been found in New Zealand. Numerous habitats are available in New Zealand for at least the Anophelini and the Uranotaeniini, and these habitats are widely and successfully utilized by the Paradixini. It is difficult to see, therefore, why the Anophelini and Uranotaeniini should not be in New Zealand unless (1) they are of more recent origin than the tribes represented in New Zealand, or (2) they were not present in the source area prior to the time of the isolation of New Zealand.

All the native species appear to be extremely primitive, usually the most primitive living forms of their respective phylads. Three monotypic genera (*Neodixa, Opifex,* and *Maorigoeldia*) are endemic and in addition at least *Mansonia* (*C.*) *tenuipalpis* may require separation into another endemic monotypic genus. All the other species are very clearly marked and all belong to different groups except some of the Dixinae and possibly the 2 *Culex*. There is very little evidence of geographical differentiation except again in the Dixinae, but these are very poorly known.

Including Auckland and Kermadec islands, the New Zealand subarea has a unique native mosquito fauna which is entirely endemic and consists of relict species without any living relatives or with distant relatives widely scattered through the world as indicated in the charts (figs. **6**, **7**, **13-17**). There is no similarity at all with the rest of the South Pacific except for a distinct species in the *trifilatus* subgroup of *Culex* (represented by 1 species each in the New Caledonia and the Santa Cruz–New Hebrides area) and an even more distinct species in the *vigilax* section of *Aedes* (represented by 1 species in Eastern Polynesia and by another in the rest of the South Pacific). The strongest general affinities of the New Zealand fauna appear to be with the South Australian–Tasmanian area (*Nothodixa, Paradixa, Climacura, Mansonia iracunda* group) and to a lesser extent with the Patagonian–South Chile (*Nothodixa*), Nearctic (*Climacura*), Palaearctic, Ethiopian, and Papuan (*trifilatus* subgroup). However, most of these affinities are very distant and include only a part of the fauna. Outside the *Culex* (*C.*) *trifilatus* subgroup, the only close affinity appears to be in the *Mansonia iracunda* group, where *iracunda* of New Zealand seems to be in general similar to *linealis* of Australia. The general resemblance of the larva of *Opifex* to *Aedes* (*Halaedes*) *australis* of Australia, Tasmania, Lord Howe, and Norfolk seems to be superficial only and owing to convergence concomitant to the utilization of a similar habitat, but the two forms may be very distantly related.

It is inconceivable that such a well-balanced mosquito fauna as that of New Zealand has developed as a result of chance dispersal of a few species capable of crossing extensive ocean barriers, since included in the fauna are groups such as the Dixinae, Corethrellini, and Sabethini, which do not seem to be salt tolerant and are apparently incapable of crossing any extensive ocean barrier. The mosquito fauna of New Zealand has all the characteristics of a very ancient continental fauna that has been isolated from the rest of the world for a very long time. Whether complete or incomplete connections with larger continental sources have existed more than once and with one or more areas cannot be determined with our present knowledge of mosquitoes of New Zealand and other critical areas, such as South Australia, Tasmania, and Patagonia.

References: Marks (1958); Miller and Phillipps (1952); Miller (1950:42–46; 1920, 1922); Graham (1929, 1939); Kirk (1923).

AUCKLAND ISLANDS.—The Auckland Islands, one of the groups of the so-called subantarctic islands, lie in an isolated position on the New Zealand *vigilax* complex, which is represented by the typical species westward from Fiji. My impression is that both *roseni* and *edgari* are relict forms whose ancestors reached Eastern Polynesia when more extensive land areas were present in both the Fiji-Tonga-Samoa area and in Eastern Polynesia. Neither species requires continuous or even closely spaced land for dispersal; *roseni* is salt tolerant and the *vigilax* complex is suspected of having a long flight range and may be dispersed also in the egg stage.

Much more puzzling is the presence in the Society Islands and the Marquesas of 3 members of the endemic *atriceps* group of *Culex* (*Culex*), which has no known relatives in the South Pacific and adjacent lands and which, superficially at least, resembles most closely some of the members of the *decens* series of Africa. These species, *atriceps, kesseli,* and *marquesensis,* are predominantly breeders in plants and plant parts, do not tolerate salt, and appear to have a short flight range. Therefore it would seem that they could not have reached their present isolated position except at a time when much larger and nearly continuous land masses existed to the west, unless, of course, their bionomics have changed subsequent to their establishment in Eastern Polynesia. To derive them directly from any of the known existing stocks in the South Pacific and nearby islands does not seem possible. They might be considered, therefore, to represent a separate, primitive stock which has become extinct elsewhere; this view is supported to some extent by their annectent features, which suggest the subgenus *Culiciomyia* and even some of the stocks of the subgenus *Culex* in the New World. A hint as to another possible explanation of their nature and origin is found in *marquesensis,* which seems to combine some of the features of *roseni* and *atriceps.* The whole group may have originated through hybridization of very ancient stocks of the *pipiens* and *sitiens* groups in the South Pacific, and their general superficial resemblance to the *decens* series may be therefore entirely fortuitous, although the *decens* series itself may have arisen in a similar fashion through hybridization of two different stocks of the same groups in Africa. Whatever actually occurred, it is clear that more extensive lands and closer connections probably existed in the past between Eastern Polynesia and the continental border area.

Additions to the mosquito fauna of Eastern Polynesia can be expected when the volcanic islands of the area are more thoroughly explored, particularly in the interior. None of the atolls or coral islands of the area have shown anything but introduced species so far, and it seems unlikely that any of them have a native fauna, although it is possible that species such as *roseni, annulirostris,* and *nocturnus* may occupy these islands naturally.

SOCIETY ISLANDS.—The Society Islands (figs. **22, 26**) are the best known of the islands of Eastern Polynesia. They comprise 9 volcanic islands and 5 atolls more or less distinctly segregated into 3 groups. The total land area is about 593 square miles, of which 402 are on Tahiti; the population is estimated at about 60,000 (about 40,000 on Tahiti). The volcanic islands are in general high and rugged in the center (maximum elevation 7,321 feet on Tahiti), but more or less extensive low flat areas are found along the coasts and sometimes in the larger river valleys. The climate is hot and damp at all times, with an average maximum day temperature of about 85° F., but there is a pronounced cooler season (southern winter) when the night temperature falls to 70° or 60° F. Rainfall is considerable and the islands are well watered. The vegetation on the volcanic islands is luxuriant and varied and the native flora has not been markedly altered in the interior.

The known mosquito fauna (fig. **7**) consists of 8 species; of the total of 10 reported from the entire Eastern Polynesia, only *Culex* (*C.*) *marquesensis* and *Aedes* (*Aedimorphus*) *nocturnus* are absent. Two species are recent introductions, *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti; Aedes* (*S.*) *polynesiensis* was probably spread into the area by the Polynesians; *Culex* (*C.*) *annulirostris* is considered to have been introduced but may be native. The remaining 4 species, *Culex* (*C.*) *atriceps, C.* (*C.*) *kesseli, C.* (*C.*) *roseni,* and *Aedes* (*Ochlerotatus*) *edgari,* are endemic and are discussed above under treatment of the entire area. Further collections may reveal additional species, especially in plant container habitats and rockholes.

References: Rageau (1958*a*:877–878); Iyengar (1955:47); Beye, Edgar, *et al.* (1952); Marks (1951*a*); Buxton (1927); Cheesman (1927); Edwards (1927:240–241).

MARQUESAS.—The Marquesas (figs. **22, 26**) consist of 10 islands and a few islets arranged in 3 more or less distinct groups on a long axis of over

200 miles from the northwest to the southeast. These beautiful islands of volcanic origin are isolated and very poorly known; their total land area has been estimated at 408 to 491 square miles; 2 of the islands (Nukuhiva and Hivao) appear to be over 125 square miles in area but the others are a third or less in size. The islands are rugged and complex in structure, with raised terraces, deep drowned valleys, and considerable faulting. The maximum elevations vary between 1,000 and more than 4,000 feet. The coastlines are rocky, very rugged, and with great lines of cliffs sometimes more than 1,000 feet in height; however, there are more or less extensive bays at the mouths of the larger rivers. Some of the interior valleys are extensive, with very flat floors. The group appears to have had a long and complex geological history. The mean annual temperature at sea level is about 78–79° F. and the mean annual range about 4° F. There is great variation in and very uneven distribution of rainfall; in wet years it may be over 100 inches, in dry much less than 40; monthly rains of over 20 inches have been recorded. The streams, even in the large valleys, are insignificant except after heavy rains and in their upper reaches; many of them are intermittent or completely dry in the lower reaches during periods of drought. There are no lakes and apparently no permanent pools of standing water but there are marshy areas in parts of Nukuhiva. The vegetation is varied and more or less distinctly zoned with altitude and rainfall; there are a number of drought-resistant species. The native flora has been markedly affected by the introduction of cultigens both by the Polynesians and the Europeans. It is estimated that at the beginning of the nineteenth century the native Polynesian population may have exceeded 50,000; it was still about 20,000 in 1842. Such a large population must have altered the original environment very significantly, at least in the valleys and at lower elevations. Tragic exploitation of the natives during the middle of the nineteenth century, the most sordid story in the history of the South Pacific, resulted in the reduction of their numbers to a few thousand (in 1923 there were only about 2,000 native inhabitants). The present population is estimated at about 4,000.

The known mosquito fauna of the Marquesas consists of *Culex* (*C.*) *quinquefasciatus*, undoubtedly introduced by Europeans; *Aedes* (*S.*) *polynesiensis*, introduced by the Polynesians; and the remarkable endemic *Culex* (*C.*) *marquesensis*, discovered by Rosen in 1952. An extensive survey of the Marquesas may reveal additional endemic species.

References: Rageau (1958*a*:877–878); Iyengar (1955:47); Marks (1951*a*); Mumford and Adamson (1933); Edwards (1933, 1927:240–241).

SOUTHERN LINE ISLANDS.—The Southern Line Islands (figs. 22, 26) consist of 6 small low coral islands and a reef scattered over a wide area north of the Northern Cook Islands and the Society Islands. The total land area is estimated at about 26 square miles. The majority of the islands have been worked for phosphate in the past. The rainfall is relatively low and the vegetation is of the strand type; there is little or no exposed fresh or brackish water. There are small coconut plantations on Flint and Caroline Islands, which are reported to be worked by about 250 Gilbertese. No mosquitoes have been reported from these islands.

NORTHERN COOK ISLANDS.—The Northern Cook Islands (figs. 22, 25) are composed of 4 widely separated groups of coral atolls north of and between Samoa and the Society Islands. Palmerston atoll is considered with the Southern Cook Islands below. The total land area for all the groups is about 10.5 square miles and the population about 2,500 Polynesians. Fresh water is apparently abundant on several of the islands, the vegetation is dense, and extensive taro gardens are cultivated in marshy areas. I have seen only 2 species of mosquitoes from the Northern Cook Islands. *Aedes* (*Aedimorphus*) *nocturnus* has been collected on Motukatava (Pukapuka or Danger atoll) and Nassau (BISHOP); this species was probably spread by natives with taro. *Aedes* (*Stegomyia*) *polynesiensis* has been collected on Pukapuka, Motukatava, and Motuko (all in the Pukapuka or Danger atoll) and was undoubtedly spread by natives (BISHOP, UCLA). No mosquitoes are known from the other 3 isolated groups in the Northern Cook Islands, but Buxton and Hopkins (1927:85) venture a guess that the mosquitoes reported by Gill (1885) as having been introduced in ships' casks from Rarotonga to Rakahanga and Tongareva (Penrhyn) in 1859 and to Maniki (Manihiki) in 1862 were *Culex* (*C.*) *quinquefasciatus*.

SOUTHERN COOK ISLANDS.—The Southern or Lower Cook Islands are "The" Cook Islands, the best known islands of Eastern Polynesia next to the Society Islands; for our purposes Palmerston

Island is also included in the group. The Cook Islands lie between Niue Island (east of Tonga) and the Society Islands (figs. **22**, **25**). The total land area is about 79.5 square miles and the population about 15,500, largely Polynesian. These islands are primarily volcanic or with a volcanic core surrounded by an ancient elevated coral reef. Rarotonga, the largest of the islands, is very rugged and has a maximum elevation of 2,110 feet; the other principal islands are less than 600 feet in elevation; the smaller islands are of coral formation. The climate is tropical but there is a difference of about 8° F. between the summer and winter average temperatures; rainfall is moderate and fairly evenly distributed. The vegetation is quite varied on Rarotonga, shows general similarities with Tonga and Tahiti, and includes several endemic species. There appear to be suitable breeding sites for mosquitoes, especially on the low volcanic islands where water collects between the central volcanic core and the coral coast. The known mosquito fauna of the Cook Islands consists of 5 species, one of these not definitely identified. The ubiquitous *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* were undoubtedly introduced by Europeans. *Aedes* (*S.*) *polynesiensis* was probably spread by the natives. *Culex* (*C.*) *annulirostris* is also probably introduced. The fifth species is an *Aedes* mentioned by McKenzie (1925:141) and may well be *nocturnus* as suggested by Buxton and Hopkins (1927:91), but it is possible that it is *vigilax* or even an undescribed endemic species.

References: Iyengar (1955:47); Laird (1954*b*:423–427); Marks (1951*a*); Edwards (1927:240–241); McKenzie (1925:141).

AUSTRAL (TUBUAI) ISLANDS.—The Austral Islands (figs. **22**, **26**) lie south of the Society Islands and east of and more or less in line with the Southern Cook Islands. They consist of 3 high volcanic islands (Rurutu, Tubuai, Raivavae) with maximum elevations of over 1,300 feet; Rimatara, a low volcanic island (elev. 315 ft.); Maria, a coral atoll; and the Thiers reef. The total land area is estimated at about 49 square miles and the population at about 3,750 Polynesians. The climate is warm but the seasons are well marked; rainfall is moderate to heavy. The volcanic islands are well watered and habitats appear to be available for mosquito breeding. Mosquito collections have been made on all the volcanic islands of the group (BISHOP). Marks (1951*a*:126) identified *Culex* (*C.*) *annulirostris* and *Aedes* (*S.*) *polynesiensis*, both of which were probably spread by natives. Iyengar (**1955:47**) records *Aedes* (*S.*) *aegypti*, and I have seen specimens of *Culex* (*C.*) *quinquefasciatus;* both of these are undoubtedly European introductions.

References: Iyengar (1955:47); Marks (1951*a*:126).

RAPA ISLAND.—Rapa Island (figs. **22**, **26**) is sometimes considered with the Austral Islands, but, being well out of the tropics, it is markedly different from these islands in climate and vegetation. In addition to Rapa Island proper, there are in the same general area to the east the rocky islets of Bass (Marotiri) and to the west the Lancaster reefs. The land area is estimated at about 14 square miles; no reliable information is available on the population, but it is apparently in the neighborhood of 280–300 Polynesians. Rapa is a rugged volcanic island with a maximum elevation of 2,077 feet. It is well watered and has considerable marshy ground. It has a temperate, moist climate with frequent rains and fogs and occasional gales and hurricanes. The temperature seldom rises above 75° F. or falls below 59° F. A considerable amount of native vegetation is still preserved in inaccessible areas in spite of depredations caused by introduced goats and by cultivation. Only *Culex* (*C.*) *quinquefasciatus*, introduced by Europeans, and *Culex* (*C.*) *annulirostris*, probably introduced by natives, have been reported from Rapa Island (BISHOP).

Reference: Marks (1951*a*).

TUAMOTU ARCHIPELAGO.—The Tuamotu Archipelago (figs. **22**, **26**) is considered here in the broad sense to include all the islands on the Tuamotu submarine rise as well as several adjacent more or less isolated island groups. The total land area is said to be 330 square miles but may be much less. The more or less permanent population of the entire group is about 8,250, chiefly Polynesians. The majority of the 80 island groups or separate islands are coral atolls or low coral islands with little or no exposed fresh or brackish water and with only strand vegetation and cultigens. These islands are seldom more than 30 feet high. The two exceptions are Makatea Island and the Mangareva (Gambier) group. Makatea is an isolated elevated coral island with a general elevation of 190–220 feet and a maximum elevation of 372 feet; it has been extensively exploited for its phosphate deposits. The Mangareva group consists of several small high volcanic islands and several islets enclosed in a coral lagoon; this

group has been formed from residual parts of the walls of extinct craters; there is little water on the islands and only a few seepages in which taro is grown; the native vegetation is very scanty. Only 4 species of mosquitoes have been reported from the entire Tuamotu Archipelago, all introduced: *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* by Europeans, and *Culex* (*C.*) *annulirostris* and *Aedes* (*S.*) *polynesiensis* by the Polynesians.
References: Rageau (1958*a*); Iyengar (1955:47); Marks (1951*a*); Edwards (1927:240–241).

PITCAIRN GROUP.—The Pitcairn group consists of 4 isolated islands (Oeno, Pitcairn, Henderson, and Ducie) extending eastward from the Tuamotu Archipelago (figs. **22, 26**). The total land area is about 15 square miles and the population is estimated to be 140. Pitcairn itself is of volcanic origin and reaches an elevation of about 1,100 feet; the other islands are of coral origin and either low atolls (Oeno, Ducie) or elevated to about 100 feet (Henderson). The climate of Pitcairn is in general similar to that of Easter Island but somewhat warmer (mean of 82° F. in summer, 65° F. in winter); the rainfall is moderate but there are no streams on the island and only one spring. The greater part of Pitcairn is said to be thickly covered with luxuriant evergreen vegetation in protected areas and with only grass and shrubs on the steeper slopes. Many cultigens have been introduced. Only 3 species of mosquitoes have been reported from Pitcairn, the ubiquitous *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* introduced by Europeans, and *Aedes* (*S.*) *polynesiensis.* The latter was reported by Theobald (1907:179; as *scutellaris*) but has not been subsequently recorded.
References: Iyengar (1955:47); Marks (1951*a*).

EASTER ISLAND AND SALA Y GOMEZ.—Easter Island and Sala y Gomez, both dependencies of Chile, are located on separate rises of the southeastern Pacific submarine plateau. Together they are the most isolated islands of the South Pacific area (figs. **22, 26**). Sala y Gomez lies about 205 miles east of Easter Island and is a barren, uninhabited volcanic rock. Easter Island, one of the most famous of the islands of the South Pacific, is the most easterly island occupied by Polynesians. Its area is variously estimated from 50 to 64 square miles. It is of volcanic origin and triangular in shape, with the 3 largest extinct volcanoes forming the angles; the area between them is composed of rolling lava flows and numerous smaller volcanic cones. The climate is subtropical and equable but the nights are cool; the range of mean monthly temperatures is from 73° F. to 62° F. Rainfall is moderate (about 54 inches a year) but variable, with occasional droughts as well as long periods of heavy rain. The volcanic soil is very porous, and there is only one short stream, which disappears underground in the sides of the highest peak (1,700 ft.); however, there are several sizable crater lakes with fresh water. The vegetation is very scanty and consists chiefly of grasses. The population is estimated at about 650–700, the majority of mixed Polynesian ancestry. The only mosquito reported from Easter Island is *Culex* (*C.*) *quinquefasciatus,* undoubtedly introduced by Europeans (BMNH; Edwards, 1927:241).

NEW CALEDONIA AREA

Figs. **6, 7, 19, 23, 24**

ENTIRE AREA.—The New Caledonia area (figs. **19, 23, 24**) consists of three subareas: (1) the Chesterfield group located on the Bellona Plateau at the north end of the Lord Howe submarine rise and separated from the remainder of the area by the Norfolk Island trough; (2) the New Caledonia group along the northwest border of the Norfolk Island ridge, including within the same 1,000 meter isobath the Huon Islands, the Belep Islands, New Caledonia proper, and Ile des Pins; and (3) the Loyalty group along the northeast border of the Norfolk Island ridge, consisting of the Loyalty Islands and Walpole Island on several separate 1,000 meter submarine rises. The area is separated to the east from the New Hebrides by the New Hebrides trench, with a maximum recorded depth of 7,660 meters. The total land in the New Caledonia area is estimated at about 7,100 square miles and its population at about 73,000 but these estimates are very rough as no reliable figures are available at present. The native population of about 37,000 is largely of Melanesian stock, but there appears to be some admixture of Polynesian stock in some of the Loyalty Islands. The European and other recent adventive population is about 36,000; it is concentrated chiefly in Noumea, the principal city, and several smaller towns on New Caledonia proper. The climate is in general similar throughout the area. Mean temperatures at Noumea vary during the year from about 80° F. to 69° F., with absolute recorded maxima of about 96° F. and 54° F. Rainfall is extremely variable in different areas, at different times of the year, and from year to year; periods of drought and downpours are not uncommon. Average annual rainfall in the Loyalties is from 54 to 65 inches, on the east coast of New Caledonia 78 to 133 inches, and on the west coast of New Caledonia 34 to 47 inches.

The mosquito fauna of the New Caledonia area is apparently very poorly known as no systematic survey has ever been made; the majority of records are based on collections made around Noumea and a few other accessible areas on New Caledonia during World War II. At present records are available only from Art and Pott Islands (Belep Islands), New Caledonia proper and the adjacent Baaba Island, Ile des Pins, and Ouvea, Lifu, Tiga, and Mare Islands in the Loyalties. Only 23 forms are known (figs. **6**, **7**), and all of these except *Culex* (*Lophoceraomyia*) sp. 14 (Art Island) have been recorded from New Caledonia proper. Three of the forms are unnamed because of insufficient knowledge and several additional species are poorly known in one or more stages (figs. **1**, **2**, **4**). I have seen individual rearings only for *Tripteroides* (*R.*) *caledonicus;* for the remainder of the forms, the associations of the immature stages and the males and females are presumptive only; therefore, the identity of some of the forms is questionable.

The known mosquito fauna is not a well-balanced one, nor is it as distinctive as the flora or the fauna in other groups of animals. Both these features are undoubtedly owing, in part at least, to the soil and climatic characteristics of the area (see New Caledonia proper). However, the mosquito fauna may present a very different picture when it is better known; therefore the present attempt at its analysis is very crude and possibly misleading. The subfamilies Dixinae and Chaoborinae are unknown in New Caledonia; the subfamily Culicinae is represented by 4 tribes only, each by a single genus, and only *Culex* and *Aedes* have more than 1 subgenus (3) represented by native forms.

Of the 23 known forms (figs. **6**, **7**) 3 are definitely introduced; *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* are undoubtedly European introductions; a species of the *atripes* group of *Tripteroides* (*Rachionotomyia*) is known from a single wartime collection and is tentatively identified here as *solomonis* from the Solomons, although it could be *atripes* from Australia. The remaining 20 forms appear to be at least in part indigenous, but it is possible that *Aedes* (*F.*) *notoscriptus* is an introduction. The degree of endemism is not outstanding; only 9 of the 20 indigenous or probably indigenous forms appear to be endemic (45 per cent).

The affinities of the indigenous mosquito fauna are almost entirely with Australia. The only affinity with New Zealand is in the *trifilatus* subgroup of *Culex* (*Culex*), which is also represented in the New Hebrides. To emphasize the contrast between the mosquito faunas of New Caledonia and New Zealand, the two areas are considered on the same charts (figs. **6**, **7**). Of the 11 nonendemic indigenous species, 9 are found in Australia: *Culex* (*C.*) *australicus, C.* (*C.*) *bitaeniorhynchus, Aedes* (*F.*) *notoscriptus,* and *A.* (*M.*) *alternans* are not found naturally elsewhere in the South Pacific; *Culex* (*C.*) *starckeae* and *Mansonia* (*C.*) *xanthogaster* are also found in the New Hebrides; and *Culex* (*C.*) *sitiens, C.* (*C.*) *annulirostris,* and *Aedes* (*O.*) *vigilax* are widespread. The 2 nonendemic indigenous species not represented in Australia are *Tripteroides* (*R.*) *melanesiensis,* which is shared with the Santa Cruz–New Hebrides area but belongs to the *caledonicus* group that is related to *tasmaniensis* of South Australia and Tasmania, and *Aedes* (*Aedimorphus*) *nocturnus,* which is shared with the Santa Cruz–New Hebrides, the Fiji-Tonga-Samoa areas, and Eastern Polynesia. Of the 9 endemic species, 6 show exclusively Australian affinities—*Culex* (*C.*) sp. 8, all 4 species of *Culex* (*Neoculex*), and *Aedes* (*O.*) sp. 6; *Tripteroides* (*R.*) *caledonicus* has close relatives in the Santa Cruz–New Hebrides area and Rotuma Island and belongs to a group which is related to *tasmaniensis* of South Australia and Tasmania; *Culex* (*L.*) sp. 14 is apparently closely related to forms in the Santa Cruz–New Hebrides and the Solomons area and distantly related to an Australian form; and *Culex* (*C.*) *iyengari,* as noted above, belongs to the *trifilatus* subgroup which is represented by 1 species each in New Zealand and the New Hebrides.

As currently known, the mosquito fauna of the New Caledonia area is clearly marked from that of the rest of the South Pacific, and is a very puzzling one. There is relatively little endemism (45 per cent) and the endemic species are not especially strongly differentiated. It gives the impression of a relatively young fauna because of the presence of a large number of nonendemic indigenous species in common with Australia. This nonendemic Australian element is so conspicuous probably because it is the dominant one on the western coastal area of the main island where the majority of the collections have been made. Even this element may be older than one would suspect at first, since all the species appear to be primitive ones, with the possible exception of *Culex* (*C.*) *annulirostris* and *Aedes* (*F.*) *notoscriptus*. This fauna could have survived without differentiation on a relatively large and stable land mass such as New Caledonia. The known endemic element is probably, at least in part, a relict of an earlier fauna and shows a great deal of affinity with the South Australian–Tasmanian fauna and only in the instance of *Culex* (*C.*) *iyengari* with the New Zealand fauna. At the present time the majority of the New Caledonia mosquito fauna consists of general ground pool-breeding species, but there is an indication that specialized ground habitats such as rockholes, as well as plant habitats, are more apt to be utilized by endemic forms. More attention should therefore be devoted to surveying these carefully.

References: Rageau (1958*b*); Iyengar (1955:44); Laird (1954*a*); Perry (1950*a*); Williams (1943); Edwards (1922*a*:99–101).

NEW CALEDONIA PROPER.—New Caledonia proper consists of the main island of New Caledonia or La Grande Terre and numerous small coastal islands. The main island is the largest island in the South Pacific next to North and South Islands of New Zealand and has an area of about 6,223 square miles and a population of about 58,000. The island of New Caledonia is almost entirely composed of metamorphic (including a great deal of serpentines) and sedimentary rocks; there is no lava or volcanic ash anywhere on the island and only a narrow short belt of emerged coral on the south coast. The greater part of the island is less than 1,000 feet in elevation, but there are rugged broken mountain ranges through most of the length of the island with two peaks approaching 5,400 feet. There is a very extensive network of rivers and streams which provide rapid drainage and may rise very quickly in the rainy season. In the serpentine country, in the south, the streams characteristically run underground for considerable distances during the dry season and there are several small lakes in the southeast corner of the island. On the west side of the island there are considerable areas of coastal lowland under 200 feet in elevation and rather extensive marshy ground in the larger river valleys. The flora of New Caledonia is quite rich in species and has a very high degree of endemism. It is markedly different from that of other large tropical South Pacific islands in that it consists very largely of drought-resistant plants; this is partially explained by variable rainfall and the poor moisture-retaining capacity of the shallow stony soils. Both these features are also undoubtedly very important in determining the composition of the mosquito fauna of New Caledonia.

All the mosquitoes known from the New Caledonia area have been reported from New Caledonia proper except *Culex* (*Lophoceraomyia*) sp. 14. The composition and the affinities of the fauna are discussed above under the entire area.

BELEP ISLANDS.—The Belep group lies about 30 miles northwest of the main island of New Caledonia and consists of two principal islands, Art and Pott, and several islets. These islands are essentially a continuation of the mountain core of New Caledonia. Art is the largest island in the group and has a maximum elevation of about 827 feet. Six species of mosquitoes (figs. **6**, **7**) have been reported from Art Island, as shown on the charts, and one of these (*vigilax*) from Pott Island. All these except *Culex* (*Lophoceraomyia*) sp. 14 are also known from the main island of New Caledonia. The latter is of considerable interest since it belongs to the *buxtoni* complex which is represented in the New Hebrides and the Solomons.

ILE DES PINS.—Ile des Pins (Kounie or Isle of Pines), together with the much smaller Koutomo Island and several islets, lies about 30 miles southeast of the main island of New Caledonia. The total land area of the group is about 58 square miles and the native population about 800. The islands are part of the same geological system as New Caledonia proper. The main island consists of a serpentine core surrounded by elevated coral limestone. The maximum elevation is 873 feet. Only 5 species of mosquitoes have been reported from the Ile des Pins, but 3 of these are of considerable interest. *Culex* (*C.*) *iyengari* is a species endemic to the New Caledonia area, and *Aedes* (*F.*) *notoscriptus* and *Tripteroides* (*R.*) *melanesiensis* are originally tree-hole-breeders.

LOYALTY ISLANDS.—The Loyalty Islands lie about 60–65 miles east of New Caledonia in a chain parallel to the long axis of the main island. The southernmost island of the New Hebrides, Aneituym, is only about 130 miles east of the closest island of the Loyalty group but is separated from it by the New Hebrides trench. The total land area is estimated at about 800 square miles and the population at about 14,000 Melanesians with some admixture of Polynesian features. The group consists of three large islands and a number of small islands and rocks. The large islands are composed primarily of elevated coral, but a few volcanic rocks have been reported from Mare. The elevation of the islands becomes progressively greater southward: Ouvea has a maximum elevation of about 100 feet, Lifu about 250 feet, and Mare about 320 feet.

The mosquito fauna of the group (figs. **6**, **7**) has not been extensively studied but presents considerable interest since it shows no endemic species, appears to be entirely derived from that of New Caledonia proper, and includes treehole-breeders. Only 11 species have been reported, 9 from Ouvea, 6 from Lifu and Mare as shown on the charts, and only *Aedes* (*F.*) *notoscriptus* from Tiga.

OTHER ISLANDS.—The outlying islands of the New Caledonia area have not been surveyed for mosquitoes, and it is not likely that they will reveal anything of interest when they are studied. The Chesterfield group consists of about eleven low-lying coral islets situated on the very extensive Bellona submarine plateau; the islands are small and their total area is about 250 acres; there is no indigenous population, but the islands are said to be very rich in phosphate and apparently have been exploited to some extent. The Huon Islands are also low-lying coral islets with phosphate deposits; they comprise four islets among the D'Entrecasteaux reefs northwest of New Caledonia with a total area of about 160 acres. Walpole Island is an isolated island of about 310 acres situated southeast of the Loyalty group; it is composed of elevated (about 230 feet) coral limestone impregnated and covered with phosphate deposits; it has been extensively exploited for phosphate and apparently there is little left of its native biota.

SANTA CRUZ–NEW HEBRIDES AREA

Figs. **8**, **19**, **24**

ENTIRE AREA.—The Santa Cruz–New Hebrides area (figs. **19**, **24**) consists of (1) the Santa Cruz, Reef, Duff, Torres, Banks, and New Hebrides (North and South) island groups, all located on the New Hebrides submarine ridge but separated from each other by depths of over 1,000 meters; (2) the outlying island groups of Tikopia, Anuda, and Fataka, to the east along the broken Melanesian border plateau; and (3) Matthew and Hunter Islands to the south along the Hunter Island submarine ridge. To the west the New Hebrides ridge is separated from the Solomons ridge by the Torres trench, with a maximum depth of 6,061 meters, and from the New Caledonia area by the New Hebrides trench, with a maximum depth of 7,660 meters; to the east it is separated from the Fiji area by the North Fiji Basin, with maximum depths of 4,963 and 5,084 meters. There is a narrow connection of a depth of less than 3,000 meters to the south with the New Caledonia area and a suggestion of a connection to the Rennell ridge on the west and of another to the Fiji area on the east through the broken Hunter Island ridge. The area is unstable, with volcanic activity and earthquakes recorded within recent times in the majority of the island groups and several active volcanoes. The islands are primarily volcanic or volcanic with considerable sedimentary rock and raised coral, but some islands are entirely of coral. The area as a whole is very poorly known and even for the land area and the population only rough estimates are available. The total land surface is about 6,000 square miles and the population about 68,000, of whom about 64,000 are natives, predominantly Melanesians but with about 9,000 Polynesians and mixed racial stocks.

The climate is tropical but not as hot as in the Solomons except in the more northern islands. On Espiritu Santo the mean temperature is about 81° F. during the hot months and about 77° F. during the cooler months. Rainfall is varied but always high, with reported annual means of about 75 inches in the south and 150 inches in the north; rainfall is considerable throughout the year but is least from June to October. The larger islands are well watered, have numerous fertile valleys, and are densely covered with luxuriant tropical vegetation from the shoreline to the highest peaks and only rarely have small grassy patches.

The known mosquito fauna of the entire area is not large, but it is a very interesting one and there are indications that many additions will be made to it with more collecting on the isolated islands, particularly in the northern part. At present most of the records are from the islands of Santo (Espiritu Santo) and Efate and the small islands adjacent to them which were rather extensively collected during the wartime years. Elsewhere in the New Hebrides only a few scattered collections have been made, and the mosquito faunas of the Banks, Torres, and Santa Cruz groups are still practically unknown. Fortunately a good percentage of the known species are represented by all stages and individual rearings are available for the majority of them.

At the present time 28 forms (fig. 8) are definitely known from the entire area, and there is a doubtful record of *Culex* (*C.*) *australicus* (Rageau and Vervent, 1958:20). Three of the recorded forms are not named because of insufficient knowledge. Two species are definitely European introductions: the ubiquitous *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti*. The remaining 26 species are apparently all indigenous, and of these 15 (58 per cent) appear to be endemic to the area as a whole, although 2 of them have been spread by natives into the outlying islands of the Solomons area.

The known indigenous mosquito fauna of the Santa Cruz–New Hebrides area is not as a whole a well-balanced one but it is highly complex, showing affinities with several other South Pacific areas as well as regional differentiation and local endemism. The subfamilies Dixinae and Chaoborinae have not been reported, but the Culicinae are represented by 6 tribes, one of them (Aedini) by 2 genera, 3 of the genera being represented by 2 or more subgenera and 2 of the subgenera by 2 or more species groups. This assemblage of forms does not appear to have been produced through random chance dispersal from adjacent source areas as they exist now, but rather seems to have been accomplished by dispersal along definite routes in the past; in several species migration could not have been accomplished across extensive expanses of sea. However, the apparent absence of the *kochi* group of *Aedes* (*Finlaya*), which is present in the Fiji-Tonga-Samoa group as well as the Solomons, suggests that effective sea barriers have existed sometime in the past in this area. This area appears to have been at the crossroads of several dispersal streams and to have acquired and preserved some of the elements of each of these dispersals. The instability of this area in the past and the recent volcanic activity have probably been responsible to a large extent in reducing the fauna to its present state, with only those species which have been able to adjust to the altered environments being preserved. It is remarkable how many relict endemic forms have been found to date, and indications are that others may exist, particularly in the northern part (Santa Cruz, Banks). The fauna of each of the subareas is discussed below, while the area as a whole is briefly considered here to emphasize its complexity and the interrelations of the subareas.

All the 11 nonendemic indigenous species are found elsewhere in the South Pacific: (1) *Culex* (*C.*) *starckeae*, *Mansonia* (*C.*) *xanthogaster*, and *Tripteroides* (*R.*) *melanesiensis* only in New Caledonia; (2) *Anopheles farauti*, *Uranotaenia barnesi*, *Aedes* (*V.*) *lineatus*, and *Armigeres breinli* only in the Solomons; (3) *Aedes* (*Aedimorphus*) *nocturnus* in New Caledonia, Fiji-Tonga-Samoa areas, and Eastern Polynesia; and (4) *Culex* (*C.*) *sitiens*, *C.* (*C.*) *annulirostris*, and *Aedes* (*O.*) *vigilax* widespread except in New Zealand and Eastern Polynesia.

The affinities of the 15 endemic species appear as follows: (1) with New Zealand and New Caledonia, *pacificus* in the *trifilatus* subgroup of *Culex* (*Culex*); (2) with New Caledonia and Rotuma Island, *folicola* in the *caledonicus* group of *Tripteroides* (*Rachionotomyia*), which is related to *tasmaniensis* of South Australia and Tasmania; (3) with the Solomons and New Caledonia, *buxtoni* in the *buxtoni* complex of *Culex* (*Lophoceraomyia*), which may also be represented in Australia; (4) with the Solomons, species 13 and 15 in *Culex* (*Lophoceraomyia*), and *Aedes* (*Geoskusea*) *daggyi*; (5) with the Solomons and the Fiji-Tonga-Samoa area, *bonneti* in *Tripteroides* (*Tripteroides*), *aobae*, *hebrideus*, *pernotatus*, *varuae*, and sp. 21 in the *scutellaris* group of *Aedes* (*Stegomyia*); and (6) without any close affinities anywhere in the South Pacific, *femineus* in *Culex* (*Mochthogenes*) with a possible distant relative in New Britain, *tulagiensis* and *robinsoni* in the *edwardsi* group of *Aedes* (*Stegomyia*), which is known elsewhere only in the Oriental region. The majority of the endemic species are breeders in specialized habitats, particularly treeholes. It is of interest that only *Tripteroides* (*R.*) *folicola* has been collected in pandanus; this habitat should be checked carefully, especially in the northern area, since on the basis of known distribution the *kochi* group of *Aedes* (*Finlaya*) should occur at least in the Santa Cruz islands.

NEW HEBRIDES GROUP.—The New Hebrides constitute the bulk of the Santa Cruz–New Hebrides area, with an estimated total land of about 5,350 square miles and a population of about 59,500, principally of Melanesians but with about 4,000 Europeans and other recent adventives. There are 12 major islands in the New Hebrides and about 40 small islands and islets chiefly grouped around the larger islands. The largest island, Santo (Espiritu Santo), is about 1,500 square miles and has an elevation of over 6,000 feet; it is three times as large as Malekula, the next largest, and five times as large as Efate, the best known. The group is a complex one, particularly in the northern half. The islands may be divided structurally into three groups: (1) Espiritu Santo and Malekula, which have extensive outcrops of Miocene volcanic and sedimentary rocks; (2) volcanic islands composed of more recent extrusions; and (3) small islands almost entirely of coral. Some of the volcanic islands have coral reef material raised to heights of over 2,000 feet. There are active volcanoes on Ambrym, Lopevi (between Ambrym and Epi), and Tana; earthquakes are common in the entire group. The volcanic islands are generally well watered; the larger ones have small rivers navigable by small boats for several miles.

The mosquito fauna of the New Hebrides proper is the best known of the entire area but only Santo, Efate, and small islands adjoining them have been more or less thoroughly surveyed, chiefly in the vicinity of the principal settlements and wartime encampments. Recent collections suggest that the more poorly known northern islands may have peculiar endemic species. Of the 28 (29) forms reported from the entire Santa Cruz–New Hebrides area, 21 (exclusive of the questionable record of *C.* (*C.*) *australicus*) are present in the New Hebrides, 6 being entirely endemic to the group, 1 a shared endemic with the Banks and the Santa Cruz groups, and 2 shared endemics with the Banks. There are 10 nonendemic indigenous forms, which include 2 New Caledonia–Australian species, *Culex* (*C.*) *starckeae* and *Mansonia* (*C.*) *xanthogaster,* and 1 New Caledonia–Eastern Polynesia species, *Aedes* (*Aedimorphus*) *nocturnus,* that do not occur elsewhere in the Santa Cruz–New Hebrides area. Similarly, among the 6 entirely endemic forms, 1 species, *pacificus,* belongs to a group with New Caledonia–New Zealand affinities, *trifilatus* subgroup of *Culex,* which is not represented elsewhere in the area. Furthermore, the *caledonicus* group of *Tripteroides* (*Rachionotomyia*) is represented by an endemic species, *folicola,* in addition to a widespread form, *melanesiensis.* Thus the New Hebrides fauna has a greater representation of the New Caledonia element (as well as Australian) than the rest of the area and is the only one with a New Zealand element. However, the affinities with the Solomons are very strong and appear to be dominant, as seen in the presence of 3 shared species, *Anopheles farauti, Uranotaenia barnesi,* and *Aedes* (*V.*) *lineatus,* 2 (3) closely related endemic species, *Culex* (*L.*) *buxtoni, Aedes* (*G.*) *daggyi,* and possibly *Culex* (*L.*) sp. 13, and the presence of the *scutellaris* group of *Aedes* (*Stegomyia*), which is represented by 3 species and also indicates affinities with the Fiji-Tonga-Samoa area. The only unique form in the New Hebrides group is the very strongly marked *Culex* (*Mochthogenes*) *femineus,* which may require separation into a distinct subgenus.

Up to the present there has been no indication of geographic differentiation of the mosquito fauna in the New Hebrides. However the recent discovery of *Aedes* (*Stegomyia*) *aobae* suggests that there may be considerable differences in the fauna of the different chains of islands in the northern part of the New Hebrides. It is of great interest, and I believe significance, that *aobae* occurs on Aoba Island and on Vanua Lava in the Banks group. A glance at even a crude map (figs. 22, 24) will show that Aoba Island, located between the two main chains of islands of the northern New Hebrides, is in line with the islands of the Banks group. Furthermore, Aoba appears to be of the same type of volcanic formation as the Banks islands and, in common with one of them (Santa Maria), has several crater lakes. It seems possible, therefore, that along the line of the existing islands from Vanua Lava to Aoba (possibly farther south) there may have been at one time in the past a more extensive series of island masses with a common mosquito fauna and that the present distribution of *aobae* is a relict one. This species is known in the New Hebrides at present only from Aoba Island and appears to replace *pernotatus* which surrounds it on the western chain (Espiritu Santo) and the eastern chain (Pentecost).

It appears, therefore, that dispersal from the north into the New Hebrides may have taken place along different island arcs. The presence of a submarine ridge to the west toward the Rennell ridge may be of significance also, as some dispersal may have occurred along this route south of the Solomons arcs; perhaps *Aedes* (*S.*) *hebrideus* and some other forms reached the New Hebrides by way of this route.

The mosquito fauna of the Banks group does not appear to differ markedly from that of the New Hebrides and probably should not be separated. This may prove to be true of the fauna of the Torres group when it is better known.

Of great interest is the apparent absence of the *kochi* group of *Aedes* (*Finlaya*) in the New Hebrides. Species of pandanus are common in these islands but have not yielded anything except *Tripteroides* (*R.*) *folicola* in collections on Espiritu Santo. If this group is really absent, this would be a strong indication that the New Hebrides were isolated by considerable water gaps from the main dispersal stream from the west at the time when the *kochi* group invaded the Fiji-Tonga-Samoa area. The apparent absence of the subgenus *Tripteroides* is also suggestive of similar isolation. Only careful further collecting will resolve these problems.

References: Rageau (1958*a*:877–878); Rageau and Vervent (1958); Iyengar (1955:43); Laird (1955*a*:276–278); Perry (1946); Buxton and Hopkins (1927:66–124).

BANKS GROUP.—The Banks group (fig. 24) is located north of the New Hebrides and consists of the major islands of Vanua Lava and Santa Maria and 6 smaller islands. The total land area is very roughly estimated at about 309 square miles and the population at about 2,500, apparently primarily Polynesian. The islands are very poorly known; it appears that they are not a distinct group but extensions of arcs represented in the northern New Hebrides. The main islands and the small adjacent islands are in line with Aoba in the New Hebrides (see above), while Mera Lava is in line with Aurora and Pentecost. With the exception of one reef island (Rowa), the islands are all high dissected volcanic cones, some of them with fumaroles and springs. Santa Maria (Gaua) has a crater lake at 1,100 feet elevation. The main islands are well watered and densely wooded.

Mosquitoes have been collected only on Vanua Lava, Santa Maria, and Mera Lava. The known fauna (fig. 8) consists of 9 species and is not markedly different from that of the New Hebrides. Of particular interest are 2 species of the *scutellaris* group of *Aedes* (*Stegomyia*): *aobae,* which is apparently common on Aoba Island in the New Hebrides, is known from Vanua Lava by a single female but there is no question as to the authenticity of this record; sp. 21 is a very interesting form which appears to be endemic to Vanua Lava. Additional collections on this group should reveal some interesting species, but it seems that the fauna of this group should be considered as a single unit with that of the New Hebrides.

TORRES GROUP.—The Torres Islands (fig. 24) lie to the northwest of the Banks Islands. These poorly known and seldom visited islands form a compact chain of 5 islands and 2 islets. The total land area is estimated at about 40 square miles and the population at about 165, apparently primarily Polynesian. All the islands are composed of terraces of coral limestone, usually with a high central plateau, and with maximum elevations of 390 to 1,230 feet. It has been suggested that the limestone overlies beds of volcanic tuff. Water is scarce on all the islands, owing to the porous nature of the soil, but small collections of surface water are found in rockholes and at the base of trees. Apparently at least one marshy area is present on Loh Island. The islands have a dense vegetation and many forest trees. The only mosquito reported from the Torres Islands is *Aedes* (*S.*) *hebrideus,* which was collected on Toga by Dr. Salaun (Rageau and Vervent, 1958:17). It seems probable that other mosquitoes occur in this group; it is very possible that 1 or more endemic species may be present among treehole- and plant axil-breeders.

SANTA CRUZ GROUP.—The Santa Cruz Islands, together with the Reef and Duff islands, comprise an isolated group of volcanic and coral islands at the north end of the New Hebrides submarine ridge east of the Solomon Islands (figs. 22, 24). These islands are among the least known in the entire South Pacific and are very seldom visited. Including Tikopia, Anuda, and Fataka (see below), the total land area of the group is probably less than 300 square miles and the population about 6,000, including both Melanesians on the larger islands and Polynesians on the smaller.

The Santa Cruz Islands proper consist of 4 principal high volcanic islands—Tinakula (an active volcano, elev. 2,200 ft.), Santa Cruz or Ndeni (elev. about 1,800 ft.), Utupua (elev. 1,241 ft.), and Vanikoro (elev. 3,031 ft.)—and several smaller islands adjacent to them, notably Temotu (Trevanion) near Santa Cruz and Tevai near Vanikoro. These islands are well watered and covered with dense vegetation. Of particular interest are the stands of a "kauri" (*Agathis macrophylla,* an endemic species), which began to be exploited in 1923 on

Vanikoro but which are also present on Santa Cruz Island; it was estimated in 1955 that 35,000,000 board feet had been cut and that 50,000,000 remained on the two islands. Except for this lumbering, the islands are largely untouched in the interior.

The Reef Islands (Swallow, Matema), north of the Santa Cruz Islands, comprise about 12 small coral islands from 100 to 220 feet in elevation (possibly tree top level). The eastern islands form a large more or less compact group with an extensive coral reef area; in this group are Naelo (Lomlom, Noali) and Fenualoa. Farther west and north is the isolated island of Nukapu, followed westward by Nupani. These islands apparently have considerable vegetation. North of the Reef Islands, several extensive shoals have been reported.

The Duff Islands (Wilson, Taumako), northeast of the Reef Islands, form a distinct separate group of 11 small volcanic islands and coral islets. Taumako (Netepa, Disappointment) is the largest island and is said to reach an elevation of 1,200 feet and to be lightly wooded.

In the Santa Cruz subarea, comprising Tikopia, Anuda, and Fataka in addition to the Santa Cruz, Reef and Duff islands, mosquitoes have been collected apparently only 4 times, by A. G. Carment in 1926 (BMNH), S. Lambert in 1933 (HOPK), F. N. Ratcliffe in 1952 (SYDN), and by the Robinson-Peabody Museum Expedition in 1956 (USNM, UCLA). I have seen material only from Nupani, Fenualoa, and Naelo in the Reef Islands, from Temotu, Santa Cruz, and Vanikoro in the Santa Cruz Islands, and from Tikopia Island.

In spite of this very incomplete and fragmentary knowledge, the known mosquito fauna of the Santa Cruz subarea (fig. 8) is of extraordinary interest. Of the 12 known species, only *Culex* (*C.*) *quinquefasciatus* is an European introduction and it has been reported only from Vanikoro, the one island where European influence has been felt. There are 6 nonendemic indigenous forms, but it is possible that at least some of these have been spread from adjacent areas by natives, since the inhabitants of the Reef and Duff islands have engaged in extensive voyages in the large and elaborate ocean-going canoes for which they are famous. However, for the present I consider all these forms as indigenous or probably indigenous, even *Aedes* (*S.*) *hebrideus*. Of these 6 nonendemic indigenous species, (1) *Armigeres breinli* is known elsewhere in the South Pacific only in the Solomons; (2) *Tripteroides* (*R.*) *melanesiensis* only in the Banks Islands, New Hebrides, and New Caledonia; (3) *Aedes* (*S.*) *hebrideus* in the Banks Islands, New Hebrides, and outlying Polynesian islands of the Solomons; (4) *Anopheles farauti* in the Banks Islands, New Hebrides, and the Solomons, including some of the outlying Polynesian islands; and (5) *Culex* (*C.*) *annulirostris* is widespread in the South Pacific.

Of greatest interest are the 5 or more apparently endemic species (45 per cent) which belong to 4 different groups. There is at least 1 (possibly 2 or more) unnamed form, sp. 15 of *Culex* (*Lophoceraomyia*), which shows strong affinities with a form, sp. 13, from Aoba Island in the New Hebrides and which may prove to be, in part at least, conspecific with it; there is some suggestion of affinity of both of these with a group of species in the Solomons. *Aedes* (*S.*) *varuae* is a very interesting form which in the past has been confused with *tongae* from the Tonga islands but appears to be a distinct endemic form, although it could have arisen through hybridization between a form similar to *tongae* and one similar to *hebrideus; varuae* is also known from Sikiana in the Solomons area where it was probably spread by natives. *Tripteroides* (*T.*) *bonneti* is a unique member of the subgenus *Tripteroides;* this subgenus is present in the Solomons and in the Fiji-Tonga-Samoa area but not elsewhere in the Santa Cruz–New Hebrides area; *bonneti* shows some affinities with the *bimaculipes* group of the Solomons but is so distinct that it may be desirable to place it in a separate group. The most interesting and peculiar endemics of the Santa Cruz subarea are *tulagiensis* and *robinsoni* which are placed provisionally in the *edwardsi* group of *Aedes* (*Stegomyia*). These forms appear to be quite similar in the adult stage to *edwardsi,* which is known only from the Andaman Islands, and to an unnamed form from Indochina which may be conspecific with *edwardsi.* The immature stages of *edwardsi* are not known but those of *tulagiensis* and *robinsoni* are suggestive of a hybrid between members of the *albolineatus* and *scutellaris* groups, which are both represented in the Solomons, and the adult characters are not inconsistent with such an interpretation. Therefore two possible explanations occur regarding *tulagiensis* and *robinsoni*: (1) they may be relict forms of the *edwardsi* group preserved in the Santa Cruz area, while in the area between Santa Cruz and Indochina and the Andamans the group has become extinct or has not been recognized as yet; or (2) they have been formed through hybridization, as indicated above, in the Santa Cruz area, and their resemblance to *edwardsi* is only fortuitous, although *edwardsi* itself may have arisen in a similar fashion through hybridization of 2 different stocks of the same groups.

The Santa Cruz area may be the most critical area for an understanding of dispersals of mosquitoes in the South Pacific. Part of it may be the remnant of an ancient island arc which extended north of the present Solomons arcs and projected along the edge of the Melanesian border plateau to the Fiji-Tonga-Samoa area. Of great interest is the presence in the Santa Cruz area of the *caledonicus* group of the subgenus *Rachionotomyia* of *Tripteroides,* which is represented also in Rotuma by an endemic species. This suggests also a close connection of this area at some time in the past to the south through the New Hebrides and New Caledonia areas to Australia and to the east at least as far as Rotuma Island. The subgenus *Tripteroides* is also represented in the Santa Cruz area and in the Fiji-Tonga-Samoa area but not on Rotuma Island. This suggests a connection across the Santa Cruz area from the Solomons to Fiji which occurred at a different time. Which of these connections was the earlier is difficult to determine, but it appears that the *caledonicus* group is more primitive than the subgenus *Tripteroides* and therefore it would seem that the dispersal of the former occurred first. As mentioned in the discussion of the mosquito fauna of the entire Santa Cruz–New Hebrides area above, the absence of the *kochi* group of *Aedes* (*Finlaya*) in this area is very puzzling, since the group is well represented in the Solomons and the Fiji-Tonga-Samoa area and must have dispersed somewhere across the northern part of the Santa Cruz–New Hebrides area. However so little collecting has been done in this area, particularly in pandanus axils, that this group may be present but has been overlooked. Intensive collections in this area as well as in the Banks and Torres groups is essential before the problem of dispersals of mosquitoes in the South Pacific can be resolved.

TIKOPIA (TUCOPIA) ISLAND.—Tikopia is a small isolated volcanic island located on a submarine rise east of the Santa Cruz Islands and separated from the latter by an ocean depth of over 3,000 meters (figs. **22**, **24**). It is roughly oval in shape, about 3 miles by 2 miles in extent, with a maximum elevation of 1,235 feet on the crater rim. Inside the crater of the extinct volcano is a large deep freshwater lake only a few feet above sea level which drains into the sea through the partly breached southeast rim of the crater wall. The island is densely wooded and has swampy ground with much pandanus on a rather large low flat area in the southwest corner. There are more than 1,300 Polynesian inhabitants on Tikopia, some of whom may now be resettled in the Russell group in the Solomon Islands. Four species of mosquitoes have been reported from Tikopia; these are considered together with the mosquitoes of the Santa Cruz group (fig. **8**). None of these species are endemic to the islands; it appears probable that all of them have been spread by the natives, although it is possible that *Anopheles farauti* and *Culex* (*C.*) *annulirostris* are indigenous.

ANUDA AND FATAKA ISLANDS.—These islets are located on a submarine rise about 75 miles northeast of Tikopia and are separated from it by a depth of over 3,000 meters (fig. **24**). Both are apparently rocky and wooded; the highest elevation on Anuda (Anuta, Cherry) is about 212 feet and on Fataka (Fatutaka, Mitre) about 400 feet. There are less than 100 Polynesian inhabitants on Anuda; Fataka is uninhabited but occasionally visited from Anuda. No mosquitoes have been reported from these islands.

MATTHEW AND HUNTER ISLANDS.—These small islands are located on the Hunter Island submarine ridge about 150 and 180 miles southeast respectively of Aneityum Island in the New Hebrides (fig. **24**). Both islands are volcanic and emit jets of sulphurous fumes from time to time. Matthew (elev. about 580 ft.) is arid and barren; Hunter (elev. 974 ft.) has a vegetation of grass and trees. These islands are not inhabited and no mosquitoes have been reported from them.

FIJI–TONGA–SAMOA AREA

Figs. **9**, **19**, **24**, **25**

ENTIRE AREA.—The Fiji-Tonga-Samoa area (figs. **19**, **24**, **25**) is a complex division of the South Pacific, the bulk of which occupies or is adjacent to what may be called the Eastern Melanesian submarine rise of the continental border area (fig. **21**). This part of the area consists of (1) the large Fiji group located on a central Melanesian plateau from which the Hunter Island and the South Fiji submarine ridges run southwestward and southward respectively; (2) the small Tonga group located on the Tonga submarine ridge near and parallel to the eastern margin of the continental border area and separated from the South Fiji ridge by the shallow Lau Basin; (3) the comparatively large Samoa group north of Tonga, usually considered to be outside the continental border area but appearing to be on an eastern extension of the Melanesian Border plateau; (4) the small isolated group of Rotuma on the Melanesian Border plateau north of Fiji; (5) the small isolated Horne group northeast of Fiji toward the Melanesian Border plateau; (6) the small isolated group of Wallis Island on the Melanesian Border plateau northeast of the Horne group; and (7) the isolated Niue Island in the ocean basin area east of Tonga and separated from it by the Tonga trench. Included in the Fiji-Tonga-Samoa area, chiefly on geographic grounds, are the following groups of low coral islands and atolls in the ocean basin area north of the Eastern Melanesian rise: (8) the Tokelau Islands, (9) the Phoenix Islands, (10) the Ellice Islands, and (11) the Southern Gilbert Islands. The total land in the Fiji-Tonga-Samoa area is estimated at nearly 8,800 square miles. The population of the area is probably over 625,000 and is rapidly increasing in all the major island groups. It is composed of about 215,000 Polynesians (Samoa, Tonga, and all the smaller island groups except principally the Southern Gilbert Islands), about 165,000 Fijians (Melanesians), about 17,000 Micronesians (principally in the Southern Gilbert Islands), and about 228,000 adventives, the chief element being about 200,000 Indians in Fiji.

The Fiji-Tonga-Samoa area (fig. **21**) is separated to the west from the rest of the continental border area by the extensive North and South Fiji basins which are relatively shallow (only 3 or 4 small areas of 5,000 meters depth). In the north there is a widely broken connection with the northern part of the Santa Cruz–New Hebrides area along the Melanesian Border plateau. In the middle, between the North Fiji basin and the South Fiji basin, there is an interrupted connection with the southern part of the Santa Cruz–New Hebrides and the New Caledonia areas along the Hunter Island ridge and a less conspicuous rise to the north of the latter. To the south, the Eastern Melanesian rise narrows toward the Kermadec ridge and continues to the New Zealand rise.

The islands on the Eastern Melanesian rise and in Samoa are largely high islands, complex, volcanic or elevated coral in formation. Fiji appears to be a relatively stable mass at present; recent volcanic activity has occurred in Samoa, and active volcanoes are present in Tonga.

The climate throughout the area is tropical oceanic; nearly everywhere the moderating effect of the southeast trade winds is felt. Near sea level temperatures seldom exceed 90° F. or fall below 65° F. except in the southern islands of Tonga where they frequently drop to 55° F. in the winter months; mean annual temperatures vary from about 75° F. in the south to about 81° F. in the north; daily variation in temperature is usually less than 11° F. and seasonal variation is usually less than 10 degrees. Rainfall is usually high but is varied and may be low and erratic near the equator (see under individual island groups). The larger islands are well watered and in general have a luxuriant native vegetation. Mosquito habitats are numerous and varied, but there are no extensive coastal lowlands, swamps, or marshes for general ground pool-breeders. The area as a whole has not been markedly altered in spite of the large population, and little mosquito control work has been done except on Viti Levu in Fiji and Upolu and Tutuila in Samoa.

The mosquito fauna of the Fiji-Tonga-Samoa area cannot be said to be well known, although rather extensive investigations have been made in Fiji and Samoa and 1 or more collections have been made in all the subareas except the Phoenix Islands and the Southern Gilbert Islands. As elsewhere in the South Pacific, attention has been centered on species closely associated with man and suspected as disease vectors; thus most of the collections have been made around the main centers of population. Practically nothing is known of the mosquito fauna of the interior of even the best-known islands, and little attention has been paid to nonbiting forms and their immature stages. However, largely owing to the careful work of R. W. Paine on Fiji, many of the known forms are represented by individual rearings and their stages are therefore definitely associated. Several of the isolated islands in the area have been collected for the first time in the last few years, but unfortunately these collections have been too brief and scattered to give anything but a glimpse of the fauna of these islands. Recent work on Fiji by C. B. Symes (1959) and G. F. Burnett (1958) suggests that species recognized and described in recent years may be involved as vectors of filariasis. Therefore it is most important that the mosquito fauna of the entire area be thoroughly studied before a decision is made as to the method of control of filariasis.

The known mosquito fauna of the Fiji-Tonga-Samoa area (fig. 9) consists of 35 forms including (1) 2 unnamed forms, *Aedes* (*Finlaya*) sp. 22 and *Aedes* (*Stegomyia*) sp. 22; (2) a questionable record of *Culex* (*C.*) *roseni* from Tonga; I have also included under this species Iyengar's record (1955:46) of *litoralis* from Samoa; and (3) *Aedes* (*S.*) *marshallensis,* which has not been collected as yet in the area but is probably present in the Southern Gilbert Islands. Six species are definite or probable introductions: (1) the 3 species of *Toxorhynchites* have been introduced for the purpose of controlling container-breeding mosquitoes on Fiji and Samoa, (2) *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* have been introduced through commerce by Europeans, and (3) the above mentioned *Aedes* (*S.*) *marshallensis,* if present in the area, was undoubtedly spread by Micronesians ultimately from the Eastern Caroline Islands. The remaining 29 species all appear to be indigenous; of these, 23 (nearly 80 per cent) are definitely or probably endemic to the area as a whole. This is the highest degree of endemism for an area in the South Pacific except for New Zealand (100 per cent).

The known indigenous mosquito fauna of the Fiji-Tonga-Samoa area is not as a whole a well-balanced one but it is complex. The subfamilies Dixinae and Chaoborinae have not been reported. The Culicinae are represented by 6 tribes, each tribe by 1 genus; only 2 genera are known by 1 species, the others being represented by 2 or more species groups. This assemblage of forms does not appear to have been produced through random chance dispersal from adjacent source areas as they exist now, but rather seems to be composed largely of relict endemic forms which dispersed along definite routes in the past and could not have reached the area across extensive ocean barriers. The area appears to have been isolated for a long time, and its mosquito fauna is very strikingly differentiated: it includes 1 monotypic subgenus (*Levua* in *Aedes*) and 3 monotypic species groups (*colocasiae* and *painei* in *Uranotaenia* and *purpuratus* in *Tripteroides*). There is a great deal of endemism within the area in the different island groups on or adjacent to the Eastern Melanesian rise, as shown on the chart (fig. 9) and discussed below.

The nonendemic indigenous element of the mosquito fauna of the Fiji-Tonga-Samoa area consists of 5 definitely known widespread species capable of dispersal over considerable ocean barriers and 1 other species, recorded on the chart as *Culex* (*C.*) *roseni,* which may prove to be an endemic species or possibly may be really conspecific with *roseni,* which occurs in Eastern Polynesia. *Culex* (*C.*) *annulirostris* has been recorded from all areas of the South Pacific except New Zealand and *Culex* (*C.*) *sitiens* and *Aedes* (*O.*) *vigilax* from all areas except New Zealand and Eastern Polynesia. *Aedeomyia catasticta* is known in the South Pacific only in the Solomons, but this form is easily overlooked and may be present elsewhere. It was not introduced into the area by aircraft as reported by Lever (1944*a*) and Laird (1956:10), since a specimen was collected in 1938 at Nandarivatu on Viti Levu before Fiji was linked by air with areas where this species is known to occur. *Aedes* (*Aedimorphus*) *nocturnus* presents a special problem which is discussed in the Systematic Treatment. This species has been reported elsewhere in the South Pacific in the New Hebrides, New Caledonia, and the western part of Eastern Polynesia; it may be spread, at least in part, in the egg stage by natives; for the present it is considered to be a species indigenous to Fiji and Samoa and spread by natives to the smaller island groups in the area. All these nonendemic species are not necessarily recent arrivals in the Fiji-Tonga-Samoa area. There is some indication of differentiation of these forms in the area from populations elsewhere in the South Pacific. It is possible that, in at least some of these species, dispersals from the west have occurred from time to time in the past and because of this no stabilization or fixation of the populations as distinct species has occurred in the Fiji-Tonga-Samoa area.

The endemic or probably endemic elements of the mosquito fauna of the area consists of 23 species in 5 tribes and are either specialized ground pool-breeders (5 sp.) or breeders in plants and plant materials (18 sp.). For a possible explanation of the preponderance of breeders in plants, see under Bionomics and Dispersal. All the endemic forms are more primitive than their relatives immediately to the west, and the majority appear to be the most primitive—or among the most primitive—known living species in their respective phylads. Some of them are so clearly marked that they require separation into distinct subgroups, groups, or even one subgenus (*Levua*). The general affinities of the endemic species fall into two groups. The first group has its closest relatives in the Santa Cruz–New Hebrides and the New Caledonia areas as well as more distant ones in Australia and Tasmania. To this group belong only 3 species: the closely related *samoaensis* and *albinervis* of the *bitaeniorhynchus* subgroup of *Culex* (*Culex*) and *rotumanus* of the *caledonicus* group of *Tripteroides* (*Rachionotomyia*). The second group shows general relationships chiefly with the Solomons and less with the Santa Cruz–New Hebrides area and has no representation elsewhere in the South Pacific. It includes the remaining 20 species, as follows: (1) the monotypic *colocasiae* and *painei* sections of *Uranotaenia,* which show distant affinities with the *atra, moultoni,* and *pandani* sections (see Systematic Treatment); (2) *fijiensis* of the *crassipes* group of *Mansonia* (*Coquillettidia*); (3) the monotypic *purpuratus* group of *Tripteroides* (*Tripteroides*); (4) *suvae* in the monotypic *Aedes* (*Levua*); this species shows affinities on the one hand with the subgenus *Geoskusea* and on the other with the *vigilax* section of the subgenus *Ochlerotatus* and may be a form of hybrid origin; (5) the *kochi* group of *Aedes* (*Finlaya*) with 6 species; this group is not known in the Santa Cruz–New Hebrides area; and (6) the *scutellaris* group of *Aedes* (*Stegomyia*) with 9 species. It must be reëmphasized that the affinities of these forms are not at all close with the species known elsewhere in the South Pacific.

The mosquito faunas of the various subdivisions of the area are discussed below under the various island groups; only a few generalities are given here. The fauna of the entire area is a remarkably uniform one in its general composition, but perhaps that of Rotuma has a discordant element in its representation of the *caledonicus* group of the subgenus *Rachionotomyia* of *Tripteroides.* However, Rotuma is located on the Melanesian Border Plateau and properly belongs in the Fiji-Tonga-Samoa area. The low coral islands of the outlying Tokelau and Ellice Islands apparently have introduced mosquitoes only, and no mosquitoes have been reported from the even more remote Phoenix and Southern Gilbert Islands, although the latter probably have several introduced forms. All the island groups located on or adjacent to the Eastern Melanesian rise have indigenous mosquitoes and show considerable endemism: Fiji (11 sp.), Samoa (3 sp.), Rotuma (2 sp.), Tonga (1 sp.), Horne (1 sp.), Niue (1 sp.), Wallis (1 sp.). Of the remaining 3 forms endemic to the area as a whole, (1) *Mansonia* (*C.*) *fijiensis* is known from both Fiji and Samoa, but it is possible that the 2 allopatric populations are not really conspecific; (2) *Aedes* (*F.*) *oceanicus* and *Aedes* (*S.*) *polynesiensis* have been undoubtedly spread by natives within the area. It is difficult to determine the place of origin of *oceanicus* and *polynesiensis,* particularly since both forms may have been formed through hybridization; they are considered here provisionally to have been originally endemic to Samoa.

To summarize, the known mosquito fauna of the Fiji-Tonga-Samoa area is the most highly differentiated of all the faunas of the South Pacific area except for New Zealand. It consists chiefly of primitive, clearly marked, relict endemics having no close relatives anywhere in the South Pacific and with distant relatives in widely separated areas in the Old World (Indomalayan, Malagasy, and Ethiopian regions) as well as in the Solomons, Santa Cruz–New Hebrides, and New Caledonia areas in the South Pacific. The endemic fauna shows (1) a small element which is best preserved elsewhere in the South Pacific in the Santa Cruz–New Hebrides and the New Caledonia areas as well as in Australia-Tasmania and (2) a much larger element which has not penetrated into New Caledonia and S. Australia–Tasmania and is only partially represented in the Santa Cruz–New Hebrides area. Therefore it appears that the second element dispersed by a northern route, possibly by way of an arc through or north of the Solomons and along the Melanesian Border Plateau. Since the majority of the species in the second dispersal are plant-breeders apparently incapable of crossing extensive ocean barriers, it is probable that extensive nearly-continuous land was present along this arc. Subsequent to these dispersals, which may have occurred more than once, the Fiji-Tonga-Samoa area has been isolated for a long time from the west. Its land area has been greatly reduced and much volcanism has occurred. This has resulted in the reduction of the original fauna and, through the isolation of small areas, in the formation of endemism within island groups in the area. Samoa has retained few species but these appear to be the most primitive. Fiji, with the largest present land mass, has retained the largest number of species. The great preponderance of container-breeding species in the area over those utilizing ground pools can be explained perhaps by the probability that the former types of habitats have been more stable and have been available during periods of great environmental changes. Ground pools are scarce or even completely absent on new volcanic islands as well as on coral islands, while plants (particularly Pandanaceae) can quickly utilize such islands and by the collection of water in their axils or treeholes provide habitats for mosquito breeding.

FIJI.—The Fiji group (fig. 24) occupies a central position in the Fiji-Tonga-Samoa area and comprises the bulk of its land area. The islands of the group form a rather compact mass on the Central Melanesian plateau at the junction of the Hunter Island and South Fiji submarine ridges (fig. 21). The total land mass is about 7,040 square miles; the population is over 396,000, with only about 165,000 Fijian natives (Melanesians with some Polynesian admixture in the Lau group) and about 200,000 adventive Indians, the remainder being Europeans and other recent adventives, including some Polynesians and resettled Micronesians (Banabans from Ocean Island).

There are over 300 islands in the group, about 100 of them inhabited. The islands vary greatly in size; the largest and best known are Viti Levu (4,011 square miles, elev. 4,341 ft.), Vanua Levu (2,137 square miles, elev. 3,386 ft.), Kandavu (169 square miles, elev. 2,790 ft.), and Taveuni (168 square miles, elev. 4,076 ft.). It has been suggested that the Fijian region is the remnant of a large Melanesian continent. All the larger islands except Taveuni have extensive sedimentary rocks; Taveuni appears to be entirely volcanic. The oldest rocks on Viti Levu are said to be Mesozoic and there is evidence of several periods of erosion, submergence, sedimentation, aerial and submarine volcanism, and reëlevation. In general these islands are moderately high, rugged, and mountainous, but there are also wide areas of rich alluvial land on the extensive deltas of the larger rivers. The majority of the smaller islands are also at least in part volcanic, many of them have elevated coral limestone formations in addition, and some are entirely elevated coral or coral atolls.

The larger islands show a marked difference between the windward and leeward sides. On the windward side the rainfall is high, usually 120 inches or more a year, well distributed throughout the year; the vegetation here is a luxuriant tropical rainforest. On the leeward side the rainfall is less, 70 to 90 inches, and comes largely during the wet season; here the slopes are covered with grass and scattered shrubs and trees while forests are confined to gullies and the higher peaks. The smaller islands in general have a lighter and rather uniform rainfall. In spite of the large population and extensive cultivation in the area, the interior of the larger islands has been largely untouched. Although considerable mosquito control work has been and is being carried out, it is chiefly confined to the principal settlements and apparently has had little effect on the native mosquito fauna.

The mosquito fauna of Fiji has attracted considerable attention in the past but it is still very imperfectly known to judge by the recent discoveries of new endemic species in the vicinity of Suva. Much of our present knowledge of the mosquito fauna of Fiji is owing to the careful work of R. W. Paine, who was the first investigator to make individual rearings of mosquitoes in the entire South Pacific area. At the present time the knowledge of the mosquito fauna, and of the distribution of individual species, is largely confined to centers of human population; very little is known about the mosquitoes of the interior, even on the best-known island of Viti Levu. Much remains to be done and it is probable that additional species will be discovered.

To date 22 species of mosquitoes have been reported from Fiji (fig. 9), including *Toxorhynchites splendens* and *T. inornatus,* which were introduced and released by Paine in 1931–1932 and apparently have been recovered recently by Symes (1959). Three other species are considered here to be introductions: *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti,* undoubtedly introduced by Europeans, and *Aedes* (*S.*) *polynesiensis,* probably spread by natives (see Systematic Treatment). Of the 17 indigenous or probably indigenous species, 11 (68 per cent) are endemic or probably endemic, but 1 of these is poorly known and another is questionably recorded from Samoa. All 6 tribes of the Culicinae known from the entire Fiji-Tonga-Samoa area are represented in Fiji, 4 of them by 1 or more endemic species.

The 6 nonendemic indigenous forms include: (1) *Mansonia* (*C.*) *fijiensis,* known elsewhere only in Samoa; however the 2 allopatric populations may prove to be distinct; (2) *Aedeomyia catasticta,* a widespread species known elsewhere in the South Pacific only in the Solomons; this species is not introduced as previously reported (see Systematic Treatment); (3) *Aedes* (*Aedimorphus*) *nocturnus,* a widespread species known elsewhere in the South Pacific in the Santa Cruz–New Hebrides area, the New Caledonia area, and the western part of Eastern Polynesia; (4) *Culex* (*C.*) *sitiens* and *Aedes*

(*O.*) *vigilax,* widespread species known in the South Pacific in the Santa Cruz–New Hebrides area, the Solomons area, and the New Caledonia area; and (5) *Culex* (*C.*) *annulirostris,* a widespread species known from all the South Pacific except the New Zealand area.

All the 11 endemic species of Fiji are clearly marked, although some of them show affinities with other species within the Fiji-Tonga-Samoa area. Only 3 of them are ground pool-breeders; all of these utilize specialized habitats. The most striking of these is *Aedes* (*L.*) *suvae,* a crabhole-breeder placed in the monotypic subgenus *Levua,* which has a suggestion of a hybrid origin between a member of the subgenus *Geoskusea* and a member of the *vigilax* section of the subgenus *Ochlerotatus.* Perhaps equally striking is *Uranotaenia painei,* a breeder in rockholes and streambed pools, which may have arisen through hybridization between a typical ground pool form and a container-breeder, *U. colocasiae.* The third of the ground pool-breeders is *Culex* (*C.*) *albinervis,* which utilizes stagnant pools with dense mats of algae and appears to be 1 of the 2 most primitive members of the *bitaeniorhynchus* subgroup, the other being *samoaensis.* In this group of endemics, it appears that *albinervis* is a pure relict of an early dispersal which included only the Santa Cruz–New Hebrides and the Solomons areas, and that *painei* is a hybrid between 2 forms in the second dispersal. The paucity of ground pool endemics and their possible hybrid origin suggests that great changes occurred in the environment in the Fiji group subsequent to the invasion of the area by their ancestral forms. The 8 container-breeding endemics belong to 4 groups, 2 of them utilizing treeholes and 2 plant axils; all these appear to have reached Fiji during a dispersal which included only the Solomons area and the northern part of the Santa Cruz–New Hebrides area. *Tripteroides purpuratus,* a treehole-breeder, is such a unique and highly differentiated species that it is placed in a separate group; it is questionably reported also from Samoa (other records from New Guinea and the Marianas are in error). This form appears to be a highly plastic and variable one but apparently shows no geographical differentiation within the Fiji group. The *scutellaris* group of *Aedes* (*Stegomyia*), primarily a treehole-breeder, is represented by 2 endemic forms, *pseudoscutellaris* and *horrescens,* which originally may have been allopatric. *Uranotaenia colocasiae,* probably primarily a breeder in aroid leaf axils but also commonly breeding in treeholes and plant materials on the ground, is as unique a form as *Tripteroides purpuratus.* It is also placed in a separate section, which shows distant affinities with sections found now in the Malagasy and Ethiopian regions, Borneo, and, to a lesser extent, the *atra* section found in the Solomons. This species is an extremely variable and plastic one but does not seem to show geographic differentiation. Finally, the *kochi* group of *Aedes* (*Finlaya*), breeding chiefly in the leaf axils of Pandanaceae but also found in aroids, is represented by 4 forms: *burnetti, fijiensis, freycinetiae,* and the unnamed sp. 22 (possibly an albino variant). These forms (together with *samoanus* and *oceanicus* found elsewhere in the Fiji-Tonga-Samoa area) are among the most primitive members of the *kochi* group; the Fiji forms belong to 2 distinct subgroups, and *burnetti* may have originated as a hybrid between the members of the 2 subgroups. Since utilization of the small, confined, and specialized breeding sites in the leaf axils of Pandanaceae appears to be conducive to speciation, it seems probable that additional members of the *kochi* group will be found on Fiji.

References: Symes (1959); Iyengar (1955:44); Amos (1947, 1944); Paine (1943, 1935); Bahr (1912:17–18).

SAMOA.—The Samoa group (fig. **25**) is composed of 4 subgroups of islands lying close together but separated from each other by depths of 3,000 meters or more. In addition, Swain's Island is included in the Samoa group because it is a part of American Samoa, although it is probably structurally a part of the Tokelau group to the north. The total land area is about 1,209 square miles and the present, rapidly increasing, population probably in excess of 125,000, chiefly Polynesian but with a fair number of Europeans and other recent adventives chiefly in Apia and Pango Pango. The Samoa group is usually considered to be outside the andesite line and therefore is not included in the continental border area, from which it is partially separated by depths of over 5,000 meters; however, it seems that the group may be an eastward extension of the broken Melanesian Border Plateau (fig. **21**). Except for the low coral islands of Rose and Swain's, the group consists of high volcanic islands, with the Western Samoa subgroup of Savaii (elev. 6,096 ft.), Upolu (elev. 3,607 ft.), and adjoining islets comprising the bulk of the land area (1,133 square miles), the central subgroup of Tutuila (elev. 2,141 ft.) and adjoining islets forming a much smaller mass (54 square miles), and the eastern Manua subgroup of Ofu (elev. 1,587 ft.), Olosenga (elev. 2,095 ft.), and Tau (elev. 3,056 ft.) being the smallest (about 21 square miles). The last recorded volcanic eruptions in the group occurred in 1905–1911, when lava flows covered a sizeable area of the north side of Savaii. Rainfall in the group is seasonal and much heavier on the south side of the two principal islands; the average annual rainfall on the north coasts is about 115–120 inches and on the south coasts 150–190; at high elevations on Savaii the annual maximum approaches 300 inches. The larger islands have numerous streams, some large, and several crater lakes. There is some standing fresh and brackish water on the coastal lowlands and in the river valleys. The vegetation is luxuriant and varied on all the islands except on the recent lava flows on Savaii. In general the interior of the islands has been little disturbed.

In spite of the extensive investigations of Buxton and Hopkins (1927), the mosquito fauna of Samoa appears to be poorly known. Little collecting has been done except in the populated coastal areas. To the present only 11 species have been definitely identified from the entire group (fig. **9**), not including *Toxorhynchites brevipalpis* and *T. splendens,* which have recently been introduced and released on Tutuila (Peterson, 1956). Additional questionable records are (1) *Culex* (*C.*) *litoralis* by Iyengar (1955:46); this is most unlikely, but the record may pertain to a species of this group close to *roseni* (under which it is recorded in the chart), and (2) *Tripteroides* (*T.*) *purpuratus* of Fiji; this is represented in the material I have examined by 3 larvae labeled "American Samoa"; it is possible that either this species or a closely related one occurs in Samoa, but it is also possible that the specimens are labeled erroneously. Of the species definitely known from Samoa, *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* are European introductions, but the remainder are probably all indigenous and 3 to 5 of these appear to be endemic. *Culex* (*C.*) *samoaensis* is definitely endemic; it is known from 3 females only and appears to be closely related to *albinervis* of Fiji. In the *kochi* group of *Aedes* (*Finlaya*), *samoanus* is definitely endemic, but *oceanicus,* which has been confused with the former, presents a problem similar to that of *Aedes* (*S.*) *polynesiensis,* since it may be a form of hybrid origin, a widespread species, or an endemic dispersed by natives (see Systematic Treatment). For the present I regard it as probably originally endemic to Samoa. In the *scutellaris* group of *Aedes* (*Stegomyia*), *upolensis* is endemic and *polynesiensis* is also considered for the present as probably originally endemic to Samoa (for other interpretations, see Systematic Treatment). Whether the *Mansonia* of Samoa is really conspecific with *fijiensis* cannot be definitely settled until all the stages are known, but the adults appear to be quite similar to those from Fiji and are provisionally regarded as *fijiensis.* The remaining species, *Culex* (*C.*) *sitiens, C.* (*C.*) *annulirostris,* and *Aedes* (*Aedimorphus*) *nocturnus,* are considered here to be probably indigenous to Samoa, but it is possible that at least the last has been spread by natives.

In spite of our present very fragmentary knowledge, the mosquito fauna of Samoa shows features of great interest. The affinity with the fauna of Fiji is very striking and unmistakable, as indicated above. However, this fauna cannot be derived directly from the present-day Fijian fauna, as all endemic species of Samoa appear to be even more primitive than their counterparts on Fiji. It is very unlikely that this fauna became established on Samoa without closer land connections to the west since the endemics consist principally of forms breeding in treeholes and in the leaf axils of plants. Therefore the most logical explanation now seems to be that Samoa was part of, or associated with, a large land mass in common with Fiji and that its connection with this area was interrupted early so that the most primitive forms were preserved there and now constitute its endemic element. The nonendemic element consists of forms which are capable of dispersal over considerable sea barriers and have reached Samoa before or after its isolation; in either instance, more or less frequent dispersals from the west may have prevented the differentiation of distinct species of this group on Samoa.

References: Marks (1957); Iyengar (1955:46); Edwards (1928*b*); Buxton and Hopkins (1927:66–124, 1925); O'Connor (1923:12).

TONGA.—The Tonga group (fig. **25**) is composed of about 150 islands and islets lying on the Tonga submarine ridge near the eastern margin of the continental border area east of Fiji, separated from the latter by the shallow Lau Basin (fig. **21**). The total land area of the group is said to be 270.37 square miles (including inland waters and reclaimed land); the present population is probably more than 60,000 Polynesians and about 1,000 recent adventives and is rapidly increasing. The majority of the islands run roughly north and south in 2 narrow parallel chains; the islands of the eastern chain are of either coral or submarine volcanic formation with coral limestone, and are seldom over 100 feet in elevation; those of the western chain are of aerial volcanic formation, range between 350 feet and 3,389 feet in elevation, and include three active volcanoes. The island of Niuafoou is isolated to the northwest, about halfway between Fiji and Samoa; this island is of aerial volcanic formation and is subject to periodic eruptions. The climate of the group is very moderate for the tropics and is particularly cool and dry during the winter months. Annual rainfall is seasonal and varies from about 100 inches in the north to about 60 inches in the south. The luxuriant vegetation of the high volcanic islands has been little disturbed, but the majority of the coralline islands are extensively cultivated and little remains of their native flora.

The mosquito fauna of the Tonga group is very poorly known (fig. 9). Practically all the collecting has been done on Tongatabu, the most populous island, and chiefly in and around its chief city of Nukualofa. The only other known collections are one or two each from the Haapai group, Vavau group, Niutobutabu, and Niuafoou. Only 7 species are definitely known from the entire group; only *Aedes* (*S.*) *tongae* of the *scutellaris* group is endemic. *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* are European introductions; *Aedes* (*Aedimorphus*) *nocturnus* and *A.* (*Finlaya*) *oceanicus* appear to have been spread by natives, but both may be indigenous; *C.* (*C.*) *sitiens* and *C.* (*C.*) *annulirostris* are probably indigenous. I have seen a single specimen of *C.* (*C.*) *roseni* bearing a Tongatabu label but this may be in error (see Systematic Treatment). In addition, there have been local reports of *Culex* (*C.*) *albinervis* and *Aedes* (*S.*) *horrescens*, but these appear to be misidentifications (Tonga, Medical Dept., 1957; Helu and Haunga, 1952).

References: Iyengar (1955:46); Buxton and Hopkins (1927:66–124).

ROTUMA.—The island of Rotuma, together with several islets, lies in an isolated position along the submarine Melanesian Border Plateau about 300 miles north of the Yasawa group of Fiji (fig. 24). The total land area is about 15 square miles and the population about 5,000, chiefly Polynesian. The main island (elev. 840 ft.) and the major islets are of volcanic formation. The majority of the hill tops are partially filled small craters of ancient volcanoes; the upper slopes are steep and composed of a porous lava; on the lower slopes near the sea there is said to be a "sandstone" formation. Rainfall averages about 140 inches a year; water drains quickly through numerous channels into swampy areas near the coast. The upper slopes of the hills are heavily wooded.

I have seen only 2 mosquito collections from Rotuma, one made by W. D. Carew in 1928 and reared by R. W. Paine in Suva, and the other by the Robinson-Peabody Museum expedition in 1956. The known mosquito fauna (fig. 9) is of very great interest; 4 species are apparently indigenous and 2 of them are endemic; in addition Paine (1934:12) states that *Toxorhynchites splendens* was released on Rotuma in 1931. One of the endemic species is *Aedes* (*S.*) *rotumae*, a member of the *scutellaris* group and probably the vector of filariasis on this island. It is of interest that the widespread *polynesiensis* of the same group does not occur on Rotuma. The other endemic is *Tripteroides* (*R.*) *rotumanus*, a member of the *caledonicus* complex, which occurs elsewhere only in the Santa Cruz–New Hebrides and the New Caledonia areas.

Reference: Iyengar (1955:45).

HORNE ISLANDS.—The Horne Islands (Hoorn, Horn, Futuna) consist of two principal adjacent high volcanic islands of Futuna (elev. about 2,500 ft.) and Alofi (elev. about 1,200 ft.), which are located about 150 miles northeast of the island of Vanua Levu in Fiji and about 100 miles southwest of Wallis Island (fig. 24). The total land area is probably about 34 square miles and the population about 2,800 Polynesians. Futuna is a little more than twice the size of Alofi. Both islands have a strip of lowland, apparently a raised coral reef, encircling a volcanic plateau from which arises the main ridge of mountains. There is at least one hot spring on each island. The climate is in general similar to that of Wallis Island but the rainfall is apparently greater, probably over 100 inches yearly. On Futuna there are numerous streams and narrow valleys. On Alofi the plateau is depressed in the center and collects water; there are no streams running to the coast. There are dense forests on the mountains of both islands, in the valleys of Futuna, and on the plateau of Alofi; on Futuna the plateau is largely arid and covered with scanty vegetation.

As far as I have been able to determine, mosquitoes have been collected in this group only by the Robinson-Peabody Museum expedition which stopped briefly at Mu'a on Alofi Island in 1956 and collected 3 species (fig. **9**). One of these is a very clearly marked endemic species, *Aedes* (S.) *futunae,* of the *scutellaris* group, which is also represented by *polynesiensis,* the latter undoubtedly introduced by the Polynesian natives. The record of the third species, *Aedes* (*F.*) *oceanicus,* is questionable as this form is represented by a single larva included in a vial with skins of an individual rearing of *futunae* from a treehole. It is very possible that this is a contamination with a collection made in Samoa, but it is not beyond the realm of possibility that *oceanicus* occurs in the Horne group as it is apparently present in the Wallis group. Future collecting on these islands will undoubtedly reveal the presence of other mosquitoes, possibly endemic forms.

WALLIS ISLANDS.—The Wallis Islands (fig. **25**) consist of the major volcanic island of Wallis (Uvea, Uea), surrounded by a barrier reef and several volcanic and coral islets within the lagoon and on the reef. The total land area is about 24 square miles and the population about 6,500, chiefly Polynesian. The main island is composed of a comparatively level central volcanic plateau with a number of isolated hills (max. elev. 470 ft.) and 5 small extinct craters, 4 of which sometimes contain water. The plateau drops down sharply to an encircling strip of lowland, apparently a raised coral reef overlain by volcanic and coral debris. The annual rainfall is probably slightly less than 100 inches but is irregular and seasonal. Surface water other than in the crater lakes is scarce, although there are two other small lakes on the plateau and several small streams run to the sea from the base of the plateau cliffs. The native vegetation is rather sparse; forest trees are chiefly confined to the area of the crater lakes in the south central area. Part of the plateau is arid and almost bare but much of it is under cultivation.

The known mosquito fauna of Wallis consists of 8 forms (fig. **9**) but 2 of these are poorly known. *Culex* (*C.*) *quinquefasciatus* and *Aedes* (S.) *aegypti* are definitely European introductions; it is possible that all the other species except one have been spread by natives. For the present, however, I consider that *Culex* (*C.*) *annulirostris* and *C.* (*C.*) *sitiens* are indigenous and *Aedes* (*Aedimorphus*) *nocturnus* spread by natives. *Aedes* (*Finlaya*) *oceanicus* I have not seen but it is probably the form reported as *samoanus;* if this interpretation is correct, it may have been spread by the natives; however there is a possibility that this form is neither *samoanus* nor *oceanicus* but an endemic species. The remaining 2 forms are members of the *scutellaris* groups of *Aedes* (*Stegomyia*); one appears to be true *polynesiensis* spread by natives, the other (sp. 22) may be an endemic form or a hybrid between such a form and *polynesiensis* (see Systematic Treatment).

References: Rageau (1959, 1958*a*:877–878); Iyengar (1955:46); Byrd and St. Amant (1959:52).

NIUE ISLAND.—Niue is an isolated island lying about 240 miles east of the Vavau group of Tonga (fig. **25**). It is located on one of an extensive group of small submarine rises in the ocean basin area between Tonga and the Southern Cook Islands (fig. **21**). The other submarine rises in the group are represented by reefs only. Niue is a comparatively large island with a total land area of slightly over 100 square miles and a population of about 4,800 Polynesians. It is composed entirely of raised coral with indications of at least two elevations in its terraced structure; the average height is close to 200 feet and the maximum about 240 feet. There are numerous caves at the base of the upper plateau or terrace. Mean monthly maximum and minimum temperatures are about 85° F. and 65° F. Rainfall is moderate, averaging about 80 inches a year, but there is considerable monthly and annual variation. Water is rapidly absorbed in the porous coral rock and soil; there are no streams but water collects in pools in some of the caves, where it tends to be brackish even at elevations of 60–70 feet above sea level. In spite of the thin soil, a great part of the island is wooded.

The only mosquito collections I have seen from Niue were made by M. O. T. Iyengar in 1957 and 1958. Only 2 species are represented in these collections (fig. **9**). The widespread *Culex* (*C.*) *sitiens* is considered here to be indigenous but it may have been spread by natives. The endemic *Aedes* (*Stegomyia*) *cooki* is a very interesting species of the *scutellaris* group which shows resemblance to *tongae* and *polynesiensis* and may have been produced through hybridization between stocks of one or both of these 2 forms spread by the natives from Tonga and Samoa respectively (see Systematic Treatment).

TOKELAU ISLANDS.—The Tokelau group (fig. **25**) consists of 3 low atolls (max. elev. about 15 ft.) located between the Phoenix Islands and Samoa, with a total land area of about 2,550 acres and a

population of about 1,750 Polynesians. Swain's Island should be included in this group but it is considered here under Samoa. The rainfall in the group is considerable but seasonal; there is no standing fresh water except in taro gardens on one island. Only 2 species of mosquitoes are known from the Tokelau group (fig. **9**): *Aedes* (*S.*) *polynesiensis* and *A.* (*Aedimorphus*) *nocturnus* (Laird, 1959), both undoubtedly brought in by the Polynesians.
References: Laird (1955*b*); Iyengar (1955:47); O'Connor (1923:42–45).

ELLICE ISLANDS.—The Ellice Islands (fig. **24**) are a group of 9 atolls and low coral islands stretching over a distance of about 360 miles south of, and more or less parallel with, the Southern Gilbert Islands. The most southern of the islands, Nurakita (Niulakita, Nukulakita), appears to be on the edge of the submarine Melanesian Border Plateau and is somewhat higher than the others. The remaining islands are in the ocean basin area. The total land area of the group is a little less than 10 square miles and the population about 5,200, chiefly Polynesians but with Micronesians on some of the islands. The rainfall is markedly greater than in the Southern Gilbert Islands, usually over 100 inches a year. Apparently there is standing brackish water and swampy areas on some of the islands. The 6 species of mosquitoes reported from the Ellice Islands (fig. **9**) are probably all introduced, although it is possible that *Culex* (*C.*) *sitiens* and *C.* (*C.*) *annulirostris* are indigenous. There is, in addition, an old report of *Toxorhynchites inornatus* and *Aedes* (*Mucidus*) *alternans* from Funafuti (Rainbow, 1897:96–97); neither of these species could possibly occur on Funafuti, and this report is undoubtedly based on mislabeled material or highly imaginative identifications.
References: Laird (1955*b*); Iyengar (1955:46); O'Connor (1923:30–37).

SOUTHERN GILBERT ISLANDS.—The Southern Gilbert Islands (fig. **24**) consist of 7 atolls and coral islands (max. elev. 12 ft.) of the Gilbert group which are located south of the equator. The total land area of the Southern islands is less than 70 square miles and the population about 15,000 Micronesians. These islands are overpopulated; some resettlement of Gilbertese has been done in the past and is continuing at present. Rainfall in these islands is low, the normal being about 40 inches a year, and prolonged periods of drought with 10–20 inches or less annually are not uncommon. There is apparently no standing water of any kind—not even brackish—on any island. Although mosquitoes have not been reported from any of the Southern Gilbert Islands, it is very probable that of the 4 species reported from the Northern islands, at least *Aedes* (*S.*) *marshallensis* occurs here—possibly also *Aedes* (*Aedimorphus*) *nocturnus*. The vector of filariasis is not known even on the Northern Gilbert Islands (see Disease Relations and Economic Importance).

PHOENIX ISLANDS.—The Phoenix group (fig. **25**) consists of 8 small atolls or low coral islands in the southern part of the central Pacific ocean basin. The total land area is about 18 square miles and the population about 1,200, chiefly composed of resettled Gilbertese on Gardner and Hull islands, but including some 325 persons residing on Canton Island in connection with an international refueling and servicing airport. Rainfall is in general variable and cannot be depended upon as a source of water. There is no exposed fresh water on any of the islands, but pools of brackish water may accumulate in the central depressions on some of the islands which have been worked in the past for their phosphate deposits. At present a few coconut plantations exist on the inhabited islands. I have seen no records of mosquitoes from the Phoenix group; it is likely that only introduced species occur here.

SOLOMONS AREA

Figs. **10-12, 19, 23**

ENTIRE AREA.—The Solomons area (figs. **19**, **23**) consists of (1) the Solomon Islands proper, a large complex group composed chiefly of large high volcanic islands (with some sedimentary rocks), located on the Solomons submarine ridge; (2) the elevated coral islands of Rennell and Bellona south of the Solomon Islands, located on the eastern end of the Rennell submarine ridge; (3) the coral atolls and low coral islands of Sikiana, Ontong Java, Nukumanu, Tauu, and Kilinailau north of the Solomons, located on the Ontong Java submarine rise; and (4) on geographical grounds only, the isolated islands of Nauru and Ocean, located near the equator in the ocean basin area. The total land area is about

15,300 square miles and the population about 172,500, including about 160,000 Melanesians (Solomons proper), about 3,500 Polynesians (outlying coral islands), about 6,000 Micronesians (including Nauruans and resettled Gilbertese), and about 3,000 Europeans, Chinese, Indians, Fijians, and other adventives.

Except for Nauru and Ocean Island, the area is entirely within the continental border area (fig. 21), but, as indicated above, it consists of three principal divisions, located on the Ontong Java rise, the Solomons ridge, and the Rennell ridge. To the east the area is separated by the deep Santa Cruz basin from the Santa Cruz–New Hebrides ridge. To the west the Solomons ridge is separated from the main islands of the Bismarck Archipelago by the very deep New Britain trench, with a depth of 9,140 meters in the Planet Deep off Bougainville. However, north of this separation there is an extensive area less than 3,000 meters deep which connects the Bismarck rise, the Caroline-Solomons ridge, the Ontong Java rise, and the Solomons ridge. Only a few small isolated depths of over 3,000 meters separate the Ontong Java rise from the Solomons ridge, and there are one or two chains of isolated islands (coral and volcanic) which continue on westward to the north of New Ireland. To the south, the Rennell ridge appears to be a continuation of the northern part of the Louisiade Archipelago; it is separated from the Solomons ridge by several small trenches of 5,000 meters in the Solomons basin; to the east, it appears to be related to a western rise from the New Hebrides ridge but is separated from it by continuous depths of 3,000 meters in the north of the New Hebrides basin.

All types of islands are present in this area but most (in the Solomons proper) are of complex volcanic and sedimentary formation. Earthquakes are common and severe in the Solomons; two active volcanoes are found on Bougainville, and evidence of recent volcanism is present elsewhere in the Solomons. In the Solomons the islands appear to be of different ages, and there is evidence of great uplift on several occasions in the past. The climate, topography, and vegetation are briefly discussed below under the Solomon Islands. Very little is known about the other islands except for Nauru and Ocean (see below).

The mosquito fauna of the area cannot be said to be well known, although extensive collections were made during wartime years in the Solomons (see below). To date 106 species have been reported from the Solomons area (figs. **10-12**), including 13 forms which are so imperfectly known that they are not formally named. Of the total, 102 species are known from the Solomons proper; the composition of the fauna is discussed under the treatment of these islands. Only 4 species are considered here to have been introduced to the area: *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* by Europeans and *Aedes* (*S.*) *hebrideus* and *A.* (*S.*) *varuae* by Polynesians to the outlying coral islands. Perhaps several other species were spread by the Melanesians into the area from the west; for the present, however, the remaining 102 species are considered to be indigenous. Of these, 79 appear to be endemic, 77 in the Solomons and 2 on Rennell and Bellona. All 3 subfamilies are represented in the area, as are all the tribes except the Dixini and Culisetini. Two of the tribes present in the Solomons, Hodgesiini and Ficalbiini, do not occur elsewhere in the South Pacific. The greatest variety of species groups is represented in the area; in most instances there are several species in each group. Quite conspicuous are 3 subgenera of carnivorous culicine mosquitoes —*Culex* (*Lutzia*), *Aedes* (*Mucidus*), and *Tripteroides* (*Rachisoura*)—in addition to *Corethrella,* which is also known from New Zealand, and *Chaoborus,* which has not been reported elsewhere in the South Pacific.

Disregarding Nauru and Ocean Islands, which are not significant, the area as a whole has a uniform, highly characteristic, well-balanced, tropical mosquito fauna. The only discordant element is on Rennell (and possibly Bellona), where the endemic *hoguei* of the *scutellaris* group of *Aedes* (*Stegomyia*) appears to be very different from representatives of this group that occur elsewhere in the Solomons. The fauna as a whole seems to be composed of segregates of groups represented by more advanced forms in the adjacent Papuan area, but there are several relicts which appear to be quite old and have no close relatives nearby. The relatively poor differentiation of many of the endemic species (nevertheless usually clear-cut in all stages), and the apparent hybrid origin of many forms, suggests that much of the fauna is of relatively recent development and that several dispersals have occurred from the west. This view is supported by the small number of forms (8 species) which are common to the Solomons area and to the rest of the South Pacific. However, there is an indication in the presence of several groups in common with the Fiji-Tonga-Samoa area, and with the Santa Cruz–

New Hebrides area, that earlier dispersals occurred through the Solomons area to the east before the present wide separation of these areas was achieved.

To summarize: the mosquito fauna of the Solomons is the most modern one in the South Pacific but it contains a number of apparently old relicts. It cannot be derived directly from the existing fauna of the Papuan area by chance dispersal of modern species, and appears to have been cut off from the west for a considerable period of time. The last dispersal from the west may have occurred relatively recently and apparently affected only the western groups of the Solomons. To the east, the Solomons area has also been cut off for a considerable time and has contributed little, if anything, in recent times to the fauna of the rest of the South Pacific. In the past it apparently formed a route through which dispersed much of the fauna of the Fiji-Tonga-Samoa area and some of the fauna of the Santa Cruz–New Hebrides area (for details, see under these areas).

SOLOMON ISLANDS.—The Solomon Islands proper (figs. **22**, **23**) constitute the bulk of the Solomons area with a total land area in excess of approximately 15,300 square miles and a population of about 165,000, chiefly Melanesians but with a few resettled Gilbertese and Tikopians, and adventive Fijians, Indians, Chinese, and Europeans. The archipelago is located on the so-called Solomons ridge and extends over a length of about 670 miles from northwest to southeast. It is usually described as a double chain of islands; in reality it is much more complex. Most of the area seems to be bounded by an isobath of 1,000 meters, but there is a central depression within this subdivision. Malaita and adjoining islands are enclosed by another 1,000-meter isobath and Ulawa, San Cristobal, and adjacent islands form another group at the eastern end. The entire Solomons ridge is separated to the north by a series of small areas of depths of 3,000 meters from the Ontong Java rise at the edge of the Caroline-Solomons ridge. To the south, it is separated from the Rennell ridge by the deep Solomons Basin, with isolated trenches of 5,000 meters; to the west, from the Bismarck Archipelago by the New Britain trench, which has a maximum recorded depth of 9,140 meters in the Planet Deep off Bougainville; and to the east, from the Santa Cruz–New Hebrides area by the Santa Cruz Basin, with a depth of 6,061 meters in the Torres trench.

There are 7 very large islands, about 20 to 30 smaller islands, and a large number of islets. Most of the larger islands are predominantly high, complex volcanic islands, which show evidence of several periods of volcanism probably dating from Cretaceous or early Tertiary times to the present; sedimentary and metamorphic rocks are known on several islands; evidently several periods of erosion, subsidence, and reëlevation have occurred; there are coral limestone terraces at several elevations up to about 1,500 feet. The various islands of the archipelago differ in these features; there are indications that the most recent elevation has not been uniform and that uneven tilting has occurred, particularly on Buka, Guadalcanal, and San Cristobal. Volcanic activity in the group is confined now to Bougainville, but there are fumaroles on Savo and Simbo. Earthquakes are not uncommon but are most frequent at the western end of the archipelago. There are a number of small islands composed entirely of coral.

All the main islands have a range of mountains as a backbone; other mountain complexes may also be present. The highest mountains are on Bougainville (10,171 ft. and 9,850 ft.) and Guadalcanal (8,005 ft.). Generally, flat coastal areas are not extensive; on the north side of Guadalcanal, however, there is a considerable coastal plain in the central part. All the larger islands are well watered and have numerous short rivers, which run relatively straight courses in deep, narrow valleys in the mountains but may meander on the coast. Owing to heavy sudden rainfall in the mountains, these rivers frequently rise very rapidly and temporarily flood the coastal plain. Lagoons are frequently formed near the mouths of the rivers; swamps, marshes, and more or less extensive mangrove areas are also found on some islands. The north and south coasts of most of the islands differ markedly in topography.

The climate of the Solomons is hot and humid. The monthly mean temperature is between 81° and 83° F. and does not vary more than 1° or 2° F. during the year; at sea level, temperatures seldom rise above 93° F. or fall below 70° F. The rainfall is usually heavy but quite variable; extremes of 70 inches and about 300 inches have been recorded at different localities on the north coast of Guadalcanal. There is a more or less definite rainy season (monsoons) lasting from November to April, but rainfall during the dry season (southeast trades) is usually considerable, particularly on the windward side of the islands. Extremely dry conditions for periods of about a month have been noted on Guadalcanal.

The islands are in general covered with a dense virgin tropical rain forest broken in a few places along the coast by coconut plantations, native clearings, and here and there small areas of scrub and grassland; the latter is extensive only on the north side of Guadalcanal. The flora is very poorly known and only the vertebrate fauna is more or less well known, particularly the birds (Mayr, 1931——, 1945). The Solomons as a whole have been little touched by civilization. The native Melanesians are chiefly concentrated in small coastal villages; only Malaita has a sizable population for its area (40,000 on about 2,000 square miles).

Prior to World War II, the mosquito fauna of the Solomons was known only from a few collections. During the war, intensive surveys were made chiefly around encampments on Guadalcanal, Bougainville, New Georgia group, Florida (Ngela) group, Russell group, and the Treasury Islands. To this day practically nothing is known from the interior of any of the islands; it is very probable that only a small percentage of the existing fauna of the Solomons is now known. The majority of the Solomons mosquito species have been reared individually so that correlation of the sexes and stages has been established with certainty. However, a considerable number of species are very poorly known and are not formally named.

The known mosquito fauna of the Solomons proper is a well-balanced and extensive one (figs. **10-12**). All 3 subfamilies are represented: the Dixinae by 1 species, the Chaoborinae by 2 species in 2 tribes, and the Culicinae by 99 species in 9 tribes and 12 genera. Of the total of 102 known species, *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* are recent European introductions and have been found only in settlements where Europeans and other adventives are concentrated. It is possible that several other forms were spread by Melanesians; for the present, however, the remaining 100 species are considered to be indigenous; of these, 76 are apparently endemic.

Of the 24 nonendemic species indigenous to the Solomons proper, (1) *Uranotaenia barnesi, Aedes* (*F.*) *albilabris,* and *Tripteroides* (*R.*) *solomonis* are endemic to the South Pacific, and the remaining 21 species occur in the Papuan area; (2) 8 species are not known in the South Pacific outside the Solomons proper: *Bironella hollandi, Anopheles punctulatus, A. koliensis, Uranotaenia lateralis; Culex* (*Culic.*) *papuensis, Aedes* (*E.*) *imprimens, Aedes* (*Aedimorphus*) *alboscutellatus, A.* (*L.*) *dasyorrhus;* (3) 8 species are not known naturally in the South Pacific outside the Solomons area: *Culex* (*C.*) *squamosus, C.* (*Lutzia*) *halifaxii, C.* (*Culiciomyia*) *fragilis, C.* (*Culic.*) *pullus, Aedes* (*F.*) *albilabris, A.* (*S.*) *albolineatus, A.* (*S.*) *gurneyi,* and *Tripteroides* (*R.*) *solomonis;* the latter may have been introduced to New Caledonia; and (4) only 8 species are known in the South Pacific outside the Solomons area: *Anopheles farauti* and *Aedes* (*V.*) *lineatus* in the Santa Cruz–New Hebrides area. *Uranotaenia barnesi* in the New Hebrides, *Aedeomyia catasticta* in Fiji, *Armigeres breinli* in the Santa Cruz group, *Culex* (*C.*) *sitiens* and *Aedes* (*O.*) *vigilax* in all South Pacific areas except New Zealand and Eastern Polynesia, and *Culex* (*C.*) *annulirostris* in all South Pacific areas except New Zealand.

The 76 endemic or probably endemic species are, for the most part, not very strongly differentiated from their relatives in the adjoining Papuan area and might be considered by some workers as subspecies of widely ranging forms. However, they are separable usually in all stages and are regarded here as good species which have differentiated in relatively recent times. There are in addition a number of clearly marked species which appear to have no relatives, or only distant ones, in the immediate vicinity to the west. Among these are *Dixina solomonis, Uranotaenia wysockii, Aedes* (*Geoskusea*) *perryi, A.* (*G.*) *longiforceps, A.* (*G.*) sp. 5, *Aedes* (*Christophersiomyia*) *chionodes, Tripteroides* (*Rachionotomyia*) *floridensis,* and *Corethrella solomonis.* It is possible that the groups to which these species belong have not yet been recognized in the Papuan area; for the present, they are considered to be relatively ancient relicts. In general all the endemic species of the Solomons appear to be more primitive than their known relatives immediately to the west. In some instances, as in some species of *Uranotaenia,* they seem more nearly to resemble forms found in the Indomalayan area than those reported from the Papuan area. Both ground pool-breeders and container-breeders are strongly represented, but the former tend to occupy specialized habitats. Of particular interest is the apparent intense speciation in the subgenera *Lophoceraomyia* of *Culex* and *Finlaya* of *Aedes.*

There appears to be considerable endemism and geographic differentiation of the mosquito fauna within the Solomons. In particular, the western group of Bougainville and adjacent islands has a number of forms not represented elsewhere, and also frequently has a distinct form complementary to one found elsewhere in the Solomons. The south-central group, composed of New Georgia and adjacent islands, also shows considerable endemism, as does the eastern group of Guadalcanal, Malaita, San Cristobal, and smaller islands. The north-central group is too poorly collected at present, but endemism in this area can be expected. In some species groups, there is evidently endemism at the level of individual islands, as in the subgenera *Lophoceraomyia* and *Finlaya*. However, on a given island, such as Guadalcanal, the mosquito fauna of the northern and southern coasts appears to be quite different, possibly influenced to some extent by the difference in climate and available habitats. Some of the apparent island endemism may be owing to spotty collecting since the major islands have not been surveyed uniformly, Guadalcanal chiefly on the north side, New Georgia and Bougainville on the south side.

Of great interest is the possibility that hybridization has played an important part in the development of the mosquito fauna of the Solomons. This, I believe, is clearly evident in the subgenus *Lophoceraomyia* of *Culex*, which is undergoing intense speciation at present (see Systematic Treatment). There is an indication that it is also occurring in the *kochi* group of *Aedes* (*Finlaya*). There is a strong possibility that in several other groups, species have been formed and stabilized through hybridization, particularly in the subgenus *Geoskusea* of *Aedes*, in the *punctulatus* and *lungae* complexes of *Anopheles*, in the *annulirostris* subgroup of *Culex* (*Culex*), and in the subgenus *Etorleptiomyia* of *Ficalbia*. This may have occurred when successive dispersals of the same basic stocks took place in the past through the Solomons area. Hybridization is apparently most intensive at the present time on Bougainville, which has seemingly experienced the most recent dispersal. Generalities on the affinities and history of the mosquito fauna of the Solomons are given above under the discussion of the entire area.

References: Iyengar (1955:42–43); Laird (1955*a*:278–288); Belkin (1953*a*, 1950); Perry (1949*b*); Belkin, Knight, and Rozeboom (1945); Lever (1934); Paine and Edwards (1929); Edwards (1926:109–110; 1925:257–258).

RENNELL AND BELLONA.—Rennell and Bellona Islands (figs. **21, 23**) lie close together within an extensive 1,000-meter isobath which also includes the Indispensable Reefs south of Rennell. This group is located on the eastern end of the Rennell submarine ridge, which extends from the Louisiade Archipelago and seems to be continued eastward toward a western rise from the New Hebrides ridge; the two rises are widely interrupted at the north end of the New Hebrides basin. Separating the Rennell ridge from the Solomons ridge is an arm of the Solomons Basin, which has three small trenches with depths of 5,000 meters. The two islands lie about 100 miles from Guadalcanal and San Cristobal.

Rennell (Munggava) is a moderately large elevated coral island about 49 miles in length and not more than about 8 miles in maximum width; its maximum elevation is over 500 feet and its total area about 250 square miles. Its population consists of about 1,250 Polynesians; some of the young males seek employment on the larger islands of the Solomons. Rennell is probably an elevated atoll since it has precipitous cliffs forming a high rim from which the ground slopes gently into a central depression. At the eastern end this depression is filled with an extensive lake which is only slightly brackish. Lake Tanggano is said to be the largest lake in the tropical South Pacific. It is about 17 miles long and 5 to 6 miles in maximum width; its surface is about 69 feet above sea level. Its depth probably exceeds 180 feet at the eastern end, but the western part is shallow and has numerous small islands. There are no streams on the island, although numerous springs of fresh water are said to be present at or below sea level at the base of the cliffs; there are a number of caves with water holes. During the rainy season water is said to stand on the surface of the ground. There are small taro gardens in swampy areas. Although the soil of Rennell is thin, the vegetation is dense and native trees are abundant.

Bellona (Munggiki) lies about 15 miles northwest of Rennell. It is a much smaller island, being only about 6 miles in length and 2 miles in maximum width. It is said to be uniformly about 250 feet in height but apparently there is a slight central depression. The soil is much more abundant than on Rennell and the vegetation denser. There are numerous caves in the cliffs and presumably some fresh water is present in these at or near sea level. There is apparently no standing fresh water on the plateau except in the swampy taro gardens. The population consists of about 530 Polynesians and a few Melanesians. There is considerable interchange virgin tropical rain forest broken in a few places along the coast by coconut plantations, native clearings, and here and there small areas of scrub and grassland; the latter is extensive only on the north side of Guadalcanal. The flora is very poorly known and only the vertebrate fauna is more or less well known, particularly the birds (Mayr, 1931——, 1945). The Solomons as a whole have been little touched by civilization. The native Melanesians are chiefly concentrated in small coastal villages; only Malaita has a sizable population for its area (40,000 on about 2,000 square miles).

Prior to World War II, the mosquito fauna of the Solomons was known only from a few collections. During the war, intensive surveys were made chiefly around encampments on Guadalcanal, Bougainville, New Georgia group, Florida (Ngela) group, Russell group, and the Treasury Islands. To this day practically nothing is known from the interior of any of the islands; it is very probable that only a small percentage of the existing fauna of the Solomons is now known. The majority of the Solomons mosquito species have been reared individually so that correlation of the sexes and stages has been established with certainty. However, a considerable number of species are very poorly known and are not formally named.

The known mosquito fauna of the Solomons proper is a well-balanced and extensive one (figs. **10-12**). All 3 subfamilies are represented: the Dixinae by 1 species, the Chaoborinae by 2 species in 2 tribes, and the Culicinae by 99 species in 9 tribes and 12 genera. Of the total of 102 known species, *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* are recent European introductions and have been found only in settlements where Europeans and other adventives are concentrated. It is possible that several other forms were spread by Melanesians; for the present, however, the remaining 100 species are considered to be indigenous; of these, 76 are apparently endemic.

Of the 24 nonendemic species indigenous to the Solomons proper, (1) *Uranotaenia barnesi, Aedes* (*F.*) *albilabris*, and *Tripteroides* (*R.*) *solomonis* are endemic to the South Pacific, and the remaining 21 species occur in the Papuan area; (2) 8 species are not known in the South Pacific outside the Solomons proper: *Bironella hollandi, Anopheles punctulatus, A. koliensis, Uranotaenia lateralis; Culex* (*Culic.*) *papuensis, Aedes* (*E.*) *imprimens, Aedes* (*Aedimorphus*) *alboscutellatus, A.* (*L.*) *dasyorrhus;* (3) 8 species are not known naturally in the South Pacific outside the Solomons area: *Culex* (*C.*) *squamosus, C.* (*Lutzia*) *halifaxii, C.* (*Culiciomyia*) *fragilis, C.* (*Culic.*) *pullus, Aedes* (*F.*) *albilabris, A.* (*S.*) *albolineatus, A.* (*S.*) *gurneyi*, and *Tripteroides* (*R.*) *solomonis;* the latter may have been introduced to New Caledonia; and (4) only 8 species are known in the South Pacific outside the Solomons area: *Anopheles farauti* and *Aedes* (*V.*) *lineatus* in the Santa Cruz–New Hebrides area. *Uranotaenia barnesi* in the New Hebrides, *Aedeomyia catasticta* in Fiji, *Armigeres breinli* in the Santa Cruz group, *Culex* (*C.*) *sitiens* and *Aedes* (*O.*) *vigilax* in all South Pacific areas except New Zealand and Eastern Polynesia, and *Culex* (*C.*) *annulirostris* in all South Pacific areas except New Zealand.

The 76 endemic or probably endemic species are, for the most part, not very strongly differentiated from their relatives in the adjoining Papuan area and might be considered by some workers as subspecies of widely ranging forms. However, they are separable usually in all stages and are regarded here as good species which have differentiated in relatively recent times. There are in addition a number of clearly marked species which appear to have no relatives, or only distant ones, in the immediate vicinity to the west. Among these are *Dixina solomonis, Uranotaenia wysockii, Aedes* (*Geoskusea*) *perryi, A.* (*G.*) *longiforceps, A.* (*G.*) sp. 5, *Aedes* (*Christophersiomyia*) *chionodes, Tripteroides* (*Rachionotomyia*) *floridensis*, and *Corethrella solomonis*. It is possible that the groups to which these species belong have not yet been recognized in the Papuan area; for the present, they are considered to be relatively ancient relicts. In general all the endemic species of the Solomons appear to be more primitive than their known relatives immediately to the west. In some instances, as in some species of *Uranotaenia*, they seem more nearly to resemble forms found in the Indomalayan area than those reported from the Papuan area. Both ground pool-breeders and container-breeders are strongly represented, but the former tend to occupy specialized habitats. Of particular interest is the apparent intense speciation in the subgenera *Lophoceraomyia* of *Culex* and *Finlaya* of *Aedes*.

There appears to be considerable endemism and geographic differentiation of the mosquito fauna within the Solomons. In particular, the western group of Bougainville and adjacent islands has a number of forms not represented elsewhere, and also frequently has a distinct form complementary to one found elsewhere in the Solomons. The south-central group, composed of New Georgia and adjacent islands, also shows considerable endemism, as does the eastern group of Guadalcanal, Malaita, San Cristobal, and smaller islands. The north-central group is too poorly collected at present, but endemism in this area can be expected. In some species groups, there is evidently endemism at the level of individual islands, as in the subgenera *Lophoceraomyia* and *Finlaya*. However, on a given island, such as Guadalcanal, the mosquito fauna of the northern and southern coasts appears to be quite different, possibly influenced to some extent by the difference in climate and available habitats. Some of the apparent island endemism may be owing to spotty collecting since the major islands have not been surveyed uniformly, Guadalcanal chiefly on the north side, New Georgia and Bougainville on the south side.

Of great interest is the possibility that hybridization has played an important part in the development of the mosquito fauna of the Solomons. This, I believe, is clearly evident in the subgenus *Lophoceraomyia* of *Culex*, which is undergoing intense speciation at present (see Systematic Treatment). There is an indication that it is also occurring in the *kochi* group of *Aedes* (*Finlaya*). There is a strong possibility that in several other groups, species have been formed and stabilized through hybridization, particularly in the subgenus *Geoskusea* of *Aedes*, in the *punctulatus* and *lungae* complexes of *Anopheles*, in the *annulirostris* subgroup of *Culex* (*Culex*), and in the subgenus *Etorleptiomyia* of *Ficalbia*. This may have occurred when successive dispersals of the same basic stocks took place in the past through the Solomons area. Hybridization is apparently most intensive at the present time on Bougainville, which has seemingly experienced the most recent dispersal. Generalities on the affinities and history of the mosquito fauna of the Solomons are given above under the discussion of the entire area.

References: Iyengar (1955:42–43); Laird (1955*a*:278–288); Belkin (1953*a*, 1950); Perry (1949*b*); Belkin, Knight, and Rozeboom (1945); Lever (1934); Paine and Edwards (1929); Edwards (1926:109–110; 1925:257–258).

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Mosquitoes have been collected on Rennell and Bellona apparently only six times: by S. M. Lambert in 1930 and 1933, R. H. Black in 1952, M. Laird and E. Laird in 1953, E. S. Brown in 1955, and J. de Beaux in 1956. A total of 14 species is now recorded from the two islands (figs. **10-12**). It is very difficult to determine whether these forms are native or introduced. *Aedes* (S.) *hoguei* of the *scutellaris* group appears to be an endemic species; this group is also represented by *hebrideus,* which was probably introduced from the Santa Cruz–New Hebrides area (see Systematic Treatment), and *gurneyi,* which is present in the Solomons and may have been introduced from these islands but is considered here to be indigenous. *Culex* (*Lophoceraomyia*) sp. 23 is known only from larvae; it is considered here to be an endemic species, but it is very close to other members of the *buxtoni* complex, which is represented in the Solomons and the New Hebrides. The remaining 10 species are provisionally regarded as being probably indigenous, although it is possible that all or the majority of them have been introduced. Lambert (1931, 1934) found no malaria and no *Anopheles* and later stated (Lambert, 1949:826–827) that malaria was introduced to these islands subsequent to his surveys. However, Rennell has a rather extensive indigenous fauna in other groups of animals and also has a high percentage of endemic species in some insects and in birds. Therefore it seems probable that a good share of its mosquito fauna is also native. The affinities of the mosquito fauna appear to be with the Solomons, but all the forms are so poorly known that it is possible that the populations in the two groups are really differentiated morphologically. Rennell and Bellona are of great zoögeographic interest as there is a possibility that a dispersal from the west occurred in the past along the Rennell ridge and may have even extended to the New Hebrides. It would be of great interest to have a thorough survey of mosquitoes of these islands, particularly an exhaustive search of plant-container habitats.

References: Laird and Laird (1959); Black (1952:11–19); Lambert (1931).

SIKIANA.—The Sikiana (Sikaiana, Stewart) group lies on the eastern end of the Ontong Java rise about 110 miles east of Malaita Island (figs. **21, 23**). It consists of five islands located on a triangular reef which drops off so steeply that vessels can approach within 200 yards of shore. The lagoon is also very deep and practically inaccessible from the sea. The main island of Sikiana is said to reach a height of 150 feet, but this probably refers to the tops of the trees. The population consists of about 390 Polynesians; many adult males leave for employment on the main islands of the Solomons. There is little fresh water on Sikiana but apparently considerable native vegetation, including some large trees from which canoes are made; there is also some mangrove in the lagoon and swampy low ground in which taro is cultivated. Five species of mosquitoes have been reported from Sikiana (figs. **10-12**). Although all of them are considered here to have been introduced, it is possible that *Culex* (*C.*) *annulirostris* is native. Of great interest is the presence of *Aedes* (S.) *varuae,* which was probably spread by natives from the Santa Cruz islands. *Anopheles farauti, Aedes* (*V.*) *lineatus,* and *Aedes* (*F.*) *hollingsheadi* are probably introduced from the Solomons. The latter species is of particular interest since it is a breeder in the leaf axils of pandanus. The population of this species on Sikiana is quite similar to that in the Solomons, and it appears probable that it has been introduced quite recently, probably with pandanus from the Solomons. The record of *Anopheles punctulatus* by Lambert (1934) actually refers to *farauti.*

Reference: Black (1952:8–11); Lambert (1934).

ONTONG JAVA.—Ontong Java (Lord Howe) is a very large atoll lying about 160 miles north of Santa Isabel Island of the Solomons in the middle of the Ontong Java rise (figs. **21, 23**). There are about 100 islands and islets on the reef but only three, Luangiua (Leuaniua), Avaha, and Hungaaka (Henguakaha), are permanently settled. The population consists of about 810 Polynesians. The islands are low but have considerable areas of freshwater and brackish swamps. Mosquitoes are said to be very numerous and annoying. At the present 5 species are known from the atoll (figs. **10, 12**) and, in addition, *Aedes* (*E.*) *imprimens* has been reported; this record is undoubtedly incorrect and may actually pertain to *Armigeres breinli.* For the present, all the species are considered to have been spread by the natives, although it is possible that at least *Culex* (*C.*) *sitiens* and *C.* (*C.*) *annulirostris* are native. *Aedes* (S.) *hebrideus* was probably brought

in originally by the Polynesians. *Anopheles farauti* and *Aedes* (*V.*) *lineatus* were probably spread from the main islands of the Solomons, where some of the inhabitants of Ontong Java have worked in the past. A program for the eradication of *Anopheles farauti* was started in 1954.
References: Brown (1955); Black (1952:4–8).

OTHER OUTLYING ATOLLS.—North of the Solomon Islands there are three inhabited atolls in addition to Ontong Java: Kilinailau (Carteret), Tauu (Mortlock, Marqueen), and Nukumanu (Tasman). They are located on the Ontong Java submarine rise and, except for Kilinailau, are sparsely populated by Polynesians. Kilinailau, which has about 450–500 Melanesian emigrants from Buka, is about 40 miles northeast of Buka and comprises 7 low islets. Tauu is about 90 miles east of Kilinailau and consists of 23 low islets with a population of about 200. Nukumanu is about 170 miles east of Tauu and about 34 miles north of Ontong Java; it consists of about 40 islets and has a population of about 100. Mosquitoes have not been reported from any of these islands.

NAURU.—Nauru (Pleasant Island) is an isolated, elevated coral island located on a submarine rise near the equator some 165 miles west of Ocean Island (figs. **21, 22**). Its area is about 8 square miles and its population about 4,500, consisting of 2,200 Nauruans (origin unknown but showing mixture of Polynesian, Micronesian, and Melanesian features), 1,200 other Pacific islanders (chiefly Gilbertese), and about 1,100 Europeans, Chinese, and other adventives. There is a ring of coastal lowland, principally of coral debris and sand, from which the land rises steeply to a height of over 100 feet. The interior of the island is an undulating plateau with occasional low hills and towering masses of coral (highest elevation 213 ft.). Average annual rainfall is about 89 inches, but it varies from 12.29 inches to over 180 inches. There is one large brackish water lagoon in the interior, several small brackish or salt coastal lagoons, and numerous caves with water. The vegetation of the island is limited and not luxuriant except during the rainy season. The island is well known for its rich phosphate deposits, which are extensively exploited, more than 20,000,000 tons having been exported to date. The known mosquito fauna of Nauru (figs. **10, 12**) consists of 4 species: (1) the European introductions *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* and (2) *Culex* (*C.*) *sitiens* and *C.* (*C.*) *annulirostris,* which are also considered here to be introduced but may actually be native. It is possible that *Aedes* (*S.*) *marshallensis* has been introduced to Nauru by the Gilbertese or Nauruans.
Reference: Iyengar (1955:46).

OCEAN ISLAND.—Ocean Island (native name Banaba) is an elevated coral island on an isolated submarine rise situated about 165 miles east of Nauru (figs. **21, 22**). Its area is about 1,500 acres and its population about 2,500 Gilbertese and 300 Europeans and Chinese. The native Banabans were resettled on Rambi island in Fiji after World War II. The island has a central plateau, about 265 feet high and nearly flat (max. elev. 280 ft.), which descends fairly regularly to the coastal cliffs (12 to 30 ft. in height) except for a short stretch on the south. Droughts are common on Ocean Island; there is no surface water except in the numerous caves. The native vegetation is limited, and the island has been and continues to be exploited for its extensive phosphate deposits. I have seen no specimens or records of mosquitoes from Ocean Island; it is likely to have a fauna similar to that of Nauru but even more restricted.

BIONOMICS AND DISPERSAL

Knowledge of the bionomics of the mosquitoes of the South Pacific, so essential to an understanding of the history and dispersal of the fauna, is unfortunately very meager; for the majority of species, it is largely confined to field notes on breeding sites and biting habits. Laird (1956) has made the only extensive comparative study of mosquitoes and freshwater ecology in the South Pacific, but he deals with only 47 of the commoner South Pacific species and with 7 Australian forms. Bick (1951) discusses more briefly the ecology of 17 species of mosquito larvae from New Guinea, 16 of which are also found in the South Pacific. In spite of the paucity of data, some inferences can be made; these may be of value in explaining the nature of the mosquito fauna and its development. The known bionomics of the South Pacific forms are briefly discussed in the Systematic Treatment under each species and group. Information on breeding sites and human blood feeding is summarized in the conspectus of the mosquitoes of the South Pacific (figs. 1-5).

In most instances, no direct evidence is available as to the actual methods of dispersal of mosquitoes in the South Pacific. It is only on the basis of a correlation between the known distributions and some feature of the bionomics that inferences can be made as to the manner in which dispersals have taken place. In general, it appears that the most significant bionomic features for dispersal over ocean barriers and survival under changing environmental conditions are the following: (1) ability to survive unfavorable environmental conditions in one or more stages, (2) tolerance of salt in the egg stage as well as in the breeding sites, (3) utilization of a wide range of breeding sites, characteristic of general breeders, or (4) utilization of a highly specialized habitat which is likely to remain stable under changing environmental conditions, and (5) "flight range" of the adults, primarily females. It is assumed, perhaps unjustifiably, that the bionomics of the various species have been essentially the same in the past, when dispersal occurred, as they are today. Negative evidence is used here in correlating distribution and bionomic features; this is, of course, not always reliable since some forms, perhaps many, may have been overlooked in many parts of the South Pacific. However, the use of negative evidence may not be a serious source of error in most instances, since it is almost never restricted to a single species but involves entire groups.

BREEDING SITES.—The availability of suitable breeding sites determines to a large extent the successful establishment of a species in a new area to which it is dispersed. Much general information on the breeding sites utilized by individual species in the South Pacific has been accumulated. This is summarized in the conspectus of the species (figs. 1-5). Laird (1956) made a comparative ecological study of some of the sites, including all the associated biota and some physical factors. A great variety of apparently suitable habitats are present in the South Pacific, but they are not always utilized everywhere within the area by species or groups that might be expected to exploit them. Breeding sites have been classified in many different ways in the South Pacific and elsewhere (see Laird, 1956:129–181), for our purposes they can be divided into two principal categories: (1) the ground water habitats and (2) the plant-container habitats.

The ground water habitats are undoubtedly the primitive breeding sites of the Culicidae. They range from general ground pools to many highly specialized restricted habitats such as rockholes and crabholes. Species that occupy them range accordingly from generalized breeders, which use a wide variety of general pools, to specialized breeders restricted to one type of habitat. Only occasionally do some species overlap between ground pool habitats and some container habitats, but never with the most specialized of the latter. Ground water habitats are available in varied quantity and diversity on the existing high islands of the South Pacific, but are scarce or absent on the low, and even on the majority of the elevated coral islands on which water quickly percolates through the porous coral soil. They are most numerous and varied on the larger, more stable, and older high islands, and are few and specialized on the younger volcanic islands; they are presumably not present on new volcanic islands. Therefore it appears that this category of habitats is not stable and may have been very restricted during some periods in the past in some of the island groups. This view is supported by the general scarcity of species utilizing this category of habitats on the majority of the islands of the tropical South Pacific except New Caledonia and the Solomons. Of great importance from the standpoint of dispersal and survival of species utilizing these habitats is the ability to tolerate salt and a wide range of aquatic conditions, as in *Culex* (*C.*) *sitiens*, *C.* (*C.*) *annulirostris*, and *Aedes* (*Ochlerotatus*) *vigilax*, or to specialize in a restricted habitat which is likely to persist under changing conditions. Examples of such habitats are crabholes in *Aedes* (*Levua*) *suvae* and the subgenus *Geoskusea* of *Aedes*, drying pools in *Culex* (*C.*) *albinervis*, and small shallow swamps in *Mansonia* (*C.*) *fijiensis*. Utilization of the more specialized ground water habitats appears to be conducive to speciation; this is particularly evident in the subgenera *Lophoceraomyia* and *Neoculex* of *Culex* and the subgenus *Geoskusea* of *Aedes* (see Systematic Treatment).

Although the plant-container category of habitats is a derived one, it appears to provide a more stable environment for mosquito breeding than the ground pool category in the tropics in general and the South Pacific tropical islands in particular. Plant-container habitats are found on all types of islands, including elevated coral islands and even some low coral islands, but they are not always utilized, particularly on the latter. During periods of environmental change it is probable that container habitats are less altered and persist longer than ground water habitats. On new islands, coral or volcanic, vegetation appears before general accumulation of ground water suitable for mosquito breeding. Container habitats are also less subject to flushing by tropical rains. Utilization of these confined microhabitats seems to be very conducive to speciation and preservation of forms. Apparently there is a great deal of variation in the physical conditions and the biota, not only in the different types of container habitats but even in individual containers at different levels on a single plant, as in the leaf axils of members of the Pandanaceae. There is considerable variation in the degree of specialization of species utilizing container habitats. Some species, notably members of the subgenera *Culex, Lutzia,* and *Culiciomyia* of *Culex,* may use general or specialized ground pools as well as treeholes and artificial containers. Quite a number of ground pool-breeders in many genera are occasionally found in large treeholes. Some treehole-breeders are generalized and may also utilize leaves and other plant parts on the ground or even rockholes containing leaves. A few of the treehole-breeders are salt tolerant; *Aedes* (*Lorrainea*) *dasyorrhus* is apparently specialized to treeholes with brackish water, while *Aedes* (*Stegomyia*) *polynesiensis* and *A.* (*S.*) *pseudoscutellaris* use crabholes at least in some instances. There is apparently little or no specificity as to the host plant in treehole-breeders, and many such forms are known to utilize artificial containers of various types for breeding. On the other hand, breeders in leaf axils and particularly pitchers tend to be confined to such habitats; only in rare instances are they found in other types of containers. However, exceptions are to be expected and are, in fact, known in the South Pacific in *Uranotaenia quadrimaculata* and possibly *Aedes* (*Finlaya*) *oceanicus.*

The most numerous and successful introductions of mosquitoes by man have been accomplished with container-breeders and ground pool-breeders prone to utilize artificial containers as breeding sites. Either natural or artificial containers on canoes and ships provide suitable habitats for the development of these forms; several generations may be produced during a trip so that a sizable population may be introduced to a new area.

EGGS.—Only general information on the types of eggs is available for mosquitoes indigenous to the South Pacific. Various adaptations to survival under unfavorable environmental conditions are evident in this stage. It seems that some types of eggs, as indicated below, are particularly well suited to natural dispersal over considerable distances. Resistance to desiccation, salt tolerance, number of eggs, and place of deposition appear to be of particular importance in determining successful dispersal in this stage. It is generally regarded now that the eggs of mosquitoes are laid in favorable environments rather than scattered at random, and that there is a high but varied degree of specialization in this respect reflected by the type of breeding site in which the larvae and pupae are found.

The eggs of ground water-breeders are of two types: (1) the resistant, diapausing eggs of temporary pool *Aedes* (possibly some others), which are laid out of water, are resistant to desiccation, and may remain viable for years after an initial conditioning period in a moist environment, and (2) the nonresistant eggs laid on or below the water surface, free or attached to plants or objects, which presumably cannot survive desiccation for more than a few days, and which normally hatch within 2 to 4 days. The resistant eggs may be laid singly and free or may be attached to objects (*Aedes* (*V.*) *carmenti*). There is a possibility that this type of egg if found in the open can be picked up and transported in the air during tropical hurricanes; there is also the possibility that some of them can be carried by man with soil or attached to plants such as taro. The nonresistant eggs may be laid singly (anophelines, some *Culiseta,* some *Mansonia*) or in groups or rafts (*Culex; Uranotaenia;* some *Ficalbia, Culiseta,* and *Mansonia;* probably *Aedeomyia* and *Hodgesia*). The floating eggs, single or in rafts, are hydrophobic and could possibly be transported by aquatic or marsh birds (particularly ducks, swamphens, and rails). In this connection, it is of interest that mosquitoes which lay egg rafts and are salt tolerant are widely distributed in the South Pacific, as are the above-mentioned birds; an introduction of an egg raft could easily result in the establishment of a population.

Very little is known about the eggs of plant container-breeders; apparently the majority of forms lay such eggs singly. In the Aedini the eggs are usually laid above the water surface; they are known to be resistant to desiccation and are diapausing in some species and presumably so in others. Some occasional treehole- and artificial container-breeders, such as species of *Culex,* lay egg rafts, but these forms are not truly adapted to container breeding. I have never seen egg rafts in leaf axils of plants, although I have searched for them diligently in specialized species of *Culex* that occupy such habitats. It seems probable that most specialized container-breeders have resistant and diapausing eggs. It is difficult to see how eggs deposited in such confined spaces could be dispersed by natural means over ocean barriers unless they are rafted with the host plant. For a dispersal to be accomplished in this manner, the eggs would have to be salt tolerant; this does not seem to be true except by inference in *Aedes* (*Lorrainea*) *dasyorrhus*, *Aedes* (*Stegomyia*) *polynesiensis*, and *A.* (*S.*) *pseudoscutellaris*. However, dispersal by man of other forms that use artificial containers may have been accomplished partially in the egg stages, but more probably as larvae and pupae in natural or artificial containers (see Breeding Sites). Of particular interest is the possible spread in the egg stage of *Aedes* (*Finlaya*) *oceanicus* and *A.* (*F.*) *hollingsheadi* by Polynesians. The first species breeds in the leaf axils of taro and pandanus, the second only in pandanus. Both plants are transported in canoes and it seems possible that, if the eggs of these species can withstand desiccation and some exposure to salt, introduction can take place in this stage. The possibility of transport of these species by man in the larval and pupal stages cannot be disregarded, however, since these stages may be quite resistant to desiccation (see Larvae and Pupae).

LARVAE AND PUPAE.—Little is known about the specific requirements of the larvae and pupae of mosquitoes of the South Pacific other than by inference from the conditions found in the breeding sites. Of importance from a standpoint of dispersal in these stages is the type of habitat utilized, resistance to desiccation, and tolerance of salt and other conditions in the habitat.

In ground water-breeders, the larvae and pupae show a wide range of adaptations to specialized habitats; in general, however, few forms tolerate salt, use a wide range of habitats, or can survive complete desiccation for more than a few hours. Special adaptations to partial desiccation are apparently present in some forms, notably in some species utilizing shallow temporary jungle pools (*Aedes* (*V.*) *carmenti*) and fluctuating waters (*lungae* complex of *Anopheles*).

Among the plant container-breeders, there appear to be fewer forms adapted to a wide range of conditions and more with narrow specializations. The leaf axil-breeders, which are often found in extremely shallow water, are apparently capable of surviving partial desiccation for considerable periods, are usually provided with elongate hairs which may prevent their being flushed out of an axil, and may even be able to crawl and fall to a more favorable habitat (Laird, 1956:174).

In general, it appears that natural dispersal in the larval and pupal stages is very limited, cannot occur over ocean barriers, but can be accomplished on land, chiefly by flooding. However, it seems quite clear that some container-breeders and some ground pool-breeders prone to using artificial containers have been transported by man in the larval and pupal stages (see Breeding Sites). In addition, it is possible that some leaf axil-breeders such as *Aedes* (*Finlaya*) *oceanicus* and *A.* (*F.*) *hollingsheadi*, which can apparently withstand some desiccation in the larval stage, may have been transported as larvae and pupae (and possibly as eggs also) over relatively short distances.

ADULTS.—Practically no direct information on adult bionomics of South Pacific mosquitoes is available except for blood feeding and time of activity of some members of the Culicinae. Although it is generally believed that females of most species of this subfamily require a vertebrate blood meal for the production of eggs, it is doubtful that this is always the case. In several groups of South Pacific mosquitoes, notably *Uranotaenia*, blooded females have never been collected in the field. It is known that in some species of several genera which normally take a blood meal, eggs can be produced without a blood meal if the larval nutrition is adequate. In the South Pacific only 50 species have been reported to feed on man readily or occasionally. The natural hosts of blood-feeding species are not definitely known, but it is probable that they are birds. Since birds are abundant on nearly all the islands of the South Pacific, it appears that the dispersal of mosquitoes in this area is probably not directly limited to any extent by the availability of a source of blood for the females.

The daily cycle of activity is known only for those species that feed on man; these include diurnal, crepuscular, and nocturnal forms. In addition, a few other forms have been collected at artificial lights, presumably indicating nocturnal activity in these species. The adults of many forms have never been collected in nature and are known only from specimens reared from larvae or pupae. Others have been collected only in the immediate vicinity of the breeding sites. The period of activity in most forms appears therefore to be limited, and much of each

24-hour cycle is spent resting in protected favorable microhabitats. This suggests that the majority of species are very sensitive to environmental factors. Few forms have been found resting in aggregations; the majority apparently rest scattered through the jungle in the vicinity of breeding sites.

Natural dispersal of mosquitoes is undoubtedly accomplished chiefly in the adult stage through the air, and the females are the effective sex. Few observations and no experimental data are available on the "flight range" of South Pacific species. The term "flight range" is a loose and misleading one, for it implies active flight by the mosquito. Much of the actual dispersal through the air may be passive carriage in air currents. However, it is very difficult in some instances to separate the *active* and *passive* phases of aerial dispersal; undoubtedly the two phases are often combined. In active aerial dispersal the adult mosquito apparently flies against the wind, as do many other Diptera as well as other insects. Active flight probably occurs only when the wind velocity is low. Moderate winds usually force the mosquitoes into shelter, while stronger air currents may pick them up and carry them over considerable distances. The distance that can be traversed in active flight over ocean barriers is not known for any mosquito species; specimens collected on ships anchored a considerable distance offshore are usually nocturnal forms, probably carried there by offshore breezes. *Anopheles farauti* has been collected on a boat 600 yards from the shore in the New Hebrides (Belkin, Knight, and Rozeboom, 1945:261). Laird (1956:8–9) reports periodic invasions by *Aedes* (*S.*) *pseudoscutellaris* (? *polynesiensis*) of an islet without obvious breeding sites, about 2 miles from Viti Levu, Fiji; however, in this instance no check was made of possible breeding in crabholes on the islet. It has been suggested that "mass flights," similar to those reported elsewhere in the world, occur in some species of ground pool-breeding *Aedes* of the South Pacific, notably *A.* (*O.*) *vigilax* and *A.* (*Aedimorphus*) *nocturnus* (Laird, 1956:9). There is no direct evidence, however, that such flights occur in the South Pacific over ocean barriers, and it is possible that the wide distribution of these species in this area is the result of dispersal of adults or eggs in hurricanes or human transport of eggs, in *nocturnus* at least.

Several factors appear to be important in the natural aerial dispersal of mosquitoes over ocean barriers: (1) extent and place of active flight, (2) location of resting places, (3) density of population, and (4) longevity of the females and their ability to survive unfavorable environmental conditions. For successful establishment in a new area, the type of egg laid and the type of breeding site utilized are also important, of course. It appears that in the majority of species in the entire South Pacific, only a few forms are capable as adults of normally crossing ocean barriers of more than a few miles. Certainly existing ocean barriers of less than 150 miles have effectively prevented dispersal; to judge by the regional differentiation in the Solomons, gaps of only 10 miles are effective for many species. The majority of species, particularly those utilizing container habitats and specialized ground habitats, are found as adults in protected places, do not venture far from their breeding sites, appear to be very sensitive to unfavorable environmental conditions, and usually have very small populations. It seems most unlikely that their dispersal could have been accomplished by aerial carriage as adults over the existing ocean gaps nearly everywhere in the South Pacific. However, it seems possible that some general ground pool-breeders found in large numbers along the coasts are more hardy as adults and could be dispersed in this stage over rather extensive ocean barriers. This may account in part for the wide distribution of such species as *Culex* (*C.*) *sitiens*, *C.* (*C.*) *annulirostris*, and possibly *Aedes* (*O.*) *vigilax*, *A.* (*Aedimorphus*) *nocturnus*, and several other widespread forms.

DISPERSAL.—As indicated in the previous paragraphs, mosquitoes may be dispersed in all stages and in a wide variety of ways. There is no direct evidence or experimental data on the manner in which dispersal actually takes place; only inferences can be made from correlations between known distributions and some information on the bionomics of the various stages. It is frequently difficult, if not impossible, to determine the method of dispersal; in some widespread species, it appears that several methods may have been used. A general summary of dispersal methods and their relative importance in the South Pacific is given here. As far as I have been able to determine, no special study of dispersal methods in mosquitoes has ever been made; therefore, it is likely that I have overlooked some methods that do not appear to be obvious in the fauna of the South Pacific. Attention is given here only to those methods which could account for dispersal over wide ocean barriers and with the current and wind patterns as they exist today between island groups.

For our purpose, dispersal in mosquitoes may be accomplished in two principal ways: (A) through human agency and (B) by natural means.

A. *Human agency.* Dispersal of mosquitoes by man is a common occurrence in the South Pacific, but it appears to be restricted to a few species with unusual breeding habits and a wide tolerance of environmental conditions. Dispersal may take place in all stages, but over ocean barriers it is most effective in the form of breeding populations and therefore involves chiefly those species which utilize container habitats habitually or occasionally. The principal means of dispersal by man are (1) aircraft, (2) sailing, steam, and motor ships, (3) native canoes, and (4) land vehicles and miscellaneous methods.

1. Aircraft. The dispersal of mosquitoes in aircraft has been emphasized in recent years. Living adults of numerous species of mosquitoes and other insects have been intercepted in commercial airplanes in many parts of the world. Although introduction of mosquitoes in this manner is undoubtedly possible, evidence of such introduction and subsequent establishment of nonindigenous species in the South Pacific is difficult to find. During the period of intensive wartime air traffic in the South Pacific, the only introduction which may have been made in this manner was that of a member of the *atripes* group of *Tripteroides* (*Rachionotomyia*), provisionally regarded as *solomonis*, on New Caledonia. Even this is questionable, however, and the form has not become established (see Systematic Treatment). It has been suggested that several other species have been introduced as adults on aircraft in the South Pacific and have subsequently become established (Rozeboom and Knight, 1946:117; Laird, 1956:10–12). These suggestions are based on finding a species near an airfield in areas where it was supposedly not known before. Such hasty conclusions are not warranted anywhere in the South Pacific, for no part of this area has been thoroughly and systematically collected; it is very possible that the species in question has been overlooked or not recognized. This has proved to be true with *Anopheles koliensis* on Guadalcanal and with *Aedeomyia catasticta* on Fiji, both of which had actually been collected in their respective areas prior to the establishment of any airfields in these areas, although they had not been recorded in literature (see Systematic Treatment). I suspect that the same applies to the supposed introductions by aircraft of *Aedes* (*O.*) *vigilax* on Fiji and of *Culex* (*C.*) *bitaeniorhynchus* on New Caledonia; both forms are also capable of dispersal to these areas by natural means (see below). Laird (1956:10) has pointed out some of the factors necessary for the successful establishment of species introduced by aircraft; it appears to me that the most important limiting factor is the small number of individuals transported in this manner. In addition to adults, it is possible that other stages of mosquitoes may be transported by aircraft, principally resistant eggs in soil or on roots and rhizomes and other parts of plants.

2. Ships. For more than 150 years, ships of all descriptions have been plying the South Pacific, engaged in exploration, missionary activities, whaling, and other commercial enterprises. These have been potent agents of mosquito dispersal. The early sailing vessels were of particular importance because of numerous water containers on board, as well as livestock and gardens in some instances. Although all stages of mosquitoes could have been transported on these ships, it is evident that only those forms which breed usually or occasionally in containers were dispersed effectively over wide areas in the South Pacific. The ubiquitous *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* were undoubtedly introduced into the South Pacific as breeding populations; both forms are still restricted everywhere in the South Pacific to settlements of Europeans and other adventives. It is probable that *Aedes* (*F.*) *notoscriptus* was also introduced in this manner into New Zealand and probably in part into New Caledonia (see Systematic Treatment). Other habitual or occasional container-breeding species indigenous to the South Pacific may have been spread in this way, but it is difficult to tell if this has been the principal method of dispersal of these species. Probably *Aedes* (*S.*) *polynesiensis* has been spread partly in ships; the record of *Culex* (*C.*) *annulirostris* breeding in a hold of a ship in Auckland (Graham, 1939:211) suggests that this species, and probably *C.* (*C.*) *sitiens* also, has been dispersed at least in part on ships. It is also possible that adults —and not necessarily breeding populations—can be introduced on ships; again this cannot be determined with certainty in the South Pacific, although it appears that at least *Anopheles gambiae*

was successfully introduced in this stage from Africa to Brazil. The statement of Laird (1954*a*:290) that *Culex* (*C.*) *bitaeniorhynchus* was introduced by ship or aircraft into New Caledonia is a questionable one, for this species could have dispersed just as well by natural means. The report of Graham (1939:213) of adult anophelines on board ships in Auckland is probably in error; even if it is correct, no establishment of the species has occurred (see Systematic Treatment). Resistant eggs of mosquitoes can also be transported in soil or in or on plants, and this may account in part for the wide distribution of some species of *Aedes*, such as *nocturnus*, *lineatus*, and *vigilax*. The distribution of *nocturnus* is a very puzzling one; it is not beyond the realm of possibility that this form is actually a strain of *vexans* that has been dispersed, in part at least, in soil and on plants carried on ships from the west and that it is not really indigenous to the South Pacific.

3. Native canoes. Prior to the entry of Europeans into the South Pacific, human dispersal of mosquitoes was undoubtedly accomplished in native canoes. As with ships, effective dispersal over considerable ocean barriers probably occurred chiefly in the form of breeding populations, but transport of resistant eggs and resistant larvae and pupae may have taken place also. Salt tolerance appears to be an important factor in enabling species to be transported considerable distances in canoes. Several members of the *scutellaris* group of *Aedes* (*Stegomyia*) are known to breed in canoes; the distributions of *polynesiensis*, *hebrideus*, *varuae*, and *marshallensis* clearly indicate that these species have been distributed in native canoes. Possibly other members of this group—and almost certainly *Tripteroides* (*R.*) *melanesiensis*—have also been transported in this manner. *Culex* (*C.*) *annulirostris* and *C.* (*C.*) *sitiens* also undoubtedly have been dispersed in native canoes, probably as breeding populations. I consider too that *Anopheles farauti* may have been introduced in canoes to Sikiana and Ontong Java from the Solomons, although it is possible that it dispersed there by natural means (birds). It seems doubtful that adult mosquitoes that cannot breed in canoes have been dispersed in them except for very short distances. Of particular interest is the probable dispersal in canoes of two breeders in the leaf axils of taro and pandanus, *oceanicus* and *hollingsheadi* of the *kochi* group of *Aedes* (*Finlaya*). They could have been transported as resistant eggs and resistant larvae and pupae in the axils of these cultivated plants carried by the natives on extensive voyages. Transport of these forms has been possible for relatively short distances, possibly because of limited tolerance of salt spray or desiccation. It seems probable also that *Aedes* (*V.*) *lineatus* and *A.* (*Aedimorphus*) *nocturnus* have been spread by natives as resistant eggs attached in soil to the rhizomes of taro; both species are frequently found in taro gardens. It is of interest that dispersal in native canoes has not been accomplished over the wide gap between Fiji and the New Hebrides. Buxton and Hopkins (1927:103) suggested that *tongae* was distributed in part in canoes from Tonga to Sikiana, but it is shown in the present study that the "*tongae*" of Sikiana is a different species (*varuae*), which was probably originally native to the Santa Cruz Islands.

4. Land vehicles and miscellaneous. Vehicles and other methods of conveyance on land are undoubtedly important human agencies of mosquito dispersal. They are of no interest here, however, and will not be discussed.

B. *Natural means.* Natural dispersal includes all agencies other than man. The vast majority of South Pacific mosquitoes appear to have attained their present distributions without the aid of man. Natural dispersal is possible in all stages but probably takes place over extensive ocean barriers only in the adult and egg stages. The following appear to be the principal means of natural dispersal: (1) active flight, (2) passive wind dispersal, (3) floods and flushing of containers, (4) rafts and drift, and (5) transport by animals other than man.

1. Active flight. Active flight is undoubtedly the most important natural method of dispersal over continuous land, but it appears to be ineffective over ocean barriers in the South Pacific except for very short distances. Judging by the distribution and the habits of mosquitoes of the South Pacific, most species apparently have a very short active flight range and tend to be restricted even to individual islands in an island group. This is particularly true of the forms that utilize restricted and specialized container and ground pool habitats. It is difficult to separate active flight, which normally takes place against a weak air current, and passive carriage with strong winds, which may perhaps be combined with it in some instances. The reported long "flight range" of some ground pool breeders is probably chiefly accomplished by passive wind dispersal.

2. Passive wind dispersal. Passive wind dispersal may be accomplished probably only in the adult

and egg stages. It is unlikely that larvae and pupae could normally survive wind dispersal, but perhaps this may occasionally occur over short distances. The present pattern of winds and hurricanes in the South Pacific (see Climate) is not generally conducive to dispersal of mosquitoes from island group to island group from the west eastward. However, the surface winds in the tropical South Pacific are known at times to blow from a westerly direction as far east as Tahiti; these winds, usually severe, could be involved in the dispersal of mosquitoes. There is no clear evidence of this, however, in the known distributions. Within island groups, surface winds are irregular and may assist in dispersal in all directions; of particular importance may be the nocturnal offshore breezes. Hurricanes in the South Pacific are at the present predominantly in the central area, do not affect the major land masses on the west and northwest, and run chiefly in a southern or southwestern direction in the west and in a southern and southeastern direction in the east. Their effect is thus rather local and could not account for the general dispersal pattern from the west. The westerly jet stream is, in general, above 16,000 feet in the tropical South Pacific; it does not seem likely that it could be a major factor in mosquito dispersal. The known distributions of South Pacific mosquitoes suggest that the majority of forms have not been dispersed aerially by winds of a pattern which prevails at present and over ocean barriers as they exist today. The majority of forms do not seem to be able to get across barriers of even a few miles, as shown by regional differentiation within island groups. As indicated above, most forms rest in protected areas and are apparently very sensitive to environmental changes, particularly breeders in containers as well as specialized ground habitats. Only a few general ground pool-breeders may have been dispersed aerially as adults, notably *Culex* (*C.*) *annulirostris, C.* (*C.*) *sitiens,* possibly *C.* (*C.*) *starckeae, Mansonia* (*C.*) *xanthogaster, Aedes* (*Aedimorphus*) *nocturnus, Aedes* (*H.*) *australis,* and *A.* (*O.*) *vigilax.* These are found in open situations and may reach sufficiently large populations. However, all of them may be more effectively dispersed by other natural means. Resistant eggs of such ground pool-breeders as *Aedes* (*O.*) *vigilax, A.* (*H.*) *australis, A.* (*V.*) *lineatus,* and *A.* (*Aedimorphus*) *nocturnus* could be transported over considerable ocean barriers in hurricanes. On the other hand, it is improbable that resistant eggs of container-breeders, even if they can be picked up in violent storms, could reach a suitable environment for development. Although the distribution of *nocturnus* is suggestive of dispersal of eggs in hurricanes from Fiji or Samoa westward to the New Hebrides and New Caledonia and eastward to Rarotonga, its dispersal, as indicated above, may have been largely a result of transport by humans. All in all, it does not seem that passive dispersal by winds has played any major part in the recent dispersal of mosquitoes of the South Pacific. In fact, the evidence would indicate that only a few resistant forms may have been dispersed in part in such a manner under the conditions now existing with respect to land masses and patterns of winds and hurricanes.

3. Floods and flushing of containers. These undoubtedly play a minor part in the dispersal of mosquitoes on land. However, they cannot be involved in dispersing mosquitoes across ocean barriers of any size, as it is evident that eggs, larvae, and pupae could not survive immersion in the ocean for any length of time.

4. Rafts and drift. Much has been said about natural rafts and other drift material as a means of dispersal of terrestrial and freshwater organisms. Perhaps in some areas mosquitoes may be commonly distributed over ocean barriers in this manner, but this does not seem to be true in the South Pacific, at least at present, except possibly within island groups. The prevailing ocean currents (see Oceanography) through most of the area are today not conducive to drift dispersal eastward, although this could occur occasionally when the "monsoons" of the Solomons are extended eastward as far as Tahiti. Extensive island rafts are not known in the South Pacific today, as far as I have been able to determine, but drift and flotage is common. Therefore probably only eggs, and possibly larvae and pupae, of salt-tolerant container-breeding species could be dispersed on drift. The most likely species to be dispersed in this manner appears to be *Aedes* (*L.*) *dasyorrhus,* but it is possible that some other salt-tolerant treehole-breeders, such as *Aedes* (*S.*) *polynesiensis,* also might be dispersed on drift.

5. Animals. Birds are the most likely animals to be involved in the dispersal of mosquitoes over ocean barriers in the South Pacific. The correlation of the distributions of certain widespread species of water, marsh, and shore birds with those of some widespread mosquitoes, such as *Culex* (*C.*) *annulirostris* and *C.* (*C.*) *sitiens* in particular, is highly suggestive of the role of the former as agents of mosquito dispersal. I have not been able to find

any references to observations or experimentation on the transport of mosquito eggs by birds, but it seems probable that surface floating hydrophobic eggs are likely to cling to the plumage, feet, and legs of birds frequenting habitats where these are present. It is probably significant that the majority of the widespread species of mosquitoes are general ground pool-breeders that usually lay egg rafts. Transport of a single raft of such a species, particularly a salt-tolerant one, would almost certainly insure the establishment of the mosquito in a new area. Although floating eggs are not generally resistant to desiccation, those of some species remain viable out of water for several days. Variation in salt tolerance and in ability to survive transport on birds may account for the more restricted distribution of some species laying egg rafts. It seems possible that, in addition to the 2 species mentioned above, the following forms may have been dispersed in this manner: *Culex* (*C.*) *starckeae, C.* (*C.*) *bitaeniorhynchus, C.* (*C.*) *squamosus, C.* (*Lutzia*) *halifaxii, Mansonia* (*C.*) *xanthogaster,* and perhaps other general ground pool-breeders which lay egg rafts (definitely or probably), such as some *Culex* (*Lophoceraomyia*), some *Uranotaenia,* and *Aedeomyia catasticta.* It might even be possible under ideal conditions for anophelines, which lay floating eggs singly, to be transported in this manner. This may account for some unusual distributions of *Anopheles farauti.* Resistant eggs of some ground pool *Aedes* may perhaps also be distributed by birds in the same manner on the body surface, possibly even as ingested material. Ducks and swamphens appear to be the most likely birds to be involved in the transport of eggs of ground pool-breeders, but many other birds that frequent mosquito habitats could also be involved. Experimental evidence as well as field observations are much needed to determine the possible role of birds in the dispersal of mosquito eggs. Perhaps even the eggs of container-breeders could be dispersed by land birds, although there is no suggestion of such dispersal in the distributions of these species. If mosquito dispersal by birds is possible, then it undoubtedly occurred in the past as well as in the present. This may account for the dispersal of such forms as *Culex* (*C.*) *albinervis, C.* (*C.*) *samoaensis,* and *C.* (*C.*) *roseni,* now endemic in the central and eastern part of the South Pacific, which are now so specialized and restricted that they can no longer be dispersed. This may also account for the failure of such forms as *Culex* (*C.*) *annulirostris, C.* (*C.*) *sitiens, C.* (*C.*) *starckeae, C.* (*C.*) *squamosus,* and *Mansonia* (*C.*) *xanthogaster* to become differentiated in the South Pacific islands because of repeated repopulation in the past from source areas in the west.

HISTORY OF THE FAUNA

As indicated in the preceding sections, the mosquito fauna of the South Pacific is a well-balanced and highly complex one, exhibits a high degree of endemism, and includes many relict species. The most primitive forms are found chiefly on the eastern periphery of the area, but some relicts are scattered throughout. This fauna cannot be derived directly from the existing mosquito fauna of the source areas immediately to the west, and it is impossible to explain the distributions of many species in the light of known dispersal methods over ocean barriers as they exist today. Therefore, it appears that this mosquito fauna has had a very long history and that the island masses and probably the wind and current patterns in the South Pacific have not always been as they are today but have changed extensively through the ages. To reconstruct with any degree of accuracy the complex history of this fauna would require a great deal more reliable data in all fields, from morphology to distribution, than we have available at present. However, even with the limited knowledge available to us now, certain trends and patterns are evident; these suggest a possible rough explanation of the development of the fauna.

The distributions and affinities of the species comprising the individual faunal areas of the South Pacific (figs. **6-17, 19**) suggest strongly that there have been in the past several orderly dispersals over routes no longer available. The principal suggested patterns of dispersal are indicated in figure **20**, but it is very probable that the actual dispersals have been much more complex. These dispersal patterns do not include either the distributions known or suspected to be caused by human introduction and spread or other doubtful cases. The actual number of dispersals is, of course, not known; there may have been more or fewer than shown. In general, the probable sequence of dispersals is represented by the numerical order starting with 1; thus, the earliest dispersal (No. 1) extended to New Zealand. The preservation of primitive relict forms in the peripheral areas is explained by the isolation of these areas through the development of extensive ocean barriers prior to the following dispersals. The complete or partial absence of the most primitive relicts toward the source areas is explained by the complete or partial extinction of these forms coincident with geological changes and their replacement by newly evolved forms in subsequent dispersals when conditions again became favorable. Here and there, however, owing to special environmental conditions or to special characteristics and adaptations, some ancient relicts of early dispersals have persisted in some areas where one or more subsequent dispersals have occurred. The composition of each of the dispersals in every island group is discussed in the analysis of the individual faunal areas of the South Pacific and will be recapitulated here only briefly.

Dispersal 1 is probably a complex of two or more dispersals which are not differentiated here because of insufficient knowledge. It comprises the entire indigenous fauna of New Zealand and is represented elsewhere in the South Pacific only by *Culex* (*C.*) *iyengari* in the New Caledonia area and *Culex* (*C.*) *pacificus* in the New Hebrides. It consists of the most primitive relicts of mosquitoes known and is very poorly represented elsewhere in the world by relicts in South Australia–Tasmania, Patagonia–South Chile, and the Ethiopian, Palaearctic, and Nearctic regions. As indicated by the dashed line, the area occupied by this dispersal may have been quite extensive and may have continued to Antarctica.

Dispersal 2 is represented now in the South Pacific only by the *atriceps* group of *Culex* (*Culex*), which has remote affinities elsewhere in the world only in the Ethiopian region. This may not be a separate dispersal but a combination of dispersals 1 and 3.

Dispersal 3 may be a complex one but consists predominantly of an Australian-Tasmanian element. It forms the bulk of the fauna of the New Caledonia area and is represented by the *caledonicus* group of *Tripteroides* (*Rachionotomyia*) in the New Hebrides, Santa Cruz Islands, and Rotuma and by the *bitaeniorhynchus* subgroup of *Culex* (*Culex*) in the New Hebrides, Fiji, and Samoa. It seems probable that *Aedes* (*O.*) *edgari* and *Culex* (*C.*) *roseni* also belong to this dispersal; it is possible that part of the distribution of *Aedes* (*O.*) *vigilax* and of the entire *sitiens* group of *Culex* (*Culex*) took place during this dispersal. Elsewhere in the world this dispersal is represented throughout nearly all the Old World tropics. It appears that during subsequent dispersals, several species first distributed in dispersal 3 were redispersed, particularly *vigilax*, *sitiens*, and possibly *annulirostris*. It is also possible that these forms belong entirely to a much more recent dispersal.

Dispersal 4 appears to have been a complex one. Included here are the *scutellaris* group of *Aedes* (*Stegomyia*), the *kochi* group of *Aedes* (*Finlaya*), the *crassipes* group of *Mansonia* (*Coquillettidia*), the *colocasiae* and *painei* sections of *Uranotaenia*, the *purpuratus* group of *Tripteroides* (*Tripteroides*), *Aedes* (*Levua*) *suvae*, and possibly *Aedeomyia catasticta*. This dispersal is represented in its purest form in the Fiji-Tonga-Samoa area. *Aedes* (*L.*) *suvae* appears to be a hybrid between a member of the *vigilax* complex and a species of *Aedes* (*Geoskusea*), so that it is possible that the latter was first dispersed at this time. A puzzling feature is the apparent absence of the *kochi* group in the Santa Cruz–New Hebrides area. This dispersal is represented elsewhere only in the Old World tropics, chiefly in the eastern part.

Dispersal 5 has affected only the Solomons and the Santa Cruz–New Hebrides areas; the only forms to have dispersed beyond the Solomons are *Anopheles farauti*, *Uranotaenia barnesi*, the subgenus *Lophoceraomyia* of *Culex*, possibly *Culex* (*M.*) *femineus* (which may have dispersed earlier), *Aedes* (*G.*) *daggyi*, *Aedes* (*V.*) *lineatus*, and possibly *Aedes* (*S.*) *hebrideus*. It is very probable that more than one dispersal is confused here and that different routes were used. Outside the South Pacific, dispersal 5 is represented only in the Old World tropics, chiefly in the eastern part but with some incursions into the Malagasy and Ethiopian regions.

Dispersal 6 appears to form the bulk of the fauna of the Solomons and apparently extended to the Santa Cruz Islands. Probably *Tripteroides* (*T.*) *bonneti* was part of this dispersal; it seems possible that the species of the *edwardsi* group of *Aedes* (*Stegomyia*) were produced at this time through hybridization between members of the *scutellaris* and *albolineatus* groups. This dispersal appears to have been a very complex one and perhaps should be subdivided. Elsewhere in the world it is represented chiefly in the Papuan, North Australian, and Indomalayan areas but has a few representatives in the Oriental region.

Dispersal 7 is the most recent invasion of Papuan forms and appears to be confined chiefly to the western group of the Solomons. Dispersal 8 is represented by apparently recent derivatives from Australia, the widespread *Aedes* (*H.*) *australis* and the endemic *Aedes* (*F.*) *lauriei.*

The analysis of the dispersals as presented here is, of course, very crude. The patterns are confused by the repeated redispersals of some forms which were able to survive in the western part of the area and probably took advantage of all subsequent opportunities to extend their ranges. However, I believe that there is clear evidence in these dispersal patterns, and in the apparent inability of the majority of species to cross the ocean gaps as they exist today, that more extensive land masses have existed in the past and that these allowed the dispersal of these forms far out into the Pacific. It is evident that continuous land is not necessary for such dispersals and that gaps of a few miles can probably be crossed even by treehole- and leaf axil-breeders.

It is generally regarded that the majority of the islands in the tropical South Pacific are of a relatively recent geological age; because of this, it is usually assumed that their faunas are younger in origin than the present islands and are derived from the contemporary faunas of adjacent stable continental areas subsequent to the formation of the islands. This is clearly not true with the mosquito fauna of the South Pacific islands, which consists largely of relict species of various ages not represented in the adjacent source areas. This apparent anachronism can be explained by the probable existence in the past of other islands adjacent to those now present and by the transfer of the mosquito fauna from the older to the younger islands. Evidence of such a mechanism is clearly seen in almost every island arc or group in the continental border area as well as in the ocean basin area of the South Pacific. In nearly every group where endemic relicts are present, one finds islands of different age, older volcanic or sedimentary islands, new volcanic islands, low and elevated coral islands. In the island arcs, there are usually two or more parallel series of islands that are of different age. This is most clearly evident, perhaps, in the Tonga group, with an eastern arc of low or slightly elevated coral islands and a western arc of young volcanic islands including active volcanoes; it is also very plainly seen in the New Caledonia, Santa Cruz–New Hebrides, and Solomons areas. That mosquitoes can survive under the sometimes violent environmental changes and accomplish the transfer to new islands is shown by the presence of essentially the same fauna within a given group. However, it is clear that those species which utilize more stable breeding habitats, such as plant containers, are more successful in surviving environmental changes.

The same mechanism may explain dispersal westward along island arcs. These arcs show a definite pattern in the South Pacific and are probably arranged on persistent orogenic belts which may date back to the Cretaceous age—even earlier in some instances. While the arcs are interrupted at the present, the bathymetric pattern (fig. **21**) of the continental border area suggests that they were connected in various ways in the past. The great troughs that exist parallel to, and sometimes across, the arcs are probably very recent geological features, the deepest troughs probably being the most recent. The bathymetric pattern suggests also that much more extensive land masses and other arcs may have been present in the past. The correlation of the bathymetric pattern with the faunal subdivisions of the South Pacific (fig. **19**) and with the dispersal patterns (fig. **20**)—the latter two developed entirely on faunal affinities—is of great interest and, I believe, significance in this connection.

Emphasis has been placed thus far on the continental border area, but much the same pattern is evident in the ocean basin area, although perhaps on a more restricted scale. The lines of islands are complex; it is clear from bathymetric data that some of the island groups have been much more extensive in the past. Therefore it seems probable that in this area conditions have existed in the past for the dispersal of forms from the west and that transfer from island to island has been possible. However, the land areas are very restricted at the present, and only a very limited specialized fauna has survived.

I suggest, therefore, that the mosquito fauna of the South Pacific as we know it was developed through a succession of complex dispersals over more extensive land areas than we see today. There is no evidence in the mosquito fauna that it was formed through fragmentation of continents in the continental border or ocean basin areas, respectively the Melanesian and Mid-Pacific continents of some biologists. Rather, dispersals by island hopping along island chains are indicated. The islands must have been close together, but a continuous chain was not essential at any one time because of probable transfer from old islands to new ones. Subsequently many of the intermediate islands may have disappeared, while those at the more stable end of the arcs remained, at least temporarily. Isolation and preservation of relict species, principally on the periphery, and destruction of much of the fauna in the proximal western area would result. Repetition of this process several times in the western part of the area by formation of new shorter island arcs and their subsequent reduction would produce a pattern of distribution such as we see today. The islands in the ocean basin area appear to have derived their fauna from the end of the longest arcs that probably extended at least as far as the present islands of Samoa. The connections with the arcs must have been quite close and the line of oceanic islands extensive to enable dispersal of container-breeding forms of the *atriceps* group of *Culex* as far as the Marquesas. As indicated elsewhere, the New Zealand area probably had very close connections to the north and west and possibly also, through Antarctica, to South America.

It is impossible at the present time to accurately date the events in the history of the mosquito fauna of the South Pacific, since mosquito paleontological evidence is completely lacking in the area (and is not significant or pertinent elsewhere) and since inferences from correlations in the distributions with other organisms have not been made. However, indications are that part of this fauna is extremely old, since it includes the most primitive known living mosquitoes. It seems to me that dispersal 1 probably took place soon after the origin of the family and was largely, if not completely, accomplished before the close of the Cretaceous. Dispersal 2 may have occurred very early in the Tertiary (possibly even before), dispersal 3 early in the Tertiary, dispersal 4 in the middle Tertiary, dispersals 5 and 6 in late Tertiary, and dispersals 7 and 8 in the Quaternary. These are, of course, no more than guesses; it may be possible to date these dispersals more or less accurately in the future, when more is known of the geological history of the area.

An interesting feature of the mosquito fauna of the South Pacific which does not at first appear to be consistent with currently accepted views is the great amount of radiative speciation in the younger elements of the fauna in the Solomons, and the general lack of it in the older elements in the islands toward the periphery. This may not be actually in conflict with the accepted views of great radiation from a few types on "old" islands but rather an indication that the elements of the South Pacific mosquito fauna are very old indeed, geologically speaking, and that they have withstood many periods of great environmental changes. It seems to me that radiation probably occurs soon after an area is invaded but that, except when the radiated forms occupy persistent habitats, most of the derivatives eventually become extinct or hybridize to form a plastic species capable of utilizing a variety of environments, and thus surviving the environmental changes. The latter situation seems to occur with all the ground pool-breeders everywhere in the South Pacific except in the Solomons, since in all these areas there is only 1 species of a given phylad in a given island group. This is true even on New Zealand (but apparently with some exceptions in the Dixinae). Container-breeders, on the other hand, probably because of their occupation of persistent microhabitats, may, under certain conditions, maintain several species of a given phylad even on a single island, as shown by the *kochi* group on the island of Viti Levu in Fiji, or 2 or more species in a compact island group, as illustrated by the *scutellaris* group in Fiji and possibly Samoa.

CENTERS OF ORIGIN

World distributions of mosquito taxa of all categories represented in the South Pacific suggest a hypothesis as to the centers of origin or formation of new types that is markedly different from current views on this subject. It will be noted on the world maps that nearly all the taxa of the higher categories show distributions centered around the major intercontinental areas, and that the majority of the phylads are restricted to the tropics or penetrate for a short distance only into the so-called "temperate" regions of the world. The two principal intercontinental areas involved are the Indo-Pacific area between Eurasia and Australia (and, to a lesser extent at present, Africa) and the American Mediterranean between the North and South American continents.

It has been customary to regard these intercontinental areas as major barriers to the dispersal of both terrestrial (and freshwater) and marine organisms because of ocean and land barriers, respectively (Darlington, 1957). I believe, however, that these areas are the most likely places for the origin and evolution of new major types of mosquitoes.

Both areas are characteristically unstable regions where major orogenic belts of adjacent continents meet, intersect, form arcs, or otherwise have complex relationships. Land areas in these regions have varied in the past; there have existed more or less broad continuous land connections between the continents at times, and these have fragmented at others into a series of more or less extensive islands. At other times the encroachment of the seas on the continents have been very extensive, as at the time of the Tethys sea, and the intercontinental areas were much larger than we see today.

It is the more or less isolated land masses of various size in these regions, largely in the tropics, that I believe provided the most suitable environment for the origin of new types of mosquitoes (and probably other terrestrial and freshwater organisms). In the course of formation of islands through the fragmentation of an intercontinental land bridge, or the reduction of the islands in a major arc, great environmental stress would be imposed on the surviving populations, and these would be greatly reduced and isolated. There would be an ideal opportunity under such conditions for the quick fixation of new adaptive types of organisms. These would have a chance to become established and better adapted; they could then disperse when the isolated areas became connected or approximated again with one or more of the adjoining continental masses. Limited hybridization between forms produced in such a manner in complete isolation would probably occur also when contact is reëstablished, and this would contribute to further evolution of new types and produce better-adapted forms.

In recent years, more and more evidence has been accumulating to indicate a tropical origin of many major groups of plants and animals (Axelrod, 1952; Darlington, 1957). The tropical areas of the world offer a wider variety of environments within a given area, particularly along orogenic belts, than any other area. Essentially the whole spectrum of environments existing at any given time in the history of organic evolution has been available in the tropical area at that time. Climates have changed in the past, but they have probably always been most equable in the tropical areas. Such equable climates of all kinds would appear to be more favorable for the original fixation of new types than the fluctuating climates of the so-called "temperate" regions.

Distributions of the mosquito phylads suggest that the Old World intercontinental area has been the most active site of evolution. The great concentration of phylads around the Indomalayan and the adjoining Oriental and Papuan regions and the absence of these phylads elsewhere suggest that this has been a most active center during the Tertiary. The American Mediterranean region has also been an important center of evolution, as indicated by the presence of several exclusively New World phylads.

The hypothesis of the intercontinental origin of new types helps to explain several vexing and controversial problems, particularly the following: (1) the presence of equally primitive but distinct members of a phylad in the Northern and Southern Hemisphere; the usual interpretation is that the phylad originated in a continental area in one hemisphere and then dispersed to the other, but there is almost never agreement among different workers as to the hemisphere of origin; this situation is easily explained if the phylad originated on an island in the intercontinental area and dispersed to both hemispheres initially and then continued evolving independently; this is illustrated most clearly by the subgenus *Ochlerotatus* of *Aedes;* (2) the extreme east-west distributions of equally primitive but distinct members of a phylad in the Indo-Pacific area; this is essentially the same as the preceding but in a different direction; the use of continental areas for migrations is not necessary, and this could be explained more simply by dispersal along orogenic belts in opposite directions from a central area; (3) the presence of annectent types on the larger islands and on the periphery of intercontinental areas; these may represent relatively unsuccessful types produced in isolation that have not been able to radiate and are confined to the immediate surrounding of their place of origin; and (4) the successive replacement of phylads in the course of evolution of a major group; this could be accomplished by the origin of new dominant types in isolation in the intercontinental area and their subsequent invasion of continental areas.

Direct evidence in support of this hypothesis may be difficult to find in the paleontological record because of the unstable nature of the intercontinental areas. This is particularly true of mosquitoes and insects in general that are so poorly represented as fossils. However, insects appear to be able to survive more drastic environmental changes than any other group of animals. It seems that the very large number of living species of hexapods is, in part at least, owing to the preservation to this day of the majority of the phylads formed in the past. In other words, there are many living fossils in the modern fauna. It is of interest that many of these are to be found in and around the intercontinental areas and along the island arcs radiating from them.

As suggested in the preceding section on the history of the mosquito fauna of the South Pacific, this fauna has been probably formed by a series of dispersals from the west and consists largely of relict species. The major phylads comprising it probably evolved originally in various parts of the Old World intercontinental area, but some of the derivative phylads were developed in the Papuan area or within the South Pacific and did not penetrate or become extinct in the areas to the west.

SYSTEMATICS

It seems advisable to present briefly in this section some observations, inferences, and speculations regarding the patterns of speciation, the importance of hybridization in speciation, the relative value of characters of the adults and immature stages, the general scheme of classification, and the evolution of the family. These subjects are controversial ones, largely subjectively inferred, and, furthermore, several of the views expressed here are unorthodox in the light of current hypotheses and practices. My conclusions regarding the nature, origin, and history of the mosquitoes of the South Pacific have been, of course, greatly influenced by what I believe can be inferred regarding these subjects through a comparison of repeated patterns in different phylads.

SPECIATION AND HYBRIDIZATION.—It may come as a shock to some readers that no subspecies are recognized in this work. Although no formal subspecific taxa are recognized, this study was done essentially at the population level; there is ample evidence that geographical and ecological differentiation is present in many groups. The reason for treatment at the specific level and a statement of the criteria used are given briefly in the section on methods of study and presentation.

Speciation in mosquitoes, as well as in many other insects, appears to take place either allopatrically in geographical isolation or sympatrically, with isolation in different microhabitats.

As can be expected in insular areas, some of the species within the South Pacific appear to have differentiated in connection with allopatric geographical isolation of populations subsequent to the original dispersal of their phylads into the area. Species produced in such isolation would not necessarily develop an absolute reproductive barrier between different members of a phylad. When at a later time such species or populations are brought together in an environment altered either through natural means or the agency of man, a limited amount of hybridization may take place. Because of genetic dissimilarity of the stocks, introgression would not necessarily follow; instead, there may be formed a species of hybrid origin. This seems to have been a common phenomenon in many groups of South Pacific mosquitoes, not only in forms developed contemporaneously but also in members of a phylad dispersed at different times.

Sympatric ecological speciation with isolation in microhabitats seems to have occurred also in South Pacific mosquitoes, but it is seldom possible to eliminate the possibility that the populations were originally isolated geographically as well. The clearest instances seem to be in forms which utilize the leaf axils and other parts of living plants, as does the *kochi* group of *Aedes* (*Finlaya*), with different species occupying leaf axils at different levels on a single pandanus plant (see Systematic Treatment). It is of interest that hybridization appears to occur in such situations and that some of the species may have been produced through hybridization. Sympatric ecological differentiation is also quite evident in some groups of specialized ground pool-breeders, such as forms utilizing rockholes and other restricted habitats. It is sometimes denied that microhabitat isolation can provide a barrier efficient enough to enable speciation to take place. However, an extreme case may show how this could operate. Breeders in *Nepenthes* pitchers occur sympatrically with close relatives that use treeholes or other less specialized habitats. The water in these pitchers is fatal to most mosquitoes, since it contains some proteolytic enzymes; only a rare individual of the undifferentiated stock would be able to survive in this marginal environment. Selection for a particular genotype that can tolerate this habitat would be most intense. Modification of the physiology and behavior of adults from *Nepenthes* pitches may be very marked; in fact, many features of the morphology of the larvae are suggestive of a neotenic condition (see *Tripteroides caledonicus*). The adults may be weak, would not fly far from the pitchers, and would tend to inbreed and use the pitchers for egg laying. Once a successful adaptive type is established, there would be very little chance for introgression with the undifferentiated parental stock, but hybridization between different stocks invading *Nepenthes* would be conducive to selection of a better-adapted stock and could even result in the fixation of a hybrid species. A marked feature of the mosquito fauna of the South Pacific is the very intense speciation that has occurred in groups utilizing specialized, restricted habitats; it seems that much of this has taken place sympatrically.

Much emphasis has been placed here on the possibility that hybridization is a potent factor in mosquito speciation. The evidence for the hybrid origin of species of South Pacific mosquitoes is entirely indirect and circumstantial but, I think, highly suggestive. It is perhaps most striking in forms that show blocks of characters of one potential parental species in one or more stages or sexes and of the other parental species in other stages or sexes. It is a common feature in such probable hybrid species to have the general external characters of the adults of one type, the male genitalia of another, and the larva and pupa of one or the other. Frequently the characters of the parental types appear to be intensified, thus suggesting hybrid vigor. This phenomenon is most evident in the *painei* section of *Uranotaenia,* the *sitiens* group of *Culex* (*Culex*), *Aedes* (*Levua*) *suvae,* and the *scutellaris* group of *Aedes* (*Stegomyia*), but it can be seen as well in many other groups of mosquitoes in the South Pacific. In other instances, the characters of the possible hybrid species are intermediate in one or more stages between those of the potential parental species. Thus, in the *punctulatus* complex of *Anopheles, koliensis* is intermediate in female characters between *farauti* and *punctulatus;* it has even been suggested that *koliensis* is not a species but consists of hybrids produced between the other 2 forms; however, this is not supported by experimental evidence (see Systematic Treatment). There are all integradations between the two extreme conditions of the manifestation of entire blocks of characters of a parental type, on the one hand, and an intermediate condition between the 2 parental types, on the other. The suspected hybrid species could, of course, be interpreted in some instances not as a hybrid species at all but as the common ancestral stock from which the 2 species, whose characters it shares, evolved independently. However, this does not seem to be plausible when members of a phylad are considered together, since characters would have to be lost and reacquired repeatedly in a single line to account for the various combinations in that phyletic line. On the other hand, hybridization would readily account for these various combinations.

Hybridization seems to have been a most important mechanism in the speciation, the formation of new types, and the evolution of mosquitoes everywhere in the world. Conditions for the formation of species through hybridization and their preservation have been particularly favorable in the South Pacific area, where environments have been altered repeatedly, successive waves of dispersals of the same phylads have taken place, and geographical and ecological isolation has been very effective. Similar conditions have existed everywhere else in the world, but due to greater complexity, the picture may not be as clear cut as in the South Pacific. In the American Mediterranean region it appears that hybridization may have played a very important part in the evolution of the genus *Deinocerites* (Belkin and Hogue, 1959:423). I believe that hybridization may explain in a large part the difficulties encountered in the classification of mosquitoes with annectent types and the noncorrelation of characters of different stages (see below).

The genetic mechanism operating in the speciation and the fixation of hybrid types in mosquitoes is not definitely known; experimental evidence has been accumulating in recent years and is reviewed by Kitzmiller and Laven (1960). An interesting feature of intraspecific and interspecific hybridization in mosquitoes is the nonreciprocal compatibility, the inheritance of maternal characters only in the majority of crosses, and the rare subsequent appearance of paternal characters in the hybrid progeny of some interspecific hybrids. The latter phenomenon cannot be dismissed as instances of contamination and may be a significant clue to speciation through hybridization (Mattingly, 1956*b*:29; 1958*a*:8).

CHARACTERS OF ADULTS AND IMMATURE STAGES.—In this study emphasis has been placed on the characters of the immature stages. This does not imply that I consider the characters of the immature stages to be in all instances superior to those of the adults as indicators of differences and affinities, but merely that the larvae in particular offer a greater number of characters amenable to analysis and frequently show affinities better than any other stage. Unquestionably larvae show many secondary adaptive features, but they also tend to preserve conspicuous phyletic characters better than the adults. Some specialists apparently believe that a classification must be based primarily on characters of the adults; if the immature stages do not fit in such a classification, then it is merely a matter of secondary adaptation or parallelism in the immature stages. I believe that all stages must be studied to reconstruct phyletic lines and that in different lines evidence of relationships cannot always be found readily in the same stages. As has been suggested above, hybridization may have been a potent factor in the formation of new types; if this is a fact, then it could easily explain both the puzzling instances of annectent types and the combination of different characters in the adult and immature stages of a single species.

All stages of mosquitoes show some conspicuous, distinguishing characters that are useful for diagnosis of species as well as some more obscure characters which enable us to determine affinities. The phyletic characters are not always easy to determine; the tendency is usually to choose the most obvious ones. In mosquito classification, emphasis has been placed on secondary sexual characters of the males and the general ornamentation of the adults. As indicated in the discussion of *Aedes* (see Systematic Treatment), it is evident that many of the characters presently used to indicate relationships are of limited value while others, even sexual ones, may be much more important. The value of the larval stage in classification is not fully realized at present, but there are indications that, when all instars of the larva are studied, it may be possible to develop a much more natural classification of mosquitoes. Of great interest is the similarity of the first instar larva in nearly all mosquitoes and the progressive specialization that occurs in subsequent instars to the pupa. There seems to be a "recapitulation" of phylogeny in the larval stage; this may be of value in determining relationships and evolution in the family. For instance, it is still generally held that the anophelines are ancestral to the "culicines" and, according to one worker (Ross, 1951), that the larval comb is a derived structure; yet it is well known that the anophelines have a comb in the first instar and lose it in the second. The pupal stage has been very poorly studied as yet with emphasis on diagnostic, adaptive specific characters and not on affinities in the different groups. It is of interest that the abdominal pupal chaetotaxy is essentially a reversion to that of the first larval instar from the more complex chaetotaxy of the fourth larval instar (Belkin, 1952:116). With further study it may be possible to find good phyletic characters in the pupal stage also.

CLASSIFICATION.—Little advance has been made in the classification of mosquitoes since the appearance of Edwards' masterly review and catalog of the family (Edwards, 1932). This classification has been questioned in small details only; it is evident that little can be done to improve it until the basic morphology of the family is thoroughly understood and broad revisionary studies are carried out. No major contributions toward this goal have yet appeared. Therefore I have followed Edwards in considering the family, in the broad sense, to include the Dixinae and Chaoborinae and have in general followed his scheme of internal classification. I am in full agreement with the practice, following Edwards, of recognizing few genera and many subgenera, since this appears to reflect the evolution of the family. However, I do not believe that a small number of species in a clearly marked phylad is a good criterion for not recognizing it as a taxon equivalent with one with many species; I have therefore elevated such phylads to tribal, generic, or subgeneric status, as the instances seemed to warrant. Lumping all small taxa into a group of a convenient size but of indefinite affinities does nothing but obscure relationships.

As indicated in a previous section, I believe that there is strong evidence that hybridization has been a major factor in the speciation and evolution of the Culicidae. If this is true, hybridization should be reflected in taxa of all categories; I believe that this is shown by the annectent groups that one finds at all levels. These annectent groups present a problem in classification, and I have in general followed the practice of not lumping them together but of recognizing them as separate entities. Therefore I am recognizing here more tribes, genera, subgenera, and species groups than has been customary and am using a different arrangement in nearly all groups, following the principles outlined for the subfamily Culicinae (see Systematic Treatment).

EVOLUTION.—As noted in the Systematic Treatment, the fossil record of the Culicidae is very meager and is of little value in reconstructing the evolution of the family. Edwards (1932) believed that the Culicidae probably existed in the Jurassic, but the earliest fossils (probably *Culex*) are from the Eocene.

At the present time our knowledge of the basic morphology of all the primitive families of the Diptera is so poor that it is impossible to determine the affinities of the Culicidae. However, they appear to be chiefly with the Psychodidae and the Chironomidae; Ross (1951) suggests that the Culicidae were evolved from the Tipulidae. Speculations as to evolution within the family have been largely based on the assumption that coördinate groups are not of contemporary origin; for instance, the Dixinae are considered the earliest group giving rise to the Chaoborinae, which later evolved into the Culicinae; similarly, the Anophelini are considered ancestral to the other tribe or tribes of the Culicinae. There is very little evidence to support these views, and it seems to me that the morphology of coördinate groups suggests that the majority of them became differentiated at the same time. Furthermore at the time of differentiation, hybridization may have taken place; this would account for the annectent groups at all levels. I suggest, too, that the Psychodidae and Chironomidae (and possibly the Tipulidae) were differentiated contemporaneously with the Culicidae and that hybridization may explain again the annectent features among the three families.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE

Malaria, filariasis, and dengue are the only mosquito-borne human diseases known to occur at present in the South Pacific. Of these, dengue is probably a recent introduction; there is also a possibility that other virus diseases may be introduced and become established in the area. In addition to the known disease vector species, a number of forms are of economic importance as pests. Some of these are potentially dangerous forms, particularly as transmitters of viruses and as secondary vectors of filarial worms. Our knowledge of the epidemiology of the mosquito-borne diseases of the South Pacific is extremely meager. Since the vector propensities of the majority of pest mosquitoes have not been thoroughly investigated, control measures directed against known vector species may be futile in attempts to control or eradicate mosquito-borne diseases in the South Pacific. Furthermore, the area is so vast and varied, and the mosquito fauna so diverse, that every island group presents a different epidemiological picture; therefore, broad generalizations based on experience in one group do not necessarily apply anywhere else in the area.

MALARIA.—Malaria in the South Pacific is restricted to the northwest island groups, being found only in the Solomons (including some outlying islands) and the Santa Cruz–New Hebrides area. Its distribution coincides with that of the *punctulatus* complex of *Anopheles.* The incrimination of members of this complex as vectors of malaria in the South Pacific is almost entirely based on distribution and the correlation of bionomics with epidemiological data, since no natural infections have been reported for *farauti* and *koliensis* and only a few for *punctulatus* (see Systematic Treatment). However, there can be little doubt that only members of this complex are vectors of human malaria in the South Pacific and that *farauti* is the only vector in the Santa Cruz–New Hebrides area, since it is the only *Anopheles* known to occur in this area. Little is known about the relative importance of *koliensis* and *punctulatus* as malaria vectors in the Solomons. *Anopheles lungae,* misidentified as *punctulatus,* was suspected at one time as a vector of human malaria on Guadalcanal because of natural infections with a *Plasmodium,* but it was subsequently shown that the parasite in question was not of human origin and that the bionomics of *lungae* precluded this species from being a vector of human malaria (see Systematic Treatment). The 4 recognized species of *Plasmodium* producing human malaria (*vivax, falciparum, malariae,* and *ovale*) have all been reported from the South Pacific (Black, 1955).

Considerable concern has been expressed about the possible extension of malaria eastward and southward in the South Pacific area as a result of the natural range extension or the human introduction of *Anopheles farauti* into these areas (Laird, 1956:5–12). Laird (1956:181–191), on the basis of a comparative study of larval habitats, suggests that suitable environments are available for *farauti* in much of the central and eastern part of the South Pacific. He also feels that there is a strong possibility of the introduction of *farauti* into these areas by aircraft or by ships. There is, of course, the possibility that, under the proper conditions, *farauti* may be introduced, but the probability of this happening does not seem to be very great. The present distribution of *farauti* suggests that this species is not capable of crossing extensive ocean barriers by natural means in sufficient numbers to become established in marginal environments and that it probably attained its present distribution largely when land connections with the west were more extensive. However, it seems probable that it has been spread by natives in canoes over relatively short distances; I suggest that this has been accomplished probably as breeding populations and not as adults. Therefore it seems very unlikely that a successful introduction of *farauti* by aircraft, ships, or natural means could take place into the central and eastern part of the South Pacific. Furthermore, for malaria transmission to occur in these nonindigenous areas following the introduction of *farauti*, such a complex combination of favorable factors would have to be present that establishment of malaria would be most unlikely. Probably the most favorable conditions existed for both the introduction of anophelines and the establishment of malaria during wartime years, but not even introduction was accomplished at that time. Even if malaria is established, its eradication would be a relatively simple problem in the small insular areas with limited breeding sites. I do not mean to imply that the possibility of spread of malaria does not exist in the South Pacific, but I do believe that the danger is minimal and that the problem could be easily met.

FILARIASIS.—Filariasis has been reported from nearly all the island groups of the tropical South Pacific (Iyengar, 1954*b*). Autochthonous filarial infections in the area are all caused by 2 forms of *Wuchereria bancrofti*, a periodic nocturnal form and a nonperiodic form. The distributions of the 2 forms and their generally accepted vectors are given by Iyengar (*op. cit.*). In addition, some imported cases of filariasis caused by *Wuchereria malayi* have been reported among Tonkinese in the New Hebrides. For an annotated bibliography on the distribution and epidemiology of filariasis in the South Pacific, see Iyengar (1954*a*, 1959).

Periodic filariasis has been little studied in the South Pacific. It is definitely known only from the Solomons, the Santa Cruz–New Hebrides area, and Nauru and Ocean Islands. It has also been reported from the Gilbert Islands, but evidence regarding the type of filarial infection found in these islands is conflicting, as both types have been reported. The confusion is, at least in part, owing to the extensive relocations and movements of Gilbertese in recent years. Schlosser (1945) found microfilarial periodicity in Gilbertese imported to the Solomons, but it was not nearly as marked as in the natives of Guadalcanal and San Cristobal. Members of the *punctulatus* complex of *Anopheles* appear to be the principal vectors of periodic filariasis wherever they occur in the South Pacific, as in the Solomons and the Santa Cruz–New Hebrides area. Experimental and natural infections in all 3 species of this complex have been reported from Guadalcanal, and in *farauti* from the New Hebrides; presumably the latter is also the vector in the Santa Cruz, Banks, and Torres groups. However, even in areas where these anophelines occur, it is possible that other vectors may be involved. Byrd and St. Amant (1959:61–63) found 90 of 385 *Mansonia* (*Mansonioides*) *melanesiensis* (as *uniformis*) infected on Guadalcanal, but only 6 harbored larvae older (3–12 days) than recently ingested microfilariae. The adult bionomics of this species in the Solomons preclude it from being an important vector (see Systematic Treatment). It is generally regarded that in the anopheline-free areas of the South Pacific, *Culex quinquefasciatus* is the important or sole vector of periodic filariasis. This idea seems to be largely a carry-over from the classical vector of periodic filariasis in the Oriental region, as established by Manson. *Culex quinquefasciatus* appears to be clearly a recent introduction with commerce by Europeans and other adventives; wherever it is found in the South Pacific, it is present only in association with these adventive populations. Therefore it could not have been the original vector of periodic filariasis among natives occupying anopheline-free islands. However, the fact seems to be clearly established that it is the principal vector on Nauru Island, on the basis of experimental and natural infections; this is understandable since *quinquefasciatus* appears to be the dominant species on this highly exploited island. It is also possible that *quinquefasciatus* is the vector under a very similar situation on Ocean Island. The known mosquito fauna of these islands (figs. **10**, **12**) is very limited; it cannot be determined at present whether *Culex* (*C.*) *annulirostris* and *C.* (*C.*) *sitiens* are indigeneous forms or introductions by Europeans or natives. These species should not be neglected as potential vectors if filariasis on these islands is a pre-European disease. It has been shown recently that *annulirostris* is an important vector in some areas of New Guinea (de Rook and van Dijk, 1959). Nothing is known about the vector of filariasis in the Southern Gilbert Islands, whose mosquito fauna is completely unknown to the present; however, the tendency is to assume that the vector is *quinque-*

fasciatus, which is regarded on epidemiological grounds to be the vector in the Northern Gilbert Islands.

Nonperiodic mosquito-borne filariasis is definitely known only from the South Pacific and has been reported from New Caledonia, the Fiji-Tonga-Samoa area, and Eastern Polynesia. Although a great deal of work on nonperiodic filariasis has been done in the past and is continuing at the present, the role of various species of mosquitoes as vectors is still not entirely clearly established. The classic investigations of Manson-Bahr (Bahr, 1912) demonstrated that on Fiji *Aedes* (*S.*) *polynesiensis* (as *Stegomyia pseudoscutellaris*) was an efficient vector and that *Culex quinquefasciatus* was not. It seems quite clear that wherever *polynesiensis* occurs, it is an important vector, as was shown in subsequent studies (see Iyengar, 1954*b*). However, other members of the *scutellaris* group in the Fiji-Tonga-Samoa area are evidently good vectors also; this is probably true of *tongae, rotumae,* and *cooki,* which are the only representatives of this group on islands with nonperiodic filariasis. The true *pseudoscutellaris* on Fiji, *futunae,* and possibly other described or unrecognized members of the group, may also be involved in transmission within the range occupied by *polynesiensis.*

It has been generally regarded that the vectors of nonperiodic filariasis are diurnal feeders, but recent studies in Fiji by Symes (1955:280–281) and Burnett (1958) strongly incriminate the predominantly nocturnal *Aedes* (*Finlaya*) *fijiensis* as a vector of nonperiodic filariasis in some situations. In view of this work, it would be well to reëxamine the possible role of other nocturnal biting members of the *kochi* group of *Aedes* (*Finlaya*) which occur in this area, particularly *samoanus* and *oceanicus,* which have been confused in the past. It has been shown recently (Kerrest, 1952; Iyengar, 1954*a*; Lacour and Rageau, 1957), on the basis of natural and experimental infections, that the natural vector of nonperiodic filariasis on New Caledonia is probably *Aedes* (*Ochlerotatus*) *vigilax,* a species which is said to bite at all times of the day and night, with a peak at sunset.

The striking differences in the distribution and in the vectors of the two types of filariasis in the South Pacific have aroused a great deal of interest and speculation as to the origin of the nonperiodic type. The simple explanation offered by Buxton (1928:70–71) of the development of the nonperiodic type from an introduced periodic one as an adaptation to day-feeding mosquitoes in an area without suitable nocturnal vectors does not seem tenable now that nocturnal vectors of nonperiodic filariasis are known. Further speculation as to the origin of the nonperiodic type seems rather futile at the present since we know so little about the actual vectors and even the characteristics of the filaria in the critical areas. However, the possibility should not be disregarded that the Polynesians may merely have acquired and spread a relict nonperiodic type already present in Melanesian natives (Fiji and New Caledonia) before their arrival in the area and that this type had several vectors, nocturnal as well as diurnal. Furthermore, there may have been a succession of vectors as the environment was changed by the human populations and as different species of mosquitoes became associated with the "native" populations. In this light it is obvious that the recent introductions with commerce, such as *Culex* (*C.*) *quinquefasciatus* and *Aedes aegypti,* would not be important vectors, since they are associated with natives in the South Pacific only where Europeans and other recent adventives are also found.

DENGUE.—Epidemics and sporadic cases of dengue have been reported from time to time from many island groups in the South Pacific, particularly in the western part during wartime years. Diagnosis has been largely on the basis of clinical symptoms and there is a possibility that it has not always been correct. It seems probable that dengue is a recent introduction into the South Pacific, and it is generally assumed that *Aedes aegypti,* one of the classical vectors, is the principal vector in this area. However, it has been shown that members of the *scutellaris* group of *Aedes* (*Stegomyia*) can transmit dengue; it is suspected, on epidemiological grounds, that *hebrideus* has been a vector of dengue in the New Hebrides (Daggy, 1944) and *polynesiensis* in the Society Islands, Marquesas, American Samoa, and Fiji (Rosen, Rozeboom, *et al.,* 1954).

PEST MOSQUITOES.—Relatively few mosquitoes are known to attack man in the South Pacific. The conspectus of species (figs. **1-5**) shows 39 species that feed more or less commonly on man and 11 species that attack man occasionally. Only 23 species can be said to be of economic importance; the majority of these are involved in the transmission of diseases mentioned in the previous paragraphs. The only species of this group that are not suspected or not known to be disease vectors anywhere in the South Pacific are *Culex* (*C.*) *pervigilans, C.* (*C.*) *annulirostris, Aedes* (*F.*) *notoscriptus, Aedes* (*E.*)

imprimens, A. (*V.*) *carmenti, A* (*V.*) *lineatus, A.* (*Aedimorphus*) *nocturnus, A.* (*Stegomyia*) *marshallensis,* and *Armigeres* (*A.*) *breinli.* These are potentially dangerous species either because of their close association with man or because of large populations produced from time to time. In addition, 15 species, including 3 beneficial ones, appear to be of economic importance occasionally in restricted areas. The majority of these species either have restricted habitats, usually not found in close proximity to man, or normally small populations. The most important species in this group are probably *Culex* (*C.*) *sitiens* and *Mansonia* (*Mansonioides*) *melanesiensis.* Little direct attempt is made to control pest mosquitoes in the South Pacific; they may be affected by efforts to control known vector species utilizing similar breeding sites.

MOSQUITOES AND HUMAN MIGRATIONS

Distributions of several mosquitoes in the South Pacific strongly suggest that these species have been dispersed by man, either recently by Europeans and other adventives or by the natives in pre-European times. In several forms that can apparently be dispersed by natural means over existing barriers, it is difficult to determine the relative role played by man in the over-all dispersal, but in species that cannot disperse over existing barriers, it is quite clear that man has been the sole agency of dispersal in recent times. It is also difficult to distinguish dispersal accomplished by the natives prior to the advent of Europeans and subsequent human dispersals. However, in several instances both problems can be resolved.

Although it would be of great interest to determine, if possible, the role of Europeans in the dispersal of indigenous species of mosquitoes within the South Pacific, I have made no attempt to do this in detail. Some forms which may have been dispersed at least in part in this manner are mentioned elsewhere (see Bionomics and Dispersal). On the other hand, it is clear that *Culex* (*C.*) *quinquefasciatus* and *Aedes* (*S.*) *aegypti* were introduced into the area by Europeans—probably also *Aedes* (*F.*) *notoscriptus,* at least to New Zealand.

Dispersals of mosquitoes by natives in pre-European times are of even greater interest, since these may give us clues to paths of native migrations into and within the South Pacific. I have made no attempt to analyze the dispersals of mosquitoes associated with Melanesians, since the patterns appear to be very complex and more information on distributions is needed than is available at present. There is obvious correlation, however, between several mosquito distributions and the migrations of the Polynesians. Detailed study of these species, I believe, may throw considerable light on these migrations. The Micronesians have also played a part in the dispersal of some mosquitoes in the same manner as the Polynesians, but the only instance of this in the South Pacific is the possible spread of *Aedes* (*S.*) *marshallensis* of the *scutellaris* group into the Southern Gilbert Islands.

Buxton and Hopkins (1927) first suggested that the Polynesians were instrumental in the dispersal of mosquitoes in the South Pacific, but they were inclined to attribute to them the transport of species over much longer distances than it appears possible to accomplish successfully. Apparently, they believed that some species had been carried all the way from the original home of the Polynesians in Asia. Their speculations were based on taxonomic affinities of species or populations that we now know to be untenable; there is no clear evidence in the South Pacific that dispersals between faunal areas have been accomplished through the agency of natives except for the doubtful one of *Aedes* (*Aedimorphus*) *nocturnus,* which may disperse in a variety of other ways (see below). The most significant instances of dispersal of mosquitoes by Polynesians are found in the *scutellaris* group (figs. **310-312**) of *Aedes* (*Stegomyia*) and the *kochi* group (fig. **225**) of *Aedes* (*Finlaya*), members of which are apparently incapable of crossing existing ocean barriers by natural means.

Members of the *scutellaris* group are typically breeders in treeholes but may utilize dead plant parts on the ground and artificial containers of various types, including canoes. It is suggested that transport in native canoes has been the principal means of dispersal with species of the group. In the central and eastern part of the South Pacific, *polynesiensis* is the most widespread species of the group; it occurs in association with Polynesians on isolated coral islands on which there were undoubtedly no breeding places available prior to human occupation. This species is unusually vigorous, plastic, adaptable, and salt tolerant, and I suggest that it may have arisen through hybridization between 2 other allopatric members of the complex transported by natives. One of the parent species may be *pseudoscutellaris;* neither the other parent nor the place of hybridization can be determined, although the latter may perhaps be the Lau group of Fiji. It may be possible to resolve these problems eventually and to determine the place of origin of *polynesiensis* through experimental hybridization and cytogenetic analysis. It is of interest that this most widespread and adaptable species of the *scutellaris* group in the South Pacific has been spread only in the central and eastern parts of the area and has not been introduced into the Polynesian areas in the western part. Buxton and Hopkins (1927:103) suggested that *tongae* was dispersed in native canoes from Tonga to Sikiana, an outlying atoll of the Solomons, but we now know that the form in Sikiana is a distinct species, *varuae,* which was probably dispersed from the Santa Cruz area. *Aedes* (S.) *cooki,* endemic to Niue Island, is another member of the *scutellaris* group which probably has been spread by natives; its morphological affinities suggest that it is a species formed through hybridization between *polynesiensis* and *tongae.* It seems well established on other grounds that the natives of Niue originally came from Samoa and had repeated contacts with Tonga. In the western part of the South Pacific, 2 species of the *scutellaris* group have been spread by Polynesians. *A.* (S.) *hebrideus* has been spread to Rennell, Bellona, Tikopia, Reef Islands, Ontong Java, and westward to all the outlying Polynesian islands north of the Bismark Archipelago and New Guinea. The spread has been apparently from the Santa Cruz–New Hebrides area northward and eastward. The origin of *hebrideus* is doubtful; there is a possibility that this species, too, is of hybrid origin. *A.* (S.) *varuae* has evidently been spread from the Santa Cruz area to Sikiana; this species has been confused with *tongae,* but there is little indication of affinities between the two forms except in the male genitalia.

Members of the *kochi* group in the South Pacific are usually breeders in the leaf axils of pandanus and aroids, including cultivated species. In the central area the distribution of *oceanicus* suggests that this species has been spread by natives in taro axils. As in *polynesiensis* of the *scutellaris* group, *oceanicus* may be a species of hybrid origin, possibly between *samoanus* (with which it has been confused) and *fijiensis.* This form is apparently only slightly salt tolerant, which may account for the fact that it is much less widely distributed than *polynesiensis.* In the western area, *hollingsheadi* has probably been spread by natives in a similar fashion from the Solomons to Sikiana in pandanus, or possibly taro, axils; it has not been collected in taro axils but may utilize these, as do some of its relatives in the Solomons.

Two other species of mosquitoes may have been spread by Polynesians as resistant eggs attached to taro roots: *Aedes* (*V.*) *lineatus* and *A.* (*Aedimorphus*) *nocturnus.* The latter presents a special problem; it may not be indigenous to the South Pacific but may possibly have been originally brought into this area by natives or by Europeans. Part of the distribution of *Tripteroides* (*R.*) *melanesiensis* is also evidently due to dispersal in native canoes of Polynesians in the Santa Cruz area. Native canoes may have also served for some dispersals of *Culex* (*C.*) *annulirostris, C.* (*C.*) *sitiens,* and even *Anopheles farauti* (see Bionomics and Dispersal).

Although the present knowledge of the mosquitoes associated with Polynesians and their distributions have little to offer toward the solution of the origin and migrations of Polynesians, I believe that this subject has many possibilities and should be thoroughly investigated. On the basis of current knowledge, it seems that the Polynesians did not bring any mosquito species with them into the South Pacific (except perhaps *nocturnus*), that within the South Pacific a number of indigenous species became associated with the Polynesians, that these were dispersed widely but over relatively short distances, and that no forms (except possibly *nocturnus*) were dispersed between the central and eastern area, on the one hand, and the western, on the other.

MATERIAL AND METHODS

MATERIAL

About 110,000 specimens from the South Pacific were examined during the course of this study, some 30,000 females, 17,000 males, 14,000 pupae, and 49,000 larvae; included in this material were about 3,600 individual rearings. Approximately half the total and the bulk of the individual rearings are from the collections made under my supervision by members of the 20th Malaria Survey Unit, AUS, chiefly on Guadalcanal. Other large collections were examined from the Solomon Islands and smaller ones from all the collected areas in the South Pacific except Pitcairn Island, Easter Island, and the Auckland Islands. For the latter I have had to rely entirely on literature records. No collections have been made, to my knowledge, on the Southern Gilbert, Phoenix, and Line Islands, Ocean Island, and many individual islands in other groups, as indicated by the absence of records in the distributional charts of the faunal areas of the South Pacific (figs. 6-12).

In the material I have examined, all the species treated here are represented except *Neodixa minuta*, *Culex* (*Culex*) sp. 3 (Auckland form), and *Culex* (*Lophoceraomyia*) sp. 14 (Belep form). More than two-thirds (134) of the species treated are represented by all stages (females, males, pupae, and larvae), and in 110 forms, chiefly from the Solomons, New Hebrides, and Fiji, the adults are associated with the immature stages by individual rearings, either larval or pupal.

Much time was spent deciphering locality labels and locating field notes for the various collections. In several instances I have not been able to obtain the correct data and have indicated this under distribution. A number of apparent errors in labeling were also noted; undoubtedly some additional errors have been committed in the course of this study.

In addition to the material from the South Pacific, I have examined for comparative purposes several thousand specimens of extralimital species.

Every specimen from the South Pacific was examined on three different occasions during the course of this study, but not every diagnostic character was studied thoroughly on every specimen each time. Except for specimens examined during visits to the British Museum (Nat. Hist.) and the U.S. National Museum, every individual pinned adult and all slides have been provided with an individual printed specific label. Undoubtedly errors have occurred in this process despite all precautions.

It has not been possible to present here a complete record of all the material examined. First of all, these records would have added about 50 per cent to the length of the text; furthermore, I have not had the time to check all the entries made by my assistants. However, every specimen has been recorded in a permanent ledger (fig. 29); after I have checked all the entries, this information will be available on microfilm to all interested workers.

The bulk of the material from the South Pacific is now or will be deposited in the U.S. National Museum (USNM), the British Museum (Nat. Hist.) (BMNH), or in my own collection at the University of California, Los Angeles (UCLA). Smaller representative collections are now located, or will be deposited as far as material will permit, in the following institutions: Walter Reed Army Institute of Research (AMGS); Bernice P. Bishop Museum (BISH); Cornell University (CU); School of Hygiene and Public Health, Johns Hopkins University (HOPK); London School of Tropical Medicine and Hygiene (LOND); U.S. Naval Medical School (NMS); University of Queensland (QUEEN); and School of Public Health and Tropical Medicine, University of Sydney (SYDN). There are also smaller and less representative collections in the other institutions mentioned in the preface.

TYPE SPECIMENS.—The type specimens of the majority of the nominal species represented in the South Pacific and adjacent areas are in the British Museum (Nat. Hist.) or the U.S. National Museum. I have studied only those indicated by an asterisk (*) preceding the type data. For information on the type specimens of other nominal species, I have had to rely on published data. The holotypes and allotypes of all new nominal species described here will be deposited at the U.S. National Museum except for the following: *Aedes* (*Finlaya*) *buxtoni* and *Aedes* (*Christophersiomyia*) *chionodes*, which will be deposited at the School of Public Health and Tropical Medicine, University of Sydney (SYDN); *Aedes* (*Stegomyia*) *cooki* and *Aedes* (*Stegomyia*) *hoguei*, which will be deposited at the British Museum (Nat. Hist.). Paratypes will be distributed insofar as possible and advisable to the institutions with representative collections from the South Pacific.

COLLECTION, PRESERVATION, AND REARING

The quality of the material, its preservation and preparation, and the geographical and ecological data accompanying it determine to a large extent what a taxonomist can do with it and how reliable his data and inferences will be. This section, therefore, will include a brief discussion of various simple techniques that I have found useful in the collection, preservation, and rearing of mosquitoes for taxonomic studies.

COLLECTION RECORDS AND LABELING.—It is frequently stated that material without accompanying data is worse than no material at all. While this is not entirely true, it is most important to have specimens properly labeled and accompanied by ecological data and other notes. All this information cannot be attached to every specimen in the field; some type of system of reference to field notes must be used. The most efficient system for mosquitoes is the widely used numerical lot system, in which a collection from a given habitat is given a number to correspond with the data entered on a standardized record sheet or card. In figure 28 is a reproduction of a modification of a record card that I used on Guadalcanal. The front of the card carries the general data while the back has a record of the material, its preservation, and its rearings. The advantage of the lot system is that species collected together in the same habitat and at the same time are associated. The different species in a given lot are assigned a sublot number; for example, in lot 612, specimens of 3 different species are labeled, respectively, 612-1, 612-2, and 612-3. If individual rearings are made, they are assigned an individual 2- or 3-digit expansion of the sublot number; for example, 3 individual rearings in sublot 612-1 would be labeled 612-11, 612-12, and 612-13, or 15 individual rearings in sublot 612-2 would be labeled 612-201, 612-202, and so on to 612-215. In individual rearings, the adult, the male genitalia slide mount, and the larval and pupal skins all bear the same individual identifying number, as, for example, 612-201. Adult collections may be recorded on the same cards or on different cards and preferably should be numbered in sequence with larval collections; the same system of sublots can be used for different species in the same lot; in progeny rearings, each parent female can be given an individual 1-digit expansion of the sublot, and if individual rearings are made from these, then 2 or 3 additional digits to the right may be used to identify each specimen. This system is an expansive one; many variations are possible. The advantages of this system are that all the material is associated throughout and that the data pertaining to the collection are recorded once. Printed labels may be made for each lot, or an entire series of lots from a given area may be provided with a general label, the specific data for each lot then being available only on the record cards. The latter is true of the collections of the 20th Malaria Survey Unit on Guadalcanal, which bear only the lot and sublot numbers and a general inclusive label.

ADULT COLLECTING AND KILLING.—Adult mosquitoes are so fragile, and in the Culicinae so easily denuded, that good material can be obtained only by picking up individual specimens with some type of suction tube or by inverting a vial on a resting mosquito. However, satisfactory specimens may be obtained with a small net. Material from light traps is often badly damaged and difficult but not impossible to study, although a person familiar with the local form can usually readily identify even the majority of the females. Collections of adults may be made in natural or artificial resting sites, on flowers, in swarms, while they are attracted to or are feeding on man and animals, in special baited traps, or in light traps. Killing is usually accomplished by transferring the specimens, one at a time for best results, into a chloroform tube or some other type of killing tube. I prefer to stupefy the mosquito first with tobacco smoke, which relaxes the leg and wing muscles, and then to transfer it into a killing tube, chloroform or cyanide. Great care must be exercised in handling specimens, preferably only fine flexible forceps should be used, and the specimens should be picked up by the legs.

ADULT PRESERVATION AND MOUNTING. —It has been customary to study adult mosquitoes preserved in the dry state and mounted either on a micropin (minuten) or on a heavy paper point attached to an ordinary insect pin (No. 3 or 2). Individual preference, freshness of the specimens, and availability of time determine the choice between the micropin and the paper point methods. Usually only freshly killed specimens make good micropin mounts, but it is possible to make satisfactory ones from material which has been dried for several months if it is relaxed in a moist jar for several hours. Although I have used the micropin method for many years, after examining the material for this study, I am convinced that the paper point method is a better and much safer method of mounting if the proper type of adhesive is used. The most satisfactory adhesive I have used is "Ambroid" cement, with the acetone solvent replaced by amyl acetate to give the desired viscosity and evaporation rate. After setting, which requires only a few minutes, this adhesive is practically invisible; it is not affected by moisture, can be removed with acetone, and dissolves in KOH. In thousands of specimens of mosquitoes mounted with "Ambroid" at the U.S. National Museum, I have seen less than a dozen that came off the mount; in every instance, these were originally improperly attached. The paper points should be punched or cut from stiff 100 per cent rag paper; I use thin, single ply calling-card stock. The specimens should be freshly killed or relaxed pillboxed material, so that the legs and wings will not break when handled and can be moved or gently blown into the desired position. They can be attached in any desired position by bending the tip of the paper point if necessary before applying the adhesive. The safest orientation of the specimen is in a horizontal position with the legs directed toward the pin. I mount my material with the right side of the thorax attached with the adhesive to the upper side of the paper point so that the left side of the animal can be examined. A very small amount of the adhesive is needed, but even an excess does very little to obstruct observation. The disadvantage of the paper point method is that one side of the thoracic pleuron is not visible; however, this is usually not a serious problem if the specimen is mounted in such a manner that the tip of the paper point does not extend beyond the upper end of the sternopleuron. In making the paper point mount, the tip of the upper side of the paper point, already attached to the pin, is touched to a glass rod or match stick dipped in "Ambroid" and is then touched to the properly oriented specimen under the low power of a stereoscopic microscope. In making a micropin mount, the specimen is best mounted by inserting the micropin between the midcoxae with the specimen lying ventral side up; the micropin should go deep into the thorax but should not project through the mesonotum. Prior to pinning the specimen, the micropin should be mounted on a piece of cork, pith, or similar material attached to a No. 3 or 2 insect pin. The micropin should be inserted with the sharp point through the supporting material, not stuck through with the blunt end. I prefer to put the micropin at a right angle to the large pin and use a very small piece of cork; the specimen is oriented vertically with the head up and the legs down and toward the large pin. This method is much safer than with the micropin parallel to the large pin; the latter method leaves very little space for handling or for attaching labels to the pin. The advantage of the micropin method is that all sides of the specimen are available for study; the disadvantages are that the micropin frequently corrodes and that the specimen has a tendency to move on the pin after repeated handling and quite frequently becomes detached; furthermore, there is usually more shriveling of the specimen than in the paper point method.

Material that cannot be mounted immediately is usually stored in cardboard pillboxes provided with cellucotton (not absorbent cotton) or lint-free tissue paper. Metal and plastic pillboxes are not satisfactory as the specimens tend to mildew in them, particularly in the tropics. Specimens should be carefully arranged in a single layer or in several layers separated by cellucotton, with the legs pulled away from the body and the wings flexed flat over the abdomen. If specimens are merely dumped into the pillboxes, they will assume all sorts of awkward positions and will become entangled in such a way that, even when relaxed, they will usually lose some of their legs, bristles, and scales. Only enough cellucotton or tissue paper should be put in a pillbox to keep the specimens from moving; if packed tight, they will be flattened and distorted.

Care must be exercised, particularly in the tropics, to dry properly both the mounted and the pillboxed material; if this is not done, it will become mouldy and will be practically worthless for study. This is usually accomplished by storing the material in a drying cabinet (box with an electric bulb) for several days or, in the tropics, until shipment to a less humid climate. It may be advisable to keep some crystals of thymol in the drying box and also to protect the stored material from insect pests, particularly ants and psocids.

While adult mosquitoes are usually studied in a dry state, many important characters can be seen best when they are preserved in alcohol or mounted on slides. Therefore it is advisable to preserve some adult material in alcohol. This requires much less work and care than dry preservation. After killing, specimens are transferred to a stoppered jar containing 75–85 per cent ethanol; the volume of alcohol should be at least 3 times the volume of the specimens. After 2 or 3 days the specimens are transferred to fresh ethanol of the same strength and proportion in small vials or tubes; to prevent injury to the specimens, a loose plug of cotton should be used to anchor them in the bottom of the container and to protect them from contact with the labels.

COLLECTION OF IMMATURE STAGES.—A much larger percentage of species can be collected as immature stages than as adults, since usually only the females that are attracted to bait or traps are encountered during a survey; these constitute only a small fraction of the mosquito fauna of almost every area in the world. Adults of many species are known only as a result of rearing of collections of immature stages, and association of the immature stages with the adults cannot be accomplished without rearing. Therefore, all or most of the immature stages collected should be brought alive into the laboratory in suitable containers with water from the habitat in which they were collected. It is a good practice to make mass rearings of part of every collection, to preserve some pupae and larvae of all instars, and to make a few individual rearings from each lot, and all or some of the sublots as desired (see below).

All types of aquatic habitats should be thoroughly examined. In the tropics a very large proportion of the known species utilize restricted accumulations of water in the ground (rockholes, crabholes, and so on), in dead or living plants or plant parts (leaves, fronds, fruits on the ground; treeholes, rotholes; leaf, frond, and bract axils; pitcher plants), and sometimes in skeletal parts of dead animals (snail shells). No collection of water is too small to be used for breeding. The immature stages can be collected with dippers, pipettes, siphons, or small nets. Eggs are seldom collected but frequently are easily found if a search is made; they can be picked up with the usual tools or, in small individual eggs, by means of a small fine brush. During the dry season, eggs of many temporary pool-breeders can be collected in the soil in low lying places; several samples of soil from different areas should be collected for rearing. In confined or container habitats that are dry, eggs of many species may be found among the debris in the bottom of the container. This debris should be collected for rearing. As mentioned elsewhere, some species may breed or survive in container habitats which are merely moist and do not appear to have any free water; by adding some fresh water to this muck, it is possible to siphon or to pipette the immature stages. In partially dry container habitats, it is advisable to fill the container, not only to make it easier to collect the larvae and pupae but also to dislodge eggs which may be adhering to the sides of the container above the water line. Care must always be exercised not to contaminate the various collections; all the collecting tools and containers should be washed out carefully between collections. The collection of the immature stages of species of *Mansonia* and *Ficalbia* requires special and careful examination of the roots, stems, and leaves of floating or submerged plants. As the immature stages of some of these species readily detach when disturbed and fall to the bottom, it is advisable to place a bucket or pan under the plant before removing it from the water. With other species all that is necessary is to remove a plant and to shake it in a panful of water. The larvae of all these species are difficult to see and often remain motionless in the flocculent material which settles in the bottom of the pan.

KILLING AND PRESERVING IMMATURE STAGES.—It is preferable not to kill and preserve immature stages in the field. It is possible to obtain fairly satisfactory larvae and pupae by transferring them directly into 75–85 per cent ethanol, but better specimens are obtained if the following simple procedure is followed: (1) The desired specimens are selected and transferred with a pipette into clean tap water in a pan, dish, or large wide-mouth jar;

it may be necessary to do this several times if the original water from the breeding site contains a great deal of suspended matter. (2) After the suspended matter has settled and the larvae and pupae are clean, transfer them with a pipette singly or a few at a time into a beaker of hot water (50–70° C.). (3) After the specimens are killed and floating on the surface, transfer them with a pipette or a lifter into 75–85 per cent ethanol in a beaker or wide-mouthed jar sufficiently large to accommodate all the specimens in a single layer on the bottom; this allows them to harden in a horizontal position. (4) After 24 hours or more, store the specimens in fresh 75–85 per cent ethanol in small vials or tubes, allowing at least 3 volumes of alcohol to 1 of specimens, and place a loose plug of cotton to prevent the specimens from moving and to protect them from contact with the labels. Fixing agents other than ethanol may be used, particularly various formulas of FAA (formalin, acetic acid, and alcohol). Formalin or a standard histological fixative instead of ethanol should be used for eggs, as they will usually retain their shape better in these preservatives. Egg rafts and resistant eggs may be put directly into a vial or tube of 2 per cent formalin (standard 40 per cent formaldehyde). Delicate floating eggs, such as those of anophelines, should be carefully transferred with a fine camel's-hair brush onto a strip of filter paper touching a cotton plug saturated with 2 per cent formalin in the bottom of a tube or small vial; the container should be securely stoppered and preferably sealed with paraffin.

STORAGE CONTAINERS FOR MATERIALS PRESERVED IN LIQUIDS.—All types of glass vials, tubes, or jars are used for the storage of liquid-preserved material. Many problems arise with the care and storage of these containers and the accessibility of the material for study. In recent years, used dental "carpules" for local anesthesia have become very popular and can be readily obtained in most areas. There is a problem, however, in cleaning these; much more important is the fact that the stoppers usually deteriorate with time. I have come to use a similar type tube, which can be prepared from clean material. The glass cartridge or tube is cut in the desired length (I use a standard length of 2.5 inches) from ordinary flint glass tubing (8–9 mm. is most useful, but large sizes are sometimes needed), and the cut ends are fire polished; this can be done by a professional glass-cutting concern for a reasonable price. For the stoppers, ordinary synthetic rubbers are not satisfactory, since they will eventually dissolve in ethanol; neoprene is quite satisfactory, and polyethylene is even better. Neoprene stoppers of different sizes can be obtained from suppliers of pharmaceutical firms; one stopper should be a plunger type to fit inside one end and the other a diaphragm type with a lip that can be used to remove the stopper. At the present time, small polyethylene stoppers of this type are not generally available. Whenever the diaphragm stopper is replaced, a needle should be inserted to let out the excess air; if this is not done, the stopper may be blown off at high temperatures. The advantage of the cartridge containers is that the material is readily available for examination and can be placed in a horizontal position in a cardboard unit adjoining the unit containing the pinned specimens. In most instances, species identification is possible without removal from the cartridge. There is practically no evaporation from these cartridges; I have had some stored for ten years without replenishing the alcohol; they should not be stored in alcohol in jars.

MASS REARINGS OF IMMATURE STAGES.—The most common practice is to rear all, or a large share, of each collection or lot of immature stages in various containers with the original water from the breeding site, rather than isolating individual specimens. This is the easiest and most successful method of obtaining large numbers of vigorous, nearly perfect adults, particularly males. The collection may be subdivided into sublots or the entire lot may be reared together. Although sometimes this is the only way in which rearing can be accomplished, this method is not a reliable one for associating the immature stages with the adults (or, for that matter, the two sexes), since quite frequently two or more closely related and superficially indistinguishable species may be found in the same collection. Therefore, at least a few individual rearings should be made whenever possible. Frequently, only nearly mature fourth instar larvae and pupae are collected, while the younger instars and eggs are discarded. Following this time-saving custom may result in missing one or more species. It is quite easy to rear most species, except some temporary pool-breeders, from the egg or from the first instar; in surveys an attempt should be made to rear at least a part of the younger instars. With fourth instar larvae, and, of course, pupae, no food need be added; with younger instars, small amounts of finely ground laboratory chow or dog biscuits and brewers' yeast in a proportion of 1 to 1 should be added from time to time. Gentle aeration with a small aquarium pump, which can serve several rearing containers, is very helpful in providing a good environment for larval growth; it practically eliminates the problem of accumulation of waste products and undesirable bacterial films. Carnivorous forms usually need a large number of other mosquito larvae for quick growth. As soon as pupae are formed, they should be transferred to clean tap water in a jar covered with netting or provided with a funnel trap. A great deal of valuable material is lost in mass rearing by neglecting to preserve the cast larval and pupal skins; these should be picked up with a lifter or pipette within 24 hours after molting occurs (preferably as soon as noted) and should be put in 75–85 per cent ethanol after a quick rinse in tap water. It is very important to label them with the appropriate lot or sublot number. After the adults emerge and before they are killed, they should be kept in a cage or in a covered jar of considerable size for at least 24 hours, preferably longer, to allow them to harden. A small wad of cotton saturated, but not dripping, with a 10 per cent sugar solution or a moistened dried fruit (prune, raisin, apple) placed on the top of the jar often helps to produce sturdier and better-hardened specimens. Debris or soil containing eggs may be used to obtain immature stages and adults. Treatment of this type of material differs with the species, but in general all that is necessary is covering the debris or soil with rainwater, distilled water, or tap water. It may be advisable to dry and reflood the material several times. A low oxygen tension in the water favors hatching in some species. After hatching the immature stages are treated in the usual manner.

INDIVIDUAL REARINGS.—Individual rearings are absolutely essential to establish correlations between the immatures and the adults and between the two sexes of the adults. They are very simple to make but are tedious and time-consuming. Individual rearings are usually made from field-collected mature fourth-instar larvae, but rearings from field-collected pupae (pupal rearings) are also useful. Individual rearings can also be made from material in progeny rearings or from any larval instar; the percentage of successful rearings, is usually much smaller in such instances, there may be a great deal of environmental modification in the morphology, and the adults tend to be weak and small. Rearings are made simply by isolating individual specimens in a small container with water from the breeding site; I use small opal glass ointment jars for larvae. As soon as the specimen is isolated, it should be labeled with the individual number as indicated above under collection records; I make the label in triplicate so that the larval skin, the pupal skin, and the adult will each have its own identical label. In mature larvae, feeding is not necessary if the original water from the breeding site is used; if the larvae are younger, a small amount of food should be added from time to time as in mass rearings, and it may be necessary to add distilled water to compensate for evaporation. As soon as possible after pupation occurs, the cast larval skin is picked up with a lifter, briefly washed in a dish of tap water, and transferred with its label to 75–85 per cent ethanol in a carpule. The pupa, with the remaining two labels, is then transferred with a pipette to a vial containing a small amount of tap water; I normally use a loose plug of cotton to stopper the vial and insert the labels between the plug and inner wall of the vial. As soon as possible after emergence, the adult is picked up with a suction tube and transferred to a clean vial, which is provided with a strip of moist filter paper and a loose cotton plug; one of the remaining labels accompanies the adult. The pupal skin is picked up with a lifter, briefly washed in a dish of tap water, and transferred with the last label to 75–85 per cent ethanol in a carpule. The adult should not be killed for at least 24 hours; it is pinned, point-mounted, or pillboxed as preferred. When only a small number of rearings are being made, the larval and pupal skins may be put into the same carpule; to avoid errors in association when a large number of rearings are being made, it is safer to put them in separate carpules. Racks to hold the pupal and adult vials and the carpules are very useful also in numerous rearings. The larval and pupal skins should eventually be placed in the same carpule and may remain indefinitely in the ethanol; preferably, however, they should be mounted together on one slide after 24 hours.

PROGENY REARINGS.—Progeny rearings are rearings of immature stages and adults from egg batches laid by individual females. Such rearings are very useful to determine the range of variation in a clone, to establish whether or not a character breeds true, to elucidate the possible hybrid nature of a form, to study the inheritance of characters, and sometimes to establish correlations between adults and immature stages. They are very simple to make but are even more tedious and time-consuming than individual rearings from field-collected immature stages; they are therefore very seldom made. Each gravid or blooded and inseminated female is isolated in a test tube or shell vial containing a moist strip of filter paper and is allowed to remain until eggs are laid. Females collected in the field or from laboratory colonies and from experimental crosses may be used. If they are not gravid or blooded, they must be fed on a suitable host, man or a laboratory animal. Females of species which lay egg rafts, such as *Culex*, should be provided with a small amount of water in the bottom of the tube. It may be advisable to feed the females on a 10 per cent sugar solution or on a moist piece of fruit; in such instances a gauze cover is substituted for the cotton plug, and the food is placed directly on it or on a small wad of cotton. Care must be exercised to have sufficient room for the female to move about and not to have moisture condensing on the walls of the tube. Eggs are usually deposited within 3–5 days. The female is then killed, mounted, and properly labeled with a number corresponding to that of its eggs, as suggested in the section on collection records. Some females may be induced to lay more than one batch of eggs, but the parent females are usually in such poor condition that many of the characters are no longer discernible. Rearing is then carried out in the appropriate manner, first as mass rearings, with individual larvae later being isolated for individual rearings. In my own work, I always preserve a part of the eggs and some of each of the subsequent larval instars and rear the remainder to adulthood (with the exception of about 10 individual rearings) in a mass rearing. Since males usually develop faster than females in all stages, it is not advisable to preserve only those specimens which molt first, since a very uneven sex ratio of the adults will be obtained.

SLIDE MOUNTS

Many of the characters of both adults and immature stages are most easily studied in slide mounts. Many different techniques have been used; I mention here only those that I have personally found to be most satisfactory in the course of this study.

HOYER'S MOUNTS.—The only aqueous medium I have found satisfactory for mosquito material is Hoyer's medium, a modification of Berlese's medium prepared as follows: (1) dissolve 30 gm. of clear gum arabic in 50 ml. of water by adding the gum gradually and stirring thoroughly in a large beaker; (2) let stand overnight or longer and then filter through several thicknesses of cheesecloth; this may take a long time, as the material is viscous; (3) add 200 gm. of chloral hydrate gradually, stirring thoroughly; and (4) add 20 ml. of glycerine. A better medium is obtained if it is prepared in a larger batch but in the same proportions as indicated. Whole larvae, pupae, and adults or parts of their bodies may be mounted in this from water or ethanol, or even freshly killed or alive. Although we have had no deterioration of mounts prepared with Hoyer's under the climatic conditions at Los Angeles even without ringing the coverslip, all aqueous media have a tendency to dry out after a number of years and cannot be considered to be permanent. No preliminary treatment of the material is needed; it may be mounted directly, but we use the following procedure with larvae preserved in ethanol; (1) cut off the terminal segments and puncture the abdomen in 1 or 2 safe areas; (2) transfer the specimens for 20–30 minutes to Hoyer's diluted 1 to 1 with distilled water; (3) spread undiluted Hoyer's on a slide in an amount sufficient to cover the specimen and to the diameter of the coverslip; (4) transfer the specimen to the medium on the slide and arrange in the desired position; (5) place the uncovered slide in a dust-free place at room temperature for 1 to 2 hours or into an oven at 50° C. for a few minutes; and (6) spread the necessary amount of undiluted Hoyer's on a coverslip and invert the coverslip on the specimen on the slide. Step 5 is usually not necessary, and a coverslip may be placed directly on the specimen on the slide. On the other hand, the best mounts are prepared when a less viscous Hoyer's is used for steps 3 and 4; this is prepared by adding a few drops of distilled water; for the final step 6, the undiluted Hoyer's is used. After the mount is finished, the slide is placed in an oven at 50° C. for 2 to 3 days or longer; when the mounts are thick, they should not be put in a vertical position for several weeks. Supports for the coverslips are not needed, but it may be advisable to ring the coverslip with some type of ringing cement or with a permanent medium such as balsam or euparal. The optical properties of Hoyer's medium are outstanding; many structures not visible in balsam or euparal are beautifully clear in Hoyer's, particularly minute setae and the fine branches of hairs. On the other hand, most structures tend to swell somewhat, and the specimens frequently become flattened and distorted. With Hoyer's we have had no difficulty with crystallization or darkening, so commonly encountered in other aqueous media.

BALSAM MOUNTS.—Balsam mounts are probably unequalled for permanency, but their preparation is tedious and time-consuming, and, while in general the optical properties of balsam are good, some structures are hard to see in this medium. Because of the greater ease and speed of preparation of euparal mounts, I have discarded balsam mounts except for whole specimens of adults, larvae, and pupae. The technique used is the same as with euparal except that more thorough dehydration is essential and clearing with xylene following or in place of clove oil is advisable. The greatest disadvantage of the balsam mounts for mosquito material is that many of the important structures may be lost during manipulation and some of the fine details are not readily visible.

EUPARAL MOUNTS.—I have used euparal as a permanent mounting medium for over 20 years in preference to balsam because of its somewhat better optical and drying properties and the much greater ease of manipulation of material in this medium. The one really unfavorable property of euparal is its tendency to shrink material; this seems to have increased considerably in the batches I have used in recent years. Specimens in euparal are also not as transparent as in balsam; this is really not a disadvantage, however, since surface structures are more sharply defined. Clear (yellowish) or green euparal are available; I prefer the latter because the color, which is caused by copper salts added to the clear material, increases the contrast of some structures. Green euparal is not suitable for mounts of material not macerated in KOH or for thick material. Clear euparal can be used for these, but I prefer balsam for this type of material. Euparal is miscible, among other substances, with 95 per cent ethanol, nearly all essential oils, a special euparal essence, and with cellosolve (ethylene glycol monoethyl ether), which is also miscible with water. Therefore it is possible to make euparal mounts with only 1 or 2 steps directly from water. However, I prefer to use the following steps in making euparal mounts: (1) After maceration with KOH if necessary and washing (see below), or from storage in 75–85 per cent ethanol, the material is transferred to fresh 75 per cent ethanol for at least 1 hour. (2) It is then transferred to 95 per cent ethanol for about 30 minutes but not longer than 1 hour. (3) The material is then placed in clove oil until it sinks, usually from 30 minutes to 2 or more hours. (4) If dissection or extensive manipulation of the specimen is needed, it is transferred to a drop of clove oil on a slide, and the necessary procedures are carried out under a stereoscopic microscope. (5) A very thin euparal diluted with euparal essence is placed on a slide in a quantity just sufficient to cover the entire specimen, or in small droplets for individual dissected parts. (6) The specimens or parts are transferred from the clove oil by means of a fine needle or a lifter to the thin euparal on the slide and are arranged in the desired position. (7) Considerable manipulation and dissection is possible in the thin euparal, since it does not form a tough film in contact with air; should it begin to set before the manipulation is completed, a tiny droplet of euparal essence is added. (8) The slide is left uncovered in a dust-free place (I use an inverted pan propped on a block) for 2–6 hours or overnight or in an oven at 50° C. for 30 minutes or less, until the structures are firmly anchored. (9) If occasionally some displacement has occurred, a drop of euparal essence will quickly free the specimen, and steps 7 and 8 can be repeated. (10) Thick euparal is placed on a coverslip and this is inverted on the specimen anchored in the thin euparal. (11) The slide can be used within less than 24 hours but should not be placed in a vertical position for about 5 or 6 days. Clearing of the specimen is rather slow, but the process can be speeded up by keeping the slide in the oven for a longer period.

MACERATION IN KOH-TSP.—Various techniques have been employed for macerating whole specimens or parts with KOH for the removal of soft tissues so that cuticular structures are more readily visible. Potassium hydroxide has also been used for decolorizing very heavily pigmented structures, but it is not suitable for this purpose; if decolorization is desired, the material should be immersed, after wetting in 95 per cent ethanol, in a 5 per cent hypochlorite solution (commercial bleach) for a few seconds to 1 or 2 minutes or longer and then thoroughly washed in water and macerated in KOH. After considerable experimentation I have adopted the following procedure for maceration with KOH: (1) The solution is prepared by dissolving 10 gm. of KOH and 0.2 gm. of trisodium phosphate (TSP) in 100 ml. distilled water; the TSP apparently increases the penetration into the tissues and produces cleaner specimens. (2) Covered opal glass ointment jars are half-filled with the KOH solution and placed in an oven at 50° C. for 30 minutes to 1 hour for preheating. (3) The specimens to be macerated are then transferred 1 to a jar, wetted with 95 per cent ethanol if they float. (4) The jars are then returned to the oven and kept at 50° C. for 30 minutes to 1 hour, depending on the nature of the material, rarely for as long as 2 hours. (5) The specimens are then transferred to covered jars of distilled water, which have been preheated for 30 minutes to 1 hour, and are kept in the oven preferably for another 1 to 2 hours. (6) The material is then transferred to covered jars of 75 per cent ethanol at room temperature. With this technique I have obtained more uniform specimens than usual and have had no difficulty with the most delicate material. However, it must be kept in mind that sclerotization varies in different specimens of the same species even in the same lot and that some variation in the macerated material is nearly always apparent. Therefore for the best and most uniform maceration, it is necessary to inspect the material during the process. For transfer of material I use a lifter made from a long thin metal dental spatula by bending the distal 0.5 mm.; male genitalia and other body parts as well as whole specimens can be easily lifted with this tool without injury.

ADULTS.—Whole adults may be mounted without maceration in Hoyer's, balsam, and sometimes in euparal, but unmacerated specimens mounted in euparal are usually too opaque for clear observation. It is advisable to puncture the adults in 1 or 2 safe places on the thorax. For maceration, mounted or pillboxed adults should be first relaxed in a moist jar for 1 to 2 hours, wetted in 95 per cent ethanol, and then kept in KOH-TSP for 1 to 2 hours at 50° C. and washed in distilled water for 2 hours or more at 50° C.; I usually mount them in balsam but euparal is also satisfactory. Parts of adults such as antennae, palpi, legs, and wings are detached from specimens relaxed in a moist jar for 1 to 2 hours and may be mounted directly into Hoyer's for semi-permanent mounts or into glycerine for temporary mounts; maceration in KOH-TSP is not advisable but can be accomplished successfully if care is taken in transferring. Permanent mounts may be made in euparal or balsam, but I prefer the unmacerated Hoyer's mounts.

BUCCOPHARYNGEAL ARMATURE.—Mounts of the female buccopharyngeal armature are difficult to make because of the curvature of the supporting sclerites, but they are useful to separate closely related species. To prepare them: (1) detach the head of a relaxed specimen, (2) wet it in 95 per cent ethanol, (3) macerate in KOH-TSP for 30 minutes at 50° C., (4) wash for 1 hour in distilled water at 50° C., (5) run through the alcohols and clove oil according to the usual schedule, (6) dissect in a drop of clove oil on a slide under a stereoscopic microscope by tearing off one eye, the clypeus, and the labrum and by gently pulling out the labrum-epipharynx and hypopharynx, together with the cibarial and pharyngeal pumps; the buccopharyngeal armature is at the caudal margin of the cibarial sclerite and projects dorsad, (7) mount the entire complex of structures or dissect and mount the cibarium separately; since this often results in tearing some of the "teeth," it is advisable to make both dorsal and ventral mounts to see the "teeth" in both aspects, (8) mount in the usual manner, as suggested above, preferably in euparal.

FEMALE GENITALIA.—Female genitalia are not frequently studied in detail and were only superficially examined in the mosquitoes of the South Pacific, but they often show good characters, both group and specific. Usually the general structure is well shown in whole mounts of adults, but special preparations are needed for detailed examination. Preparation of mounts is essentially similar to that of the male genitalia as outlined below, with the following exceptions: (1) species with retracted genitalia should have them pulled out before mounting, (2) the genitalia should be mounted in all 3 aspects (dorsal, lateral, and ventral) for thorough study, and (3) in some forms, the genital atrium must be opened for examination of the supporting sclerites.

MALE GENITALIA.—More reliance for specific determination of mosquitoes is placed at present on male genitalia than on any other structure in the adults, and, furthermore, the male genitalia show very excellent group characters. Therefore it is essential to be able to make reasonably good preparations for identification purposes or for detailed study. The technique is very simple but requires some practice for mastery. I have used the following method for the present study: (1) Adults are relaxed in a moist jar for at least 1 hour. (2) Individual specimens must always be associated with the corresponding genitalia; if the specimen bears an individual number, as in an individual rearing, this number is used for the genitalia; if it does not, duplicate labels are made to identify each specimen with its genitalia; I use a simple system of arabic numerals to indicate the year (2 digits), the month (2 digits), and the day (2 digits) when the genitalia were prepared and follow this with a dash and an individual number for each specimen; for example, 36 specimens whose genitalia were prepared on April 6, 1959, would be marked respectively 590406-1, 590406-2, and so on to 590406-36; one label is attached to the pin bearing the specimen, the other accompanies the genitalia throughout the treatment and is eventually marked on the slide with a diamond point and also written on the slide label; to minimize errors, the numbers and the data on the specimens should be entered in a ledger. (3) The tip of the abdomen is cut at about the middle of segment VII with a pair of fine iris scissors; this should be done under a stereoscopic microscope, with the pin in a horizontal position in some type of container which will prevent accidental loss of the cut genitalia; I use a small standard pinning unit with a cork attached to one side; the genitalia may cling to the scissors or drop into the bottom of the unit; it is safer to dislodge the genitalia from the scissors by gentle tapping. (4) The genitalia are transferred to preheated KOH-TSP with a bent dental probe dipped into 95 per cent ethanol; the probe should barely touch the specimen and should not bear an excessive amount of alcohol. (5) The labeled jars containing the genitalia are covered and placed in an oven at 50° C. for about 30 minutes; rarely is it necessary to increase the time to 1 hour. (6) The remainder of the schedule is the standard procedure described above for euparal mounts; it is best to wash for twice the time used for maceration; transfer is done with a lifter and care must be exercised not to mix the labels. (7) Dissection is made in a drop of clove oil under a high power of the stereoscopic microscope, using special tools or stainless steel micropins (minuten) inserted into applicator sticks; in most instances dissection is neither needed nor even desirable, but it is almost always necessary to pull the genitalia out from the eighth segment into which they are usually at least partially retracted; I usually tear the membrane between segments VIII and IX and do no further dissection; if dissection is necessary, only practice will enable one to accomplish it satisfactorily, but the process is greatly simplified if the genitalia are left in the clove oil for several hours or overnight, after which the membranes between sclerites separate very readily. (8) The dissected or undissected genitalia are transferred to thin euparal on a slide by means of the micropin tool, are properly positioned, and are allowed to dry for 2 to 6 hours, or even overnight if a sufficient amount of thin euparal has been used; it is sometimes recommended that the pregenital segments be discarded, but it is best to mount them along with the genitalia, for at least segment VIII and sometimes segment VII may show important characters. (9) After drying, the coverslip with the thick euparal is added and the slides are placed in an oven at 50° C. (10) The slides are ready for examination overnight but should be kept in the oven for 2 or 3 days before storage in a slide box in a horizontal position; it is best not to keep them in a vertical position for any length of time for at least a week or 10 days. Staining is sometimes desirable, but properly macerated unstained material is nearly always as satisfactory, or even better, for fine detail; in undissected genitalia, staining may be a hindrance to observation. If staining is desired, the material is transferred after maceration and washing in distilled water into a dilute solution of acid fuchsin. The stock acid fuchsin stain is prepared as follows: (1) 0.5 gm. of acid fuchsin (not basic fuchsin), (2) 25 ml. of 10 per cent HCl, and (3) 300 ml. of distilled water. For the dilute stain I use 4 to 6 drops of the stock stain to about 10 ml. of distilled water; the specimen is kept in the dilute stain for at least 4 to 6 hours, preferably overnight, and then is briefly transferred to distilled water and handled according to the usual schedule through the alcohols, clove oil, and mounting.

WHOLE LARVAE AND PUPAE.—Whole larvae and pupae are usually mounted without maceration either directly into Hoyer's or, after dehydration and clearing, into balsam or euparal. It is possible to macerate them in KOH-TSP, but whole specimens are difficult to handle and tend to lose many hairs. I use clove oil for clearing of specimens to be mounted in either balsam or euparal; balsam mounts are usually much clearer. While in the clove oil, the distal segments of the larva are cut with a sharp needle or with an angled microscalpel between abdominal segments VI and VII; with euparal mounts, if the thorax is not punctured in several places, shrinking and distortion will take place. The terminal segments are mounted with the left side up; it is customary to mount the main part of the body with the dorsal side up, but it is advisable to mount at least a few specimens with the ventral side uppermost. Whole pupae do not make satisfactory or useful mounts unless the cephalothorax is separated from the metanotum and abdomen and mounted with the left side up; the abdomen, together with the metanotum, is mounted dorsally or ventrally. I prefer to study whole pupae in alcohol and make whole mounts directly in Hoyer's only when pupal skins are not available.

LARVAL AND PUPAL SKINS.—In individual rearings the associated larval and pupal skins should be mounted on the same slide and preferably under the same coverslip. I always mount them in euparal because this medium allows considerable manipulation of the specimens, and there is practically no loss of hairs; however, very satisfactory permanent mounts can be made with care in balsam and semipermanent mounts in Hoyer's. When working with larval skins, the terminal abdominal segments should be stretched or "pulled" by inserting one dissecting pin in the thorax and the other at the base of the siphon or spiracular apparatus; the membrane between abdominal segments VI and VII may be partially torn to allow a lateral orientation of the terminal segments and a dorsal orientation of the remainder of the body. These manipulations may be performed in clove oil; however, since further manipulations are needed in the thin euparal, I prefer to do them all at that time. The pupal skin must be dissected before mounting in clove oil or in thin euparal; I usually separate the cephalothorax from the metanotum and abdomen in the clove oil, with the pupal skin in a lateral position, by inserting one dissecting pin just cephalad of the wing cases and, with another, teasing the metanotum away from the cephalothorax. The two parts are then transferred to the thin euparal. The cephalothorax is usually connected by a narrow sclerotized strip caudad of the ecdysial suture; this is broken and the cephalothorax is then opened and mounted, with the outer wall up and the ventral part in the middle, as shown in figure **410.** The abdomen, together with the metanotum, is mounted with the dorsal surface up, but it is best to place it first with the ventral side up (in order to flatten it) and then to flip it over. For all skin mounts I use a medium thin euparal for the first step, taking care to have enough euparal to cover the specimens during the preliminary drying period; after 2 to 3 hours a coverslip with thicker euparal is inverted on the specimens.

ILLUSTRATIONS

All graphic presentation requires interpretation of the material represented. Therefore a statement of the techniques used and their limitations is essential for the proper use of the illustrations presented here.

DRAWINGS.—All the original drawings for this study were made in the following manner: (1) A "typical" specimen was selected for general proportions, and all the pertinent details were drawn from this specimen. (2) An ocular micrometer reticule with 400 divisions was used in either a compound binocular microscope or a stereoscopic microscope and calibrated for all magnifications. (3) The original drawing was made in pencil on tracing paper superimposed on a sheet of cross-section paper; various sizes of grids were used, and the drawing was made with the aid of the one most appropriate to show the desired detail; a mm. scale was drawn on each sheet of cross-section paper of different size grid and for each magnification used to correspond to the calibrated ocular reticule. (4) Symmetrical arrangement of structures such as hairs was obtained by measuring the structure and drawing it in the desired position; all missing structures were drawn from other specimens, but this was a rare occurrence with bilaterally symmetrical structures. (5) The original drawing was checked first with the specimen from which it was drawn and then with at least 4 other specimens, and corrections were made to show the modal condition for the 5 specimens. (6) The corrected drawing on the tracing paper was projected with the aid of a hydraulically operated opaque projector (Saltzman projector) onto a sheet of drawing paper (2-ply Hi-Art bristol board, mat), reduced (rarely enlarged) to the desired size to fit on a standardized plate size, and a tracing in pencil was made over the projected image; this results in much greater accuracy than is found in tracings made on a tracing table through a thickness of paper. (7) Inking of the final drawing was made with continual reference to the original specimen; India ink fountain pens (Rapidograph) were used for lines of uniform width, such as outlines of the body and structures. (8) The individual drawings were assembled and glued with rubber cement on standard size plates (14″ x 19½″). (9) Lettering was done with LeRoy lettering guides after assembly on plates. All the drawings, except a few for which only one specimen was available, are therefore composites, but great care was exercised to use only material from a single locality or a single island to prepare the composite drawing. In new species, only specimens from the type series were used. Various nonessential details were left out of the drawings, as, for example, long hairs on the male genitalia; missing hairs on larvae and pupae were indicated by their alveoli. In general the various types of drawings are self-explanatory; with the exception of the chaetotaxy, no attempt was made to label all the structures.

MALE GENITALIA.—The majority of drawings of male genitalia are in dorsal aspect and include the entire phallosome complex and the entire proctiger but only the right (morphological) sidepiece and only part of segment IX; pertinent details are shown in insets. In related species or groups, the homologous structures are similarly shaded. In many instances, the large hairs of the sidepiece are represented only by their alveoli. In the subgenus *Finlaya* of *Aedes*, both sidepieces are shown in dorsal aspect, the left (morphological) with details of the mesal and tergal hairs, the right with scales. Except for special drawings of some species of *Culex*, all the genitalia are drawn with the phallosome and aedeagus in the normal resting position; these structures may appear very different in the everted mating position, particularly in the genus *Culex* (figs. **99, 154**), and there is considerable variation in the resting position, depending on the angle at which they are observed or drawn.

PUPAE.—The majority of the drawings are made from pupal skins. In such material the ventral and lateral portions of the cephalothorax are folded and distorted; therefore, no reliance should be placed on the shape of the sclerites; even the position of the hairs is often misleading. Only the anterior part of the left (morphological) side of the cephalothorax is represented; the entire cephalothorax is shown in figure **410.** The metanotum and abdomen are drawn together, with the left side dorsal on the left half of the drawing and ventral on the right half. Since the abdomen is curved in life and flattened in mounts, there is considerable distortion in the drawings; the intersegmental sclerites are not shown and segments overlap each other in various ways; therefore the differences in the shape of the segments are usually artifacts. Since the trumpet is very difficult to orient in the same plane in different specimens, no attempt was made to show its shape accurately and from a uniform aspect; again many of the apparent differences in the drawings are artifacts. The chaetotaxy as represented in the drawings is usually the modal condition for 5 specimens (10 hairs), except for species where fewer specimens were available; in groups that I have studied in detail, it is based on at least 10 specimens (20 hairs). Anomalies are quite common in the pupal chaetotaxy; quite frequently, but not always, the anomalous hairs have been shown in the drawings.

LARVAE.—The general outline of the body is usually drawn from specimens mounted in balsam. The proportions of the thorax and abdomen and the total length are extremely variable; any apparent differences in these dimensions are not to be regarded as real. On the other hand, the dimensions of the sclerotized parts (head capsule, siphon or spiracular apparatus, and anal saddle) are variable only within narrow limits, and they are represented more or less accurately in the drawings. The chaetotaxy is represented in the same manner as in the pupae. No attempt is made to show all the fine barbs or spicules on the hairs and their branches; they are usually left out completely except in groups or species where they appear to be significant, and mention of this is made in the text. The first instar larvae of anophelines are drawn from 1 to 3 specimens only, and no attempt is made to show the modal chaetotaxy except for the diagnostic characters mentioned in the keys and text. Most mosquito larvae have fine integumentary spicules, particularly on the venter of the abdomen; these are not shown in any of the figures, and only the long dense, conspicuous spiculation is shown in a few species. The length and proportion of the siphon vary greatly in some species; usually only the modal or average condition is shown in the drawings. A "typical" comb scale is drawn from the middle of the row (caudal row if more than one is present); there is considerable variation in the shape of these, and they may be quite different in appearance from those at the dorsal or ventral ends of the row(s). The pecten tooth drawn is usually one of the 2 or 3 distal ones; not only is there a great deal of variation in the shape of the pecten teeth, but the same pecten tooth may present a different appearance when viewed in different aspects; the pecten teeth are drawn flat and not necessarily in the position they occupy on the siphon. The mental plate is drawn from a single specimen, variations in the number of teeth are indicated in the text.

CHARTS.—The information that it seemed advisable to show on the charts (figs. **1-17**) could not be set up economically in regular typographic composition; these charts were, therefore, prepared as plates. Reproduction proofs for the printed matter were made in desired type faces on adhesive acetate film, and the individual lines and titles were cut out and assembled on ruled quadrille paper. Commercially available symbols printed on similar acetate film (Artype, Micotype, and so on) were used. The acetate film is available with several different types of adhesive surface; some require burnishing (wax and low tack), others do not do (high tack or seal).

The extralimital distributions shown on the charts are probably inaccurate in many instances, as no attempt was made to check all the recent literature and the records were derived largely from regional summaries. The world faunal areas are indicated on figure **18** and are explained in the section on terminology and abbreviations. The South Pacific distributions are derived from the material I have examined as well as from literature records; all the major islands from which indigenous or endemic species are known are included; in New Zealand, the land districts are also given. The South Pacific faunal areas are indicated on figure **19** and are discussed in the section on terminology and abbreviations. Each of the charts is discussed in the appropriate section of the General Considerations.

MAPS.—All the maps were especially prepared for this study, as no suitable outline maps could be found. The world map was drawn on an Aitoff equal area projection and centered on 150° E. longitude, so that North Pacific connections between the Old World and the New World could be shown more clearly than on the usual types of world projections. This map is not intended to be accurate but merely to show the general relationships of the continental masses and island chains. The remaining maps were all made on Lambert conformal conic projections, first because this type of projection is most useful for distribution maps covering relatively large areas, since distances are represented quite accurately (less than 6 per cent error), and, second, because maps on this type of projection are available for all parts of the world. The projection for the map of the entire South Pacific area was made from data in Deetz and Adams (1921:86) and the land masses were plotted from 1:5,000,000 Aeronautical Planning Charts AP-23, AP-24, AP-29, AP-30, and AP-31 (U.S. Air Force). All the maps were reproduced by planograph offset printing on bond paper (32 lb., 25 per cent rag); maps of the world and the entire South Pacific were printed on 17″ x 22″ sheets; a half reduction of the world map was printed for use as an inset to show world distributions of South Pacific groups. The sectional maps of the South Pacific were printed on 10″ x 14″ sheets at a uniform reduction so that they could be assembled into composite maps.

The distributions are shown in the maps only in a general manner by enclosing with a heavy line the area where the species or group has been reported; dashed extensions of such lines indicate doubtful occurrence or introductions. For extralimital distributions, the general area of occurrence is indicated by connecting points of peripheral distribution only if one or more records are available for the intermediate central area. Widely disjunct distributions are shown as separate enclosed areas. For South Pacific distributions, the same procedure is followed unless there is reason to believe that a form occurs in intermediate areas, even though it has not been reported.

METHODS OF STUDY AND PRESENTATION

As indicated in the preface, this study is a preliminary one; no attempt is made at this time to analyze any group exhaustively, in spite of the fact that in several instances, material is available for much more detailed work. In the majority of instances, much of the essential data is lacking and only tentative inferences can be made. The methods of study and the general reliability of the data, together with explanations of the manner of presentation, are discussed below.

GENERAL STUDY METHODS.—The data were derived from 3 general fields: morphology, bionomics, and distribution. The material was first sorted as to geographical source and habitat and then identified as far as possible, with the aid of existing keys, to species or group. All similar material from different sources was retained in separate units but was assembled together for comparison. For the association of stages and sexes of a given form, individual rearings are absolutely essential. In many instances, where these were not available, the associations are presumptive only and are so indicated in the text. Preliminary keys to all the forms were then prepared, using what appeared to be significant morphological characters; this is the only intuitive phase of taxonomic procedure and is comparable to the working hypothesis of an experimental design. Every specimen was then reëxamined for the key characters; if departures were noted and were found to be correlated in the different stages or with habitat or geographic differences, these specimens were segregated as a new unit. Following this, drawings were prepared for all available stages, as indicated in the section on illustrations. Descriptions were then made for all stages, as indicated below, and keys were rewritten. All specimens were checked again for the diagnostic characters, any departures were noted for individual, ecological, or geographical variations, individual species labels were attached, and the material was recorded on temporary record sheets, from which the final permanent ledger sheets (fig. **29**) were prepared. In the course of reëxaminations, a number of errors were found and additional species were discovered. Prior to the return of the material to the various institutions, most of the specimens were checked again; even at this stage, some errors in labeling (and sometimes in identification) were discovered.

In spite of all precautions to eliminate discrepancies between the text and the drawings, some errors remained undetected too late to be corrected. In general, more reliance should be placed on the text in such instances.

TAXONOMIC CATEGORIES.—The basic taxonomic unit used throughout the study is the species, although all the material was studied essentially at the population level. Subspecies are not recognized in this work for several reasons: (1) Not enough time was available for a thorough analysis of allopatric populations and sympatric ecotypes of most of the species. (2) It was not possible to determine whether the apparent differences between the various populations of a species were genetic or were environmentally induced. (3) It seems doubtful that subspecies in the classical sense exist in mosquitoes (as well as in many other insects). (4) If the various populations or races were treated as subspecies, so many would have to be recognized that confusion rather than clarification would result. Therefore, for the present, all such forms of a species are treated as geographical or ecological races, and no subspecific names are attached to them.

The basic criterion used for determining a taxonomic species was the constancy of correlated morphological characters; most species recognized here are marked by constant correlated characters in at least 2 stages—usually in all 3 stages—as well as in the male genitalia. In questionable instances, where 1 or more critical stages are not available, apparently distinct forms are treated as species but are not provided with formal specific names. The species from the different areas of the South Pacific are not equally well differentiated. Those in the Solomons seem to be of recent origin and may prove to be races of extralimital species; for the present, since they show apparent constant differences, they are treated as distinct species.

The taxonomic species are arranged into various types of taxonomic groups to show, as much as possible, their natural genetic affinities. The various groups used do not necessarily correspond in distantly related forms, as the pattern of evolution has not been the same in the different groups.

The characteristics of each group have been derived from comparison of all the included forms found in the South Pacific and, insofar as possible, from a representation of extralimital forms as well. In most instances, some of the characteristics were found to be at variance with published statements; an attempt was made not to repeat any statements second-hand but to check all the presumed diagnostic characters. This was not always possible because of lack of material; in such instances, reference is made to the authority.

TERMINOLOGY AND ABBREVIATIONS.—The morphology of mosquitoes, as well as of all insects, is still so imperfectly understood that clear-cut homologies are not evident in most structures (Snodgrass, 1959). Therefore it is necessary to use for descriptive purposes a mixture of homologous morphological terms and topological terms. In this study I have adhered in general to the descriptive terminology currently in vogue among mosquito taxonomists but have made some changes and have introduced a few new terms wherever it appeared advisable. This terminology, together with the more or less standard abbreviations, is briefly explained in the section on terminology and abbreviations and is illustrated in figures **406-412.** Included also are explanations and abbreviations of terms used in the discussions of systematics, bionomics, and distribution.

GENERAL PLAN OF PRESENTATION.—A description and a discussion of every group precedes the treatment of the included species, starting with the most inclusive category. I have included even a brief section on the entire family. The more inclusive the group, the less reliable is the information given. I have not confined the descriptions of the inclusive groups to a statement of a few diagnostic characters but have attempted to indicate also some of the variable characters within each group, so that comparison can be made with coördinate categories. Insofar as possible, uniformity in presentation has been adhered to in coördinate groups, but it has not been carried to groups belonging to different categories or to subgroups in coördinate groups; for example, a treatment of subgenera in *Aedes* is not the same as in *Culex,* but within each of these 2 genera, the subgenera are treated in the same manner.

In the description of subordinate groups and species, only the departures from the characteristics and the restrictions of the variable characters of the more inclusive group are indicated; in other respects, the characters of the subordinate group or species are in general within the range of the inclusive group.

For ease of reference the species are numbered under each subgenus, or under the genus if the genera are not subdivided into subgenera. The species are arranged alphabetically only when a large number is involved and relationships are not clear; in all other instances, they are arranged into groups to show affinities. Unnamed species or forms are usually placed at the end of the subgenus in alphabetical sequence and are referred to in the text and maps by their number.

KEYS.—All keys are in general applicable only to forms represented in the South Pacific. Every effort was made to key out related forms together whenever this did not interfere with the primary purpose of providing the easiest possible means of identification. Keys are not grouped together but are inserted following the discussion of the subfamilies, tribes, genera, and subgenera. In the keys to species, for ease of reference the specific name is preceded by a number which indicates its place in the numerical sequence of the treatment of the species. In supraspecific keys, a page reference is given for the included taxa; in all keys, a reference will be found to the pages of the next more inclusive keys.

ILLUSTRATIONS.—Wherever possible, illustrations are used to present the data. With the exception of charts, all the illustrations pertaining to a group are assembled together. Illustrations are identified by **boldface** numerals; these numerals refer to the pages in the second volume devoted to the figures. For example, figure **106** will be found on page 106 of this separately paginated volume. An explanation of the methods of preparation and the reliability of the illustrations is presented above.

SYNONYMY AND TAXONOMIC REFERENCES.—These are given only for generic and specific group taxa. For generic group taxa, a partial synoptic synonymy of nominal group taxa is presented, which includes, in most instances, only the currently accepted taxon and the taxa that include species represented in the South Pacific; for a complete synonymy, Stone, Knight, and Starcke (1959) should be consulted. The type species of each generic group nominal taxon is given in the original combination, followed by its type locality and data on the manner in which the type species was determined. An asterisk (*) preceding these data indicates that the type specimens of the type species were examined. For specific group taxa, the synoptic synonymy is usually complete, except when the species is an introduced one; when the latter occurs, reference is made to Stone, Knight, and Starcke (1959) for the complete synoptic synonymy. For each specific group nominal taxon, the data for the type specimen or specimens are given in as complete form as possible; if the specimen was examined, this is indicated by an asterisk (*) preceding the data. In addition, for every species a brief summary of the previous taxonomic treatment is given under every major combination, starting with the most recent; under each combination the references are in chronological order, beginning with the first author(s) using the combination; these taxonomic references are usually not complete and normally do not include mention of the species in extralimital works, nontaxonomic papers, and textbooks. For species described here as new, reference is made to previous names applied to this form, and full data is given on the types.

DESCRIPTIONS.—All descriptions are composite, being based on several specimens, except rarely in species where only a single specimen was available. Characters shared by members of a group are described under that group and are not repeated in the descriptions of the individual members of the group. The following paragraphs indicate the manner in which descriptions of the various stages and forms of each species were made.

MEASUREMENTS.—All measurements are

given in millimeters (mm.) and were made (except in the Dixinae) on a "typical" individual, mounted on a slide whenever possible (including adult females). These measurements are meant to show only the general size and proportions; large departures from these measurements are to be expected. The manner in which measurements of the different structures were made is indicated in the section on terminology and abbreviations and is illustrated in figures **406-412.**

ADULTS.—The adults were studied largely as dry specimens mounted on pins or points, but wherever possible at least one female (and sometimes a male as well) was cleared and mounted on a slide. For each sex 10 specimens were thoroughly examined, if sufficient material was available. The female sex is describe first, since it is the one most commonly encountered; the male is compared with it, and only its departures from the female are noted. Unfortunately, it was not possible to make drawings of adults; therefore the verbal descriptions are sometimes lengthy. No attempt was made to study all the characters, and only those which appeared to be significant in a particular group were analyzed. Diagnostic characters were checked on additional specimens, usually the entire available series, before the final version of the verbal description was prepared. Measurements were made on specimens mounted on a slide whenever possible.

MALE GENITALIA.—Wherever sufficient material was available, at least 10 slides of whole or dissected genitalia were examined—usually a much larger number—with due regard to a representation of localities and habitats. In many instances, it was possible to check the diagnostic characters of the genitalia on whole adults; when this was true, all available specimens were checked. The descriptions of the genitalia are usually detailed because of the difficulty in interpreting details in the illustrations and because of considerable variation.

IMMATURE STAGES.—The complete chaetotaxy of at least 5 pupal and 5 larval skins was studied whenever material was available, and the modal condition for the pattern and branching of the hairs is shown in the drawings. Diagnostic characters were checked on additional specimens, usually the entire available series, before the final verbal descriptions were prepared. The descriptions are largely confined to characters not shown in drawings, to diagnostic characters of the chaetotaxy, and to variable characters. Color and color pattern are described from pupal and larval skins. Measurements were made on pupal skins and whole larvae. In general, more time was spent on the study of the immature stages than on the adults and the male genitalia.

MATERIAL EXAMINED.—Only material from the South Pacific is included, except where stated otherwise. The purpose of this section is to indicate the amount of material used for study of each sex and stage and the number of individual rearings used to establish correlation of the stages.

SYSTEMATICS.—Only striking infraspecific variation (individual, ecological, and geographic) is mentioned; in most instances, no attempt is made to analyze carefully the individual populations. The affinities and the zoögeographic relations are frequently discussed under the group rather than the species. Affinities are inferred largely from similarities in morphology, with emphasis on the immature stages. A summary of the affinities and zoögeography is presented in the "Analysis of the Mosquito Fauna," figures **13-17.**

BIONOMICS AND DISEASE RELATIONS.—Only general information on bionomics is presented, consisting chiefly of the habitat of the immature stages and the activity and blood-feeding habits of the adults. Much of this information is based on unpublished field notes. The economic importance and disease relations have been determined for only a few species; for the remainder they are inferred from the general information on the habits of the adults. The bionomic and economic importance are summarized in the "Conspectus of the Culicidae of the South Pacific," figures **1-5.**

DISTRIBUTION.—The South Pacific distributions are based on the material examined for this study, as well as on apparently authentic literature records; the latter are followed by a reference to the authority responsible for the record. These records are usually restricted to a citation of the individual islands under the island group; the groups and islands are arranged west to east and north to south. The extralimital distributions are based both on material examined and literature records; the latter usually do not include citation of the authority. The arrangement of extralimital localities is generally from east to west and north to south. All distributions are shown on maps which are grouped under subgenera, genera, tribes, or subfamilies, depending on the size and complexity of the group.

Systematic Treatment

FAMILY CULICIDAE

ADULTS.—Small to medium-sized Diptera Nematocera with a characteristic venation; scales present or absent on body, legs, and wings. *Head:* eyes above antennae from widely separated to contiguous, frons well developed or not; ocelli completely absent; vertex and occiput with hairs, scales, or both; clypeus varied in size and shape, with or without hairs, scales, or both; mouthparts short or developed into a proboscis which consists of an elongate labium bearing labella apically and containing mandibles, maxillae, labrum-epiphraynx, and hypopharynx within an anterior groove; maxillary palpus pendant or porrect, varied in length, apparently primitively 5-segmented and with a basal palpifer, frequently reduced in segmentation; antenna varied in length, usually at least equal to combined length of head and thorax; antennal scape relatively small or greatly reduced in size; antennal pedicel (torus) well developed, from moderately to strongly swollen; antennal flagellum with 13,14 segments (reduced to 8–10 in some *Chaoborus*), segment 1 frequently deeply inserted into torus, flagellar hairs numerous and frequently long and arranged into a conspicuous whorl on each segment. *Thorax:* pronotum represented dorsally by a narrow transverse sclerite and laterally by the prominent anterior pronotal lobes (*apn*) and the large flat posterior pronotum (*ppn*); mesonotum (mesoscutum, scutum) very strongly developed, without longitudinal or complete transverse sutures, but with a more or less distinct short scutal suture extending mesocaudad from a more or less prominent lateral scutal angle cephalad of level of mesothoracic spiracle; a small spiracular sclerite (*sp*) usually in a depression below scutal angle, behind *ppn* and in front of mesothoracic spiracle; paratergite usually distinctly developed as a varied lateral sclerite between scutal angle and wing root, apparently homologous with the mesoprescutum of Bonhag (1949); parascutellum (postalar callus) small, with 1,2 bristles; scutellum (mesoscutellum) strongly developed, its posterior margin evenly rounded or more or less distinctly trilobed; postnotum (mesopostnotum) strongly developed, without distinct longitudinal suture or ridge; metanotum very poorly developed, represented dorsally by a very narrow transverse sclerite, laterally sometimes with a small erect appendage; homologies of pleural and sternal sclerites not definitely established; prothoracic pleuron represented chiefly by the proepisternum (*ppl*), which extends dorsad to and is separated by a more or less distinct suture from *apn* and is continuous cephaloventrad with the prosternum (*pst*), which Cook (1956) homologizes as the prokatepisternum; extent of proepimeron not definitely known, possibly represented by the larger part of the subspiracular area (*ssp*); mesopleuron very strongly developed and complex, mesopleural suture nearly straight; mesepisternum more or less distinctly divided into a smaller cephalodorsal part, which is known as the postspiracular area (*psp*) and is often continuous cephaloventrad with subspiracular area (*ssp*), and a much larger posterior part, the sternopleuron (*stp*), which is more or less distinctly separated from a dorsal process, the prealar knob (*pra*); mesepimeron (*mep*) large and relatively simple except for articular sclerites below wing; meron usually very distinct, rarely (Dixinae, some Chaoborinae) not separated proximally, often overlain by a flange of mesepimeron proximally; a small sclerite cephalad of base of midcoxa, the pleurotrochantin of Crampton (1942), mesokatepimeron of Cook (1956); metapleuron complex, represented chiefly by the anterior metepisternum; a small sclerite at base of hindcoxa is called the metameron but has been homologized as the metakatepisternum by Cook (1956); the metepimeron is apparently represented by a narrow posterior sclerite and by the expanded area caudad of the haltere; thoracic sclerites with a definite pattern of bristles or hairs and sometimes scales. *Legs:* usually long and slender and with a pattern of bristles and hairs which have not been studied; coxae usually relatively large; forcoxa with large anterior (*acx*) and posterior (*pcx*) membranes; trochanters well developed and complex; femora always elongate, frequently slightly "swollen" near base or distally; tibiae elongate, without large apical "spurs," but frequently with distinct specialized apical and subapical setae; tarsi always (?) longer than either the femora or tibiae, always 5-segmented, segment 1 at least nearly half as long as tibiae; pretarsi usually with 2 claws, sometimes with 1 only, empodium usually present, pulvilli present or absent. *Wing:* membrane with distinct or extremely minute microtrichia; venation very characteristic; all veins, except usually plical, reaching wing margin and with setae, scales, or both; vein C continued around wing margin beyond apex; basicosta (humeral plate) very small and inconspicuous; vein Sc long and ending on vein C, connected to the latter by the humeral crossvein (*h*) and to vein R by the subcostal crossvein (*sc*), which is often incomplete and may represent an evanescent vein Sc_2; vein R 4-branched, without crossveins *r* or *s*; stem of R (remigium) with or without conspicuous bristles, R_{2+3} branched except in *Neodixa* (may be an anomaly), R_{4+5} unbranched, base of Rs and R_{4+5} sometimes right-angled and with a proximal spur; crossvein *r-m* (anterior crossvein) always strongly developed, varied in position but always near or distad of middle of wing; vein M very long, 2-branched distally, M_{1+2} and M_{3+4} both unbranched; crossvein *m-cu* (posterior crossvein) always strongly developed and near crossvein *r-m*; vein Cu forked into Cu_1 and Cu_2 proximad of crossvein *m-cu*; plical (Pl) vein more or less distinct in the plical furrow, often evanescent distally; only one anal vein (1A) developed; arculus more or less distinct, prearculus sometimes developed in line with arculus between R and Sc; posterior border with conspicuous fringe of hairs or scales; both upper and lower calypters developed, upper larger and frequently with marginal hairs or hairlike scales, lower sometimes (Dixinae) with marginal hairs. *Haltere:* varied in size and shape, sometimes with bristles and indication of venation. *Abdomen:* 8 distinct pregenital segments; tergites I-VIII all distinct, tergite I reduced in length, its lateral part more or less differentiated as the laterotergite; sternites II-VIII always distinct, sternite I usually reduced in length, sometimes completely unsclerotized; spiracles varied in number, located anteriorly in extensive membrane between tergite and sternite, usually 6 pairs (II-VII) in Culicinae, said to be present on I-VII in some Dixinae (Nowell, 1951:217), on IV-VII in others (Edwards, 1932:9); genital segments usually highly modified. *Sexual Dimorphism:* varied; usually not marked in Dixinae and strongly marked in Culicinae and Chaoborinae; usually confined chiefly to mouthparts, palpus, antenna, legs, and abdomen; females sometimes with buccopharyngeal armature.

FEMALE GENITALIA.—Homologies poorly understood. *Segment VIII:* variously developed; sometimes completely retractile; tergite and sternite both distinct, sternite usually larger. *Genital Atrium:* variously developed between sternite VIII and postgenital plate; gonopore and spermathecal pore always separate; a large bursa copulatrix developed in some Dixinae. *Spermatheca:* varied in number from 1 to 3. *Segment IX:* highly modified; tergite usually small and more or less distinct; sternite apparently represented by the more or less distinct cowl. *Proctiger:* variously developed; tergite distinct or not; sternite apparently developed as the more or less conspicuous postgenital plate; cercus strongly developed, varied in shape, always with setae, sometimes also with scales.

MALE GENITALIA.—Inverted beyond segment VII. *Segment VII:* rarely modified; always with distinct tergite and sternite. *Segment VIII:* varied in development but always with distinct tergite and sternite. *Segment IX:* variously developed, frequently greatly reduced and forming merely an irregular ring from which arise the sidepieces; tergite frequently with a simple or divided median lobe or a pair of lateral lobes bearing hairs or bristles; sternite in the form of a more or less triangular sclerite between the sidepiece bases; tergite and sternite connected by a narrowed, or rarely a broad, lateral piece which is sclerotized or membranous; sometimes tergite articulated laterally (*Deinocerites*). *Sidepiece:* a large more or less conical appendage articulated with segment IX sternally and dorsolaterally; extremely varied in development. *Clasper:* a terminal or subterminal articulated appendage of the sidepiece; variously developed; frequently with 1 or more spiniforms. *Phallosome:* homologies poorly understood; variously developed; usually composed of an aedeagus, a pair of ventral parameres, and a pair of basal pieces; sometimes dorsal parameres also present; sometimes entire complex reduced to a single pair of "parameres." *Proctiger:* variously developed; with or without a pair of basolateral sclerotizations and a pair of sclerotized paraprocts; with or without cercal setae.

PUPAE.—Body composed of (1) the cephalothorax, which includes the head, prothorax, and mesothorax; (2) the metanotum, which actually includes most of the metathorax, is distinctly separated from the cephalothorax, and appears as part of the abdomen; and (3) the abdomen; a pair of articulated respiratory trumpets developed on cephalothorax around the mesothoracic spiracles, no other functional spiracles present; abdomen with a pair of movable or immovable paddles arising caudad of segment VIII; chaetotaxy homologous with that of the larva and essentially as in the first instar but highly modified on cephalothorax, metanotum, and segments I and VIII of the abdomen. *Cephalothorax:* head more or less distinctly marked dorsally by a small head shield, laterally by relatively large ocular areas, and ventrally by the mouthpart cases, usually 3 pairs of hairs on ocular areas; a small "pupal" eye caudad of imaginal eye; antennal case very long, curving over the eye and below the wing case; palpal case usually different in appearance in the 2 sexes; pronotum and mesonotum not at all separated from each other, with a weakened median longitudinal ecdysial line surrounded on each side by a more or less distinct, transversely striated middorsal ridge, hairs in 2 groups, the prothoracic group anterior and usually with 4 pairs of hairs, the mesothoracic group posterior and usually with 2 pairs of hairs; leg cases very large, the prothoracic most dorsal and closest to wing case, the metathoracic near mouthparts cases; wing case very large and projecting a long distance caudad around base of abdomen. *Trumpet:* sessile or located on a more or less distinct tubercle; apparently representing a specialized protuberant spiracular atrium; double-walled throughout; the lumen continuous proximad with that of the internal mesothoracic trachea, distad partially closed by ental spicules from the inner wall, these spicules sometimes fused or developed into a perforated double peritremal plate; apex often more or less truncate to form the pinna, the remainder being the meatus; external surface of meatus sometimes with a basal tracheoid and a distal reticulate part or entirely reticulate. *Metanotum:* representing the greater of the metathorax exclusive of the leg bases; usually with 3 pairs of hairs dorsally; haltere case relatively small, projecting caudolaterad around abdominal segment I. *Abdomen:* usually with 8 distinct segments, sometimes (Dixinae) with a more or less distinct segment IX; segment I with poorly sclerotized sternal area and usually with highly modified tergal surface; segments II-VIII without lateral membrane between tergite and sternite but usually with a more or less distinct lateral ridge or margin separating the ventral and dorsal surfaces; intersegmental membranes usually strongly developed and frequently with sclerites, so that segments are movable and abdomen is curved, rarely abdomen rigid and horizontal (Corethrellini); tergites usually without transverse ridges, sometimes (Dixinae) with conspicuous transverse ridges producing a secondary annulation; sternites sometimes with oblique ridges; spiracular sensilla present on segments I-VII, usually dorsolateral in position; chaetotaxy homologous with that of the larva and resembling most closely that of the first instar, with hairs 12 and 13 absent except as anomalies, more or less modified on segments I,II and greatly reduced on VIII; a small alveoluslike dorsal sensillum usually present on III-V, apparently on II-VII in Dixinae. *Terminal Segments:* segment IX usually indistinct and represented dorsally by a small transverse median caudal lobe on tergite VIII, apparently large and forming the base of the fused paddle in Dixinae, frequently with 1 pair of simple or highly modified setae; genital lobe sternal and more or less prominent; proctiger tergal and more or less prominent, with a more or less distinct cercal lobe in females, the cercus sometimes with 1 hair. *Paddle:* apparently developed as a caudolateral tergal process of segment IX but usually appearing to arise from caudal border of segment VIII; either immovable and the pair fused (Dixinae, Corethrellini) or movable at base and separate; often with a basal external buttress and a more or less distinct midrib; usually with 1 or 2 apical or subapical hairs; sometimes with distal marginal spicules or serrations. *Females:* genital lobe small and indistinctly separated from the proctiger; proctiger with more or less distinct cercal lobes. *Males:* genital lobe usually strongly developed and including a pair of projecting sidepiece lobes which extend a considerable distance beyond the proctiger; proctiger without cercal lobes but sometimes with a cercal hair as in the females.

LARVAE.—Always 4 instars present; only fourth instar described here; head capsule strongly developed and completely sclerotized, except rarely caudally (*Chaoborus*); antenna prominent; only 1 pair of functional spiracles, located on abdominal segment VIII, rarely these are not functional (some Chaoborinae and perhaps others) and may be completely absent (*Chaoborus*). *Head:* varied in shape and development; usually a more or less distinctly separated anterior dorsal labrum; a large frontoclypeus occupying the central dorsal area and usually separated laterally from the rest of the head capsule by long anterior forks (frontoclypeal) of the ecdysial suture, which is represented caudally by a very short median longitudinal part (coronal); ocular lobe forming the lateral parts of the head capsule, often with conspicuous ocular bulge; a small larval eye caudad of imaginal eye; labial plate forming the midventral part of head capsule, sometimes separated laterally from ocular lobes by the maxillary sutures, which do or do not reach the posterior tentorial pits and may even extend dorsocaudad beyond them; caudal portion of head capsule usually more or less constricted to form a collar; oral part of labrum usually with complex spicules, lateral portion with or without mouthbrushes which are variously developed; entad of the anterior border of the labial plate usually a more or less complex aulaeum followed by the more ental mental plate, both rarely poorly developed and apparently sometimes completely absent; mandible strongly developed; maxilla complex and with a distinct palpus which is sometimes antennalike; mouthpart homologies poorly understood and chaetotaxy not studied; chaetotaxy of head capsule complex, usually consisting of 16-18 pairs of hairs but frequently 1 or more pairs absent and rarely additional pairs present, position of hairs varied and dependent on development of sclerites; cervical area rarely with sclerites, sometimes with 2 pairs of hairs (Dixinae) which may be represented by homologs on the head capsule (hairs 16,17-C). *Antenna:* strongly developed; usually more or less cylindrical; apparently not segmented but sometimes with articular sclerites in basal membrane and with constrictions distally; usually with 6 setae in varied positions and not all hairlike; a small basal dorsal alveoluslike sensillum; often with spicules. *Thorax:* segmentation indistinct except in Dixinae, usually the composite thoracic mass conspicuously broader than abdominal segments; no indication of legs, but some workers consider the pleural groups of hairs (9-12-P,M,T) as vestiges of legs; no sclerotized plates except sometimes at base of hairs; mesothoracic and metathoracic spiracles usually represented by sensilla;

chaetotaxy complex but hairs definitely arranged in prothoracic, mesothoracic, and metathoracic groups, homologies between the 3 groups obscure; apparently 15 pairs of hairs on prothorax, 14 on mesothorax, and 13 on metathorax, frequently 1 pair of hairs absent on prothorax; pleural groups (9-12-P,M,T) usually distinct, apparently metathoracic reduced in Dixinae (all?). *Abdomen:* usually 8 distinct segments and a complex terminal area, which in Dixinae includes a well developed segment IX; usually no indication of prolegs except in Dixinae, which have distinct prolegs on segment I and usually II and spicules suggesting prolegs on V-VIII; usually no extensive tergal or sternal sclerotizations on proximal segments, usually with small sclerotizations or tubercles at base of the larger hairs; complex intersegmental folds usually present; spiracular sensilla usually present dorsolaterally on I-VII; a pair of dorsal sensilla usually developed on III-V and possibly elsewhere; chaetotaxy homologous throughout the family, only rarely with marked departures from basic number and plan; usually 15 pairs of hairs on each of segments I-VII but usually segment I with several hairs not developed. *Segment VIII:* chaetotaxy reduced, usually only 7 pairs of hairs developed; frequently a lateral comb of spines or spicules called scales present, sometimes arising from a common sclerotized plate, which may be connected across the tergite with its mate. *Spiracular Apparatus:* usually developed, only rarely absent in some Chaoborinae; spiracles morphologically those of segment VIII; a complex system of lobes or movable valves around and caudad of spiracles developed from the caudal dorsal part of segment VIII and dorsal part of segment IX, latter clearly developed in Dixinae; valves normally composed of 1 median dorsal and a pair each of dorsolateral and ventrolateral lobes; spiracular apparatus sessile or produced on a siphon which appears to be homologous with the lateral pecten plate of segment IX of the Dixinae and Anophelini; chaetotaxy varied but homologous throughout family; in Dixinae a conspicuous fringe of long hair-like spicules on valves. *Anal Segment:* apparently composed of the ventral part of segment IX in addition to the proctiger; in Dixinae segment IX distinct and separate; usually with a conspicuous sclerotization forming a dorsal saddle or complete ring; chaetotaxy homologous throughout family but quite varied; 1 or more pairs of lateral hairs; a dorsal brush composed of 2 pairs of hairs on a distinct tubercle in the Culicinae and Chaoborinae; in Dixinae apparently the homologous part is conspicuously produced as a postanal process bearing 3 pairs of hairs, 1 of which may be hair 1-X; a ventral brush of 1 or more pairs of hairs usually developed in Culicinae and Chaoborinae, in the Dixinae 1 or more of the ventrolateral hairs may be the homologs of the ventral brush; usually 2 pairs of distinct anal gills or papillae, retractile in Dixinae; supraanal (Dixinae) or subanal (Chaoborinae) spicules sometimes developed.

SYSTEMATICS.—The family Culicidae is considered here in the broad sense to include the Dixinae and Chaoborinae, which are sometimes regarded as constituting two separate families. The affinities of the Culicidae appear to be, on the one hand, with the Psychodidae through the Dixinae and, on the other, with the Chironomidae (Tendipedidae) and Ceratopogonidae (Heleidae) through the Chaoborinae. In the third subfamily, the Culicinae or true mosquitoes, there are indications of a close relationship or a hybrid origin of some of the groups with the Dixinae (as in the Anophelini and possibly *Deinocerites* of the Culicini) and with the Chaoborinae (as in the Mansoniini). Therefore, I prefer to retain all three groups in one family. Both the Dixinae and Chaoborinae appear to have retained the more primitive condition in several characters which are secondarily modified in the Culicinae, but the reverse is also evident for other characters. A natural classification of the family cannot be accomplished until the comparative morphology of all three groups is thoroughly studied. Unfortunately, at present the Dixinae and Chaoborinae are very poorly known, the basic morphology of the Culicinae is not well understood (Snodgrass, 1959), and therefore the currently accepted classification of Edwards (1932, 1941) is far from being a satisfactory one.

On the basis of morphological relationships and distributional data, it appears that the Dixinae, Culicinae, and Chaoborinae originated contemporaneously with each other, probably in the early or middle Mesozoic, and that the Dixinae cannot be considered to be ancestral to the Chaoborinae and the latter intermediate between the former and the Culicinae. It appears probable that all three subfamilies arose in the Old World.

In the South Pacific the family is known at present by about 183 indigenous species in 21 genera and 14 tribes. The 3 subfamilies are very unevenly represented: the Dixinae by 9 species in 4 genera and 2 tribes; the Culicinae by 171 species in 15 genera and 10 tribes (5 of the genera represented by a total of 27 subgenera, so that at least 37 subgeneric entities are known); and the Chaoborinae by 3 species in 2 genera and 2 tribes. The unequal representation of the subfamilies is in part owing to the relatively much poorer knowledge of the Dixinae and Chaoborinae, but it appears that these subfamilies are, in general, not as well represented in the present-day fauna throughout the world.

BIONOMICS.—The immature stages of the Culicidae are relatively better known from a world standpoint than those of any other family of insects. As far as is known, they are always aquatic and are predominantly found in fresh water, but some species utilize brackish water and may even be found in pools with a salt concentration higher than that of sea water. Breeding sites include various types of water on the surface of the ground (from stagnant to fast flowing) as well as accumulations of water in living plants or in dead plant material on the ground (from treeholes, rotholes in fruits, axils of leaves, fronds, and bracts, and pitchers containing proteolytic enzymes to leaves, fronds, and fruits on the ground). A number of species, some of which are economically important, utilize water in all types of artificial containers—from water tanks and boats to tin cans, bottles, cups, and saucers. The majority of species require a considerable amount of free water in their breeding sites, but some have been collected in muck in leaf or frond axils where only a few drops of water are present, and others are known to breed in the marshy margins of swamps where no water is seen on the surface. A number of species are capable of surviving desiccation for a considerable length of time in the larval and pupal stages.

The larval food of most species apparently consists of freshwater microörganisms, planktonic or attached, and dissolved, suspended, or settled organic matter in the water. Cannibalism is not uncommon; a number of groups are specialized as predators of other mosquito larvae, crustaceans, other larger freshwater invertebrates, and apparently even very small vertebrates. The majority of species require direct access to atmospheric oxygen for respiration; some obtain oxygen from the air vessels of plants, while others apparently utilize dissolved oxygen in the water or capture gas bubbles produced by submerged plants. As far as is known, all species go through 4 larval instars. The length of the larval stage is varied but is seldom more than two weeks; however, in colder areas it may be prolonged or the species may even hibernate in the larval stage, sometimes frozen in ice.

The pupa is usually motile and quite agile when disturbed and most frequently obtains atmospheric oxygen for respiration at the surface film by means of the respiratory trumpets. Some forms obtain oxygen from the air vessels of aquatic plants and may even be fixed to one plant for the duration of the pupal stage. Some (Corethrellini) have a more or less rigid abdomen and float just below the surface film. The length of the pupal stage is seldom more than three days, but a few forms in the colder regions may hibernate in this stage. In general the pupal stage appears to be resistant to desiccation; while in the majority of species, emergence of the adult takes place with the pupa at the surface film, in some forms the pupa may be out of the water at this time (*Anopheles lungae* complex).

The adult bionomics have been studied in detail for relatively few species, largely those forms which are of economic importance (see Culicinae). The adults of the majority of forms are delicate insects that are very sensitive to light, temperature, humidity, and probably other environmental stimuli. They are active only for a limited time during each 24-hour period and rest in suitable environments for the remainder of the time. Some forms are active during the day, others are crepuscular or nocturnal. The flight range is usually limited to less than 1 or 2 miles, although a number of species are known to migrate over much longer distances and a few are possibly capable of dispersing over ocean barriers of 200–300 miles. Dispersal over such distances may, however, actually be accomplished through the egg stage. The food requirements of the adults are largely unknown, but it is generally believed that both sexes obtain some nourishment from nectar, honeydew, or other exudates from plants. In the Culicinae the females of a relatively large number of species apparently require a vertebrate blood meal for the formation of eggs, but it has been shown for several of these forms that viable eggs may be produced under certain circumstances without such a blood meal, particularly if the larval nutrition is high. Mating is preceded in at least some members of all 3 subfamilies by a swarming of the males. There appears to be a considerable difference in the longevity of the 2 sexes; the males seldom live as long as 2 weeks, while the females probably live to 2 to 3 weeks or longer, depending on the species, temperature, and other factors. In colder regions, females of some species hibernate for several months.

The eggs of the Culicidae are quite varied but can be classed into two groups: (1) the nonresistant eggs, in which hatching must take place within a few days or immediately after embryonic development has been completed, and (2) the resistant or diapausing eggs, in which hatching is delayed until the egg is conditioned and then subjected to an external stimulus. The nonresistant eggs are usually laid on the water surface or are inserted into aquatic plants and will quickly desiccate out of the water. The resistant eggs are usually laid out of water on moist surfaces or above the water line in containers; these eggs, once conditioned, are resistant to desiccation, and some may remain viable for several years; they will hatch when submerged in water with the proper environmental conditions. Eggs are usually laid in a suitable environment rather than at random. A female may lay from one to several batches of eggs, each batch containing from less than 100 to several hundred eggs.

The number of generations produced during a year varies greatly, depending on the species and the type of egg. In the colder regions, some species have only one generation a year; others have several generations through the warm period of the year. In the tropics, most species with nonresistant eggs have continuous and partially overlapping generations throughout the year, but there is some indication of periodicity in these forms; the species with resistant eggs produce a generation each time the eggs are flooded and suitable conditions are present.

Periods of unfavorable conditions are met in several ways, depending on the resistant stage or stages in the life cycle. In the colder regions, some species hibernate as inseminated females, others as larvae and pupae, and still others as resistant eggs. In the tropics, species with nonresistant eggs nearly always have suitable environments for breeding throughout the year, but there may be an adjustment to meet unfavorable dry periods through hardiness of the adults and wide tolerance in the immature stages. The species with resistant eggs naturally survive unfavorable conditions in the egg stage.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—The family Culicidae is the most important family of insects from the standpoint of human health. Only the subfamily Culicinae is of paramount importance; a few Chaoborinae may become pests, and the Dixinae are entirely innocuous. The disease relations and economic importance of the Culicidae of the South Pacific are discussed in a section of the General Considerations.

DISTRIBUTION.—The Culicidae are nearly worldwide in distribution; indigenous species are absent only from Antarctica, Arctic and Antarctic islands, and some isolated oceanic islands, including low-lying coral atolls. On the continents they are absent only from permanently frozen and snow- or ice-covered areas. The subfamily Culicinae is dominant in the tropics but is represented by conspicuous species in the temperate and even the subpolar regions. The Dixinae and Chaoborinae are poorly represented in the Old World tropics, but this may be owing partially to insufficient collecting, since they have been shown to be well represented in the New World tropics; however, both subfamilies appear to have more different types in the north and south temperate regions. In the South Pacific the Culicinae are represented by indigenous species throughout the area as far east as the Society Islands and the Marquesas; the Dixinae and Chaoborinae are known at present only from the Solomons and New Zealand.

KEYS TO SUBFAMILIES

ADULTS

1\. Mouthparts long, labium forming a proboscis .... CULICINAE, p. 115
Mouthparts short, labium not elongated into proboscis 2
2(1). Wing veins without or with only a few inconspicuous hairs; vein Sc ending on wing margin near separation of Rs .... DIXINAE, p. 93
Wing veins with numerous long hairs or hair-like scales; vein Sc ending on wing margin distinctly distad of separation of Rs .... CHAOBORINAE, p. 535

MALE GENITALIA

1\. Phallosome neither joined by sclerite to nor articulating with sternomesal margin of sidepieces or distal margin of sternite IX .... CULICINAE, p. 115
Phallosome either joined by sclerite to or articulating with sternomesal margin of sidepieces or distal margin of sternite IX 2
2(1). Phallosome very complex; sidepiece and clasper relatively short, often modified .... DIXINAE, p. 93
Phallosome simple, with a single median aedeagus or with a pair of free projecting dorsal

parameres (penis valves); sidepiece and clasper relatively long and simple . . . . CHAOBORINAE, p. 535

PUPAE

1. Abdominal tergites with incomplete submedian transverse ridges; segment IX well developed, distinct . . . . DIXINAE, p. 93

   Abdominal tergites without transverse ridges; segment IX poorly developed, indistinct, at least sternally 2

2(1). Paddles fused at base, not articulated *or* trumpet without pinna or tracheoid but with large ovoid reticulate meatus and small apical process . . . . CHAOBORINAE, p. 535

   Paddles always separate and articulated at base *and* trumpet usually with pinna; if pinna indistinct, then trumpet without a large ovoid reticulate meatus and small apical process . . . . CULICINAE, p. 115

LARVAE

1. Venter of abdominal segments I and II with short unsegmented paired lobes (prolegs) ending in recurved spines; thoracic segments same width as abdominal and rather distinctly separated . . . . DIXINAE, p. 93

   Venter of abdominal segments I and II without such lobes; thoracic segments consolidated into a single mass wider than abdominal segments and not segmented 2

2(1). Mouthbrushes completely absent or represented at most by about 5 long bristlelike spicules; the 2 antennae inserted close together on midline in front (CHAOBORINI and CORETHRELLINI) . . . . CHAOBORINAE, p. 535

   Mouthbrushes always well developed, usually very numerous, rarely reduced to about 10 heavy long flattened spines; the 2 antennae always widely separated, inserted laterally . . . . CULICINAE, p. 115

SUBFAMILY DIXINAE

The Dixa Midges

ADULTS.—Mouthparts not developed into a proboscis; scales completely absent; integument generally spiculate throughout. *Head:* eyes widely separated dorsally, more or less rounded, inner anterior margin at times slightly truncate but never emarginate; vertex and occiput with several short proclinate hairs, orbital margin laterally with a few larger hairs; clypeus small, shorter than head, with hairs largely apical; mouthparts short, not developed into proboscis; maxillary palpus long, incurved at rest, pendant not porrect, 5-segmented, distal 3 segments distinct, proximal 2 indistinctly separated, segment 1 appearing as basal external lobe on segment 2; antenna with scape well developed and bearing bristles; torus (pedicel) moderately swollen but with basal flagellar segment not deeply inserted into it; flagellum 14-segmented and with short hairs or bristles in both sexes. *Thorax:* anterior pronotal lobes (*apn*) rather broadly connected; sternopleuron divided by a conspicuous longitudinal external fold into upper (prealar) and lower parts; meron not separated by suture from mesepimeron; scutellum evenly rounded, without lateral lobes; mesonotal and pleural bristles poorly developed; upper anterior part of mesospiracular depression with a small sense organ. *Legs:* femora, tibiae, and tarsi with very numerous short bristles evenly distributed; all tibiae with a small apical "spur"; hindtibia more or less strongly swollen apically and bearing a diagonal subapical comb on posterior (inner) surface; foretibia with a smaller, less distinct comb on anterior (inner) surface; claws with long spicules at base ventrolaterally and dorsally, shaft of claw simple in female and pectinate or simple in male; no distinct pulvilli. *Wing:* membrane with uniform microtrichia; veins with microsetae, replaced by longer hairs on vein C; fringe of hairs on posterior border, including alula; upper and lower calypters both without fringe; costal margin weak between humeral plate (basicosta) and crossvein *h*, strong beyond; Sc connected to R by prearculus (a crossvein in line with anterior arculus) and by a more or less definite and incomplete sclerotization about halfway between prearculus and end of Sc which reaches C before base of Rs or slightly beyond; Rs straight and oblique, at least the portion basad of *r-m* if latter is proximal to furcation; R_{2+3} branched except in *Neodixa* and more or less strongly arched, not in line with Rs; R_{4+5} varied at base; Rs and R_{4+5} without basal spurs. *Haltere:* long and resembling a wing; proximal part slender but with a thickened costal margin bearing bristles; distal margin expanded and bearing bristles in a line on dorsal surface and along posterior margin. *Abdomen:* tergites and sternites without scales but with short bristles, more numerous and evenly distributed on distal segments; spiracles apparently variable in number, present on segments IV-VII in *Dixina solomonis,* and on I-VII in *Dixa brevis* Garrett, 1924, according to Nowell (1951:217). *Sexual Dimorphism:* noted only in genitalia and usually claws; palpus and antenna similar in the 2 sexes.

FEMALE GENITALIA.—*Segment VIII:* well developed; tergite usually about two-thirds length of preceding segment; sternite distinctly longer. *Segment IX:* tergite about 0.6–0.75 of tergite VIII, with or without lateral lobe, all parts with bristles; sternite represented by the sclerotized posterior cowl articulating laterally with tergite IX. *Genital Atrium:* no ventral sclerotizations between sternite VIII and cowl. *Proctiger:* strongly developed; tergal sclerotization light or absent; a basal lateral sclerotization leading ventrad and continued as ventrolateral caudal sclerotized bristly process on each side of the postgenital plate, which also includes a variable median ventral sclerotized plate, the entire structure more or less conical in outline; cercus well developed, projecting only slightly beyond tergite, with numerous bristles. *Spermatheca:* only 1 present; its duct arising from a heavily sclerotized barlike lateral plaque. *Bursa Copulatrix:* present or absent.

MALE GENITALIA.—Inverted beyond segment VII. *Segment VIII:* usually about two-thirds length of VII, fully exerted. *Segment IX:* well developed, with bristles dorsally and laterally. *Sidepiece:* short, usually broad, with or without lobes or processes. *Clasper:* about as long as sidepiece, simple or complex, with or without spiniforms. *Phallosome:* complex; joined by sclerite to or articulating with sternomesal margin of sidepiece; aedeagus varied, sometimes with filiform penis filament; usually with basal supporting platelike or rodlike sclerites developed from basal piece and parameres; sometimes with 2 pairs of parameres bearing strong spines. *Proctiger:* strongly developed; largely membranous dorsally and ventrally; basal lateroventral sclerotization usually present; cercal setae present or absent.

PUPAE.—*Cephalothorax:* chaetotaxy generally as in the Culicinae but hairs 1,2-C apparently absent and an extra hair (*x*) present on mesonotum. *Trumpet:* widely separated, arising from more or less distinct lateral cephalic tubercle; spiracular closing mechanism within cephalothorax, but a trachealike tube continues into trumpet and is constricted at or beyond middle before it forms the funnellike or flasklike inner wall that distally is provided with complex spicules which appear to close the lumen; apex of trumpet wide. *Metanotum:* with very long haltere case; 3 pairs of hairs (10-12-C) always present; with tubercles. *Abdomen:* very long and rather slender, strongly curved under cephalothorax; segments poorly sclerotized, without lateral border; tergites II-VII with submedian transverse ridges and angular processes; spiracular sensilla present on I-VII, very large on I; dorsal sensilla present on II-VII; chaetotaxy essentially as in Culicinae except that hair 8 is absent, all hairs single and simple; tergite I very short, hairs 1-5 near caudal border. *Terminal Segments:* tergite VIII almost as long as VII, with 4 pairs of hairs (0,4,6,7) its caudal border indistinctly emarginate; sternite VIII as large as VII, with 2 pairs of hairs (9,14); tergite IX represented by broad fused bases of paddles and bearing hair 1-IX ventrolaterally; sternite IX distinct, broader than long; hair 1-X apparently not developed. *Paddle:* long, triangular, not articulated at base and not movable, continuous with tergite IX, without supporting sclerotizations, with one hair, 1-P, subapically on external margin. *Females:* anal lobe single, only slightly cleft apically, the lateral portions probably representing cerci. *Males:* anal lobe consisting of a pair of lateral ventral lobes containing the developing sidepieces and a more dorsal median lobe representing the proctiger and phallosome.

LARVAE.—*Head:* small, flattened dorsally, convex ventrally, capable of folding back over thorax; posterior tentorial pits small, located ventrally about halfway between oral and caudal margins of head capsule; maxillary sutures not developed; mouthbrushes strongly developed, filaments hairlike; labial plate produced anteriorly as a rounded process bearing hair 15-C; aulaeum prominent; mental plate not toothed; maxillary palpus 2-segmented, large distal segment antenniform; chaetotaxy essentially as in Culicinae, hair 0-C near apex of labrum which is long and bent ventrad, hair 7-C not on frontoclypeus but laterally; cervical membrane with 2 pairs of bristles (16,17-C) ventrally, one near collar of head capsule laterally, the other about halfway to prothorax. *Antenna:* inserted on a tubercle low on the side, strongly curved from base to apex, with concavity dorsad, shaft cylindrical; never prehensile; apical hairs (2-6-A) all small. *Thorax:* segments not or only slightly wider than on abdomen, not compacted together, their dorsal surface somewhat flattened, ventral convex; integument densely spiculate; prothorax distinctly separated from mesothorax and metathorax, which are less distinctly separated; spiracular sensilla both present; chaetotaxy essentially as in Culicinae but several hairs absent, all hairs apparently single; prothorax with all hairs present except apparently 0,13-P; mesothorax with hairs 6,7 and 13 absent; metathorax with hairs 6,7 and 2 hairs in pleural group (9-12) absent. *Abdomen:* tergites somewhat flattened, sternites convex; paired prolegs present on anterior end of sternites I, II (absent on II in *Meringodixa*), bearing rows of curved spines apically; integument densely covered with simple hairlike spicules and/or restricted complex spinules dorsally; sternites V,VI or V-VII with rows of spines; chaetotaxy essentially as in Culicinae but apparently hair 8 absent on all segments, 12 on I,II, and 10 on II. *Segment VIII:* distinctly separated from segment IX; with full chaetotaxy; lateral comb not developed. *Spiracular Apparatus:* composed of posterodorsal portion of segment VIII and dorsal part of segment IX; essentially similar to that of *Anopheles* except that it is much larger and lobes are not movable but are provided with lateral fringe of long bristlelike spicules articulated at base; an anterior median lobe with 3 pairs of branched hairs (3-5-S); a pair of anterolateral projecting lobes laterad of spiracles, bearing hair 7-S near apex and 6-S ventrolaterally near base; a pair of projecting posterolateral lobes bearing hairs 8,9-S ventrolaterally near apex and hairs 10-14-S dorsally on external and internal margins; basad each posterolateral lobe is continued as a lateral sclerotization with similar marginal fringing spicules; a more or less well developed median plate, which may be connected with basal sclerotizations of posterolateral lobes; pecten a large plate ventrad of basal sclerotization of posterolateral lobe, with ventroapical teeth and hair 1-S. *Segment IX:* always well differentiated and completely separated from segment VIII and anal segment. *Anal Segment:* basal part more or less conical and with an incomplete dorsal saddle, which forms a complete cylindrical process just caudad of anus, a number of supraanal spicules at base of this process ventrally above anus; 3 pairs of hairs laterally on basal conical portion, probably homologs of ventral brush (4a,b,c-X); a cylindrical sclerotized caudal process separated from the apical process of basal part by an unsclerotized line, 3 pairs of hairs near apex of caudal process, the most cephalic and lateral probably homolog of 1-X, the others 2,3-X; no distinct accessory hairs (*x,y,z*); 2 pairs of retractile anal gills.

EGGS.—According to Nowell (1951:197), the small eggs are encased in a gelatinous matrix and are laid as a mass by the female directly on water. The egg mass sinks into the water and may become attached to various objects.

SYSTEMATICS.—The dixa midges have been considered from time to time as a family distinct from the Culicidae by some workers, most recently by Nowell (1951:189–270), who reviewed most of the previous work and made some original observations. As pointed out by Edwards (1930*a*:99–100), the similarities of the Dixinae to the Chaoborinae and Culicinae are very numerous and are probably indicative of actual relationship rather than convergence. Particularly important, I believe, are the similarities in the chaetotaxy of the larvae and pupae, the spiracular apparatus of the larvae, and the wing venation of the adults. It is possible to separate the Dixinae as a distinct family on a number of unique characters, but if such a course is followed, the Chaoborinae should also be recognized as a distinct family, or even as two or more families. Since in the Culicinae the supraspecific categories are used in a very broad sense, I believe it would be better to retain the Dixinae and the Chaoborinae as subfamilies of the Culicidae. Such a treatment emphasizes the relationship of the groups and would encourage the study of the nonhaematophagous species, which may result in a better understanding of the complex phylogeny of the Culicidae. Morphological studies should be particularly fruitful in the Dixinae, for in many respects this group has retained more primitive features than have the other subfamilies of mosquitoes. Information obtained from such studies should be helpful in interpreting the more specialized condition found in the Culicinae, particularly with respect to thoracic sclerites, male and female genitalia in the adults, and numerous features in the immature stages.

Following Edwards (1932), only two genera (*Dixa* and *Neodixa*) have been generally recognized in the subfamily, with *Dixa* divided into several subgenera. Nowell (1951:221–230), in reëlevating the group to familial rank, raised all the validly proposed nominal subgenera to generic status, added the new genus *Meringodixa,* and recognized three subfamilies (Dixinae, Paradixinae, and Meringodixinae), chiefly on the basis of characters used by Edwards and previous workers. It is evident from the present limited study that the Dixinae need to be revised on a worldwide basis, utilizing more characters than have been used in the past. Special emphasis should be given in the adults to the complex and varied structure of the phallosome and proctiger of the male genitalia as well as to differences in the female genitalia. In the larvae, the chaetotaxy as well as the spiracular apparatus and anal segment should be of considerable value. Too few pupae have been described as yet in sufficient detail to judge whether or not this stage may be of value in classification. Until such a revision is accomplished, I believe that every supraspecific taxon validly proposed to date should be recognized as a genus. For the present I would retain also as tribes the three suprageneric groups, as defined by Nowell (*loc. cit.*), but would suspect that *Meringodixa* is merely an aberrant genus in the Dixini. I have made no attempt to characterize the tribes, since I have not studied enough material from outside the South Pacific and since practically no detailed morphological information is available for any of these forms. Therefore, the treatment below is on a generic level. However, the general tribal characters are indicated in the keys to the adults and fourth instar larvae, the only stages where they have been studied.

In the South Pacific area, 4 genera have been reported: *Nothodixa, Neodixa,* and *Paradixa* in New Zealand and *Dixina* in the Solomons. The first 2 belong in the Dixini and the others in the Paradixini. There is no question of the utilization of the first 3 genera for South Pacific material, since the type species of all 3 are from New Zealand. However, there is considerable doubt in *Dixina,* for the type species, *obscura* (Loew, 1849), is a Palaearctic form which has not been adequately described in any stage. I have placed *solomonis* in this genus on the basis of similarity in adult characters only, as indicated under treatment of this species.

The material available for this study has been very scanty. Only a few adult specimens (and no immature stages) have been seen from New Zealand. For the immature stages I have had to rely entirely on original descriptions and figures. Even in the limited available adult material, it is evident that there is a great deal of variation in New Zealand species, not only in size, as can be expected, but also in coloration and in some details of wing venation, characters which were used by Tonnoir for the diagnosis of species. I have tried to use less variable characters in this study but cannot judge how reliable these really are. All stages of *solomonis* were studied, but only 2 males were available and not all details of the genitalia could be discerned.

Species of dixa midges have been described in the past chiefly on the basis of differences in antennal structure, wing venation, wing spotting or infuscation, coloration of body parts, and conspicuous differences of the male genitalia, chiefly of the sidepiece and clasper. Very little attention has been paid to details of morphology of the head, thorax, and legs, to female genitalia, or to the complex, sometimes bewildering, phallosomal structures of the male genitalia. It is essential that these be studied in the future if a natural classification of the group is to be developed. Such studies will be greatly simplified if adults are preserved in alcohol and not pinned dry in the conventional manner. Only a few larvae and pupae have been described to date and these mostly in very general terms. I cannot overemphasize the importance of studies of these stages in arriving at a natural classification of the group.

BIONOMICS.—Very little is known about the bionomics of dixa midges. Nowell (1951:197–212) has made some field and laboratory observations on immature stages as well as on adults.

The immature stages of Paradixini are found along the edges of creeks with slow or moderate flow of water, in springs, seepages, stream bed pools, and even temporary pools, often in association with anophelines. The body of the larva is bent in a U, with only the head and tail ends in the water; the rest of the body is held out of the water level on the bank, vegetation, or flotage but is covered by a film of water. The larvae are capable of crawling out of the water and can move quickly on the surface film in their habitat by a backward looping motion of their bodies. Pupae can swim in the water by movements of the abdomen but are most frequently found partially or completely out of water, surrounded, of course, by a water film. Emergence of the adult takes place with the pupa usually completely out of the water. The larval stage is long, usually in the neighborhood of 4 weeks or more, and the pupal stage lasts several days.

The immature stages of the Dixini are found in fast-flowing water, usually along the margins of rocks or boulders in the stream bed. Although the larval habits of *Nothodixa* and *Neodixa* are unknown, they may be similar to those of *Dixa* as described by Nowell (1951:198–200).

Adult dixa midges are usually found close to the habitats of the immature stages, on vegetation or various objects around or in the breeding site. Males of some species fly in small swarms, usually near sunset. Both sexes live only a few days under laboratory conditions. Nothing is known of the feeding habits of the adults.

DISTRIBUTION.—The subfamily is probably distributed throughout the world but has not been reported as yet from the Malagasy region. The majority of the approximately 150 described forms are known from temperate areas; much smaller numbers have been reported from the tropics. However, Lane (1939–1945) has found numerous species in the Neotropical region, and it is very likely that some undescribed species occur in the Old World tropics. Prior to this study, dixa midges were known in the South Pacific only from New Zealand. The discovery of a species in the Solomons is of considerable interest and indicates that this group is undoubtedly present in New Guinea and adjacent areas, although unreported to date.

The Dixinae should be of great value in zoögeographic studies. Although little is known of their habits, it would appear that the retiring, delicate, short-lived adults and the delicate eggs are not capable of dispersal by air currents over wide areas and that therefore these forms would not be able to cross extensive water barriers. The presence in New Zealand of several endemic species of 2 tribes, and the high percentage of these species in the total endemic culicid fauna, is of considerable interest, because it probably indicates, first, that this subfamily was the dominant one during the Mesozoic and, second, that the connection of New Zealand to the rest of the world was close, at least without extensive ocean barriers. Representatives of this group should be searched for on all islands in the South Pacific, particularly in the western portion, where they are likely to be found.

KEYS TO TRIBES AND GENERA

(Keys to subfamilies, pp. 90–91)

ADULTS

1\. Antenna about as long as head and thorax together; first flagellar segment fusiform, at most 5 times as long as wide, next 4 or 6 segments also fusiform (DIXINI) 2

Antenna about twice as long as head and thorax together or longer; first flagellar segment cylindrical, at least 10 times as long as wide, next 5 or 6 segments also cylindrical (PARADIXINI) 3

2(1). Vein R_{2+3} branched; base of M_{3+4} complete .... NOTHODIXA, p. 98

Vein R_{2+3} unbranched; base of M_{3+4} broken (1. *minuta*) .... NEODIXA, p. 103

3(1). Crossvein *r-m* distad of furcation of Rs .... PARADIXA, p. 105

Crossvein *r-m* basad of furcation of Rs (1. *solomonis*) .... DIXINA, p. 111

FEMALE GENITALIA

(*Neodixa* not included)

1\. Middle of postgenital plate unsclerotized .... NOTHODIXA, p. 98

Middle of postgenital plate more or less strongly sclerotized, apex of this plate produced into a cone 2

2(1). Tergite IX very large, with conspicuous strongly sclerotized lateral lobe *or* bursa copulatrix present .... PARADIXA, p. 105

Tergite IX small and with indistinct poorly sclerotized lateral lobe *and* bursa copulatrix absent (1. *solomonis*) .... DIXINA, p. 111

MALE GENITALIA

1\. Cercus in form of a small heavily sclerotized process with 2 or 3 bristles; proctiger with free spine; parameres with 1 or more free spines .... PARADIXA, p. 105

Cercus in form of a large, poorly sclerotized, hairy or spiculate lobe; proctiger without free spines; parameres without free spines 2

2(1). Long filiform penis present, enclosed in a long sheath within body; sidepiece with a long fingerlike subbasal process (1. *solomonis*) .... DIXINA, p. 111

No filiform penis developed; sidepiece without long fingerlike subbasal process .... NOTHODIXA, p. 98 .... NEODIXA (1. *minuta*), p. 103

PUPAE

Known in detail for *Dixina* only; insufficiently described in *Nothodixa* and *Paradixa;* unknown in *Neodixa*

LARVAE

(*Neodixa* not included)

1\. Tergites of abdominal segments II-VII each with a conspicuous rosette of plumose spinules (DIXINI) .... NOTHODIXA, p. 98

Tergites of abdominal segments without rosettes of plumose spinules but with uniform dense vestiture of slender simple spicules (PARADIXINI) 2

2(1). Posterior border of median plate of spiracular apparatus with a fringe of long bristlelike spicules (1. *solomonis*) ... DIXINA, p. 111

Posterior border of median plate of spiracular apparatus without long spicules .... PARADIXA, p. 105

Genus NOTHODIXA Edwards

1930. *Nothodixa* Edwards, Diptera Patagonia South Chile 2(3):101. TYPE SPECIES: *Dixa campbelli* Alexander, 1922, New Zealand; original designation.—As subgenus of *Dixa.*

FEMALES.—*Head:* antenna about as long as head and thorax together; flagellar segments 1-5(6) more or less fusiform, each with heavier, longer bristlelike hairs near base and sometimes near apex and shorter, weaker hairs elsewhere, segment 1 at most 3 times as long as maximum width; clypeus distinctly longer than wide, without basal transverse impression; frons between antennae broad. *Thorax:* mesonotal and scutellar bristles short and inconspicuous; *apn* and *ppn* with a few short bristles; *stp* below longitudinal suture with at least 1,2 hairs; *mep* with 1 or more hairs in upper part; no other pleural bristles apparently present. *Legs:* hindtibia strongly swollen apically and with a large ovoid depressed dull area just proximad of comb near dorsal margin, some short fused spicules in depression; claws of all legs simple. *Wing: r-m* always well before fork of Rs; vein M setose for only a short distance basad of *m-cu. Genitalia:* tergite IX small, poorly sclerotized, lateral lobe small; postgenital plate without distinct sclerotization in the middle.

MALES.—Essentially as in the females. *Legs:* hindtarsal segment 1 with a short heavy bristle near base ventrally; all claws pectinate.

MALE GENITALIA.—*Segment IX:* tergite narrower than sternite and separated from it by a membrane, its caudal margin smoothly rounded; sternite broad, extending to dorsal surface. *Sidepiece:* without processes except for slight, hairy subapical dorsal and basoventral lobes. *Clasper:* simple; without spiniforms. *Phallosome:* membranous externally; with 2 pairs of internal rods and a median dorsoapical median sclerotization; paramere indistinct. *Proctiger:* a simple membranous lobe, without spines but with indistinct basal sclerotizations; cercus large and very conspicuous, with many bristles.

PUPAE.—Insufficiently described.

LARVAE (based on *campbelli*).—*Antenna:* with triangular spinules only; hair 1-A inserted near apex. *Thorax:* ventral prothoracic bristles only about 0.33 of head capsule. *Abdomen:* prolegs present on sternites I,II; tergites II-VII each with a conspicuous rosette of plumose spinules; sternites V,VI each with 2 rows of 6 spines on each side of midline. *Spiracular Apparatus:* spiracles widely separated; basal sclerotizations of posterolateral lobes not connected to median plate, which is poorly sclerotized and without caudal hairlike spicules; posterolateral lobes without toothlike apical ventral process. *Anal Segment:* hairs 4-X all short; caudal process short, projecting only a little beyond end of posterolateral lobe; hairs 1-3-X moderate in length and strongly plumose.

SYSTEMATICS.—Edwards (1930*a*:101–106), in describing the subgenus *Nothodixa,* designated *D. campbelli* Alexander, 1922 as the type species but included in it 4 Chilean and Patagonian species and indicated that all the Australian, Tasmanian, and New Zealand species placed by Tonnoir in the subgenus *Dixa* belonged to it. Subsequently he listed 10 species in *Nothodixa* (Edwards, 1932:11). It appears that the New World species are similar to the 4 New Zealand, 1 Tasmanian, and 1 southeast Australian species both in general adult morphology and, apparently, in larval characters. However, they are strikingly different from the Old World species in the possession of a filiform penis. For this reason, I believe that they should be separated at least as a distinct subgenus of *Nothodixa,* but I refrain from proposing a new name without examining adequate material. A decision as to the status of the Tasmanian and Australian species must also await detailed study of additional material.

The 4 described New Zealand forms of *Nothodixa* fall into two distinct groups of two species each. The differences between the 2 members in each group are slight and may prove to be of only subspecific or even lesser significance after more material is studied.

BIONOMICS.—Adults have been collected in swarms over streams and near waterfalls and larvae in fast-flowing streams (Tonnoir, 1924*b*:228).

DISTRIBUTION (figs. **30, 31**).—The typical species of *Nothodixa* occur in New Zealand and probably in Tasmania and southeast Australia. As indicated above, the 4 species from Chile and Patagonia are undoubtedly related, but they are sufficiently different to be placed in a distinct genus or, at the very least, in a separate subgenus.

KEYS TO SPECIES

(Keys to tribes and genera, p. 97)

ADULTS

1. Wing conspicuously spotted and infuscated along some veins 2
Wing clear or with a faint infuscation on *r-m* only 3

2(1). Vein R_{2+3} with only a marginal infuscation; vein M proximad of *m-cu* usually with an elongate dark streak ...... 1. *campbelli*
Vein R_{2+3} with a large square or roundish blotch extending into cell R_1; vein M proximad of *m-cu* with a large restricted quadrate blotch .... 2. *philpotti*

3(1). Wing with a faint infuscation on *r-m;* vein M beyond *m-cu* at most equal in length to vein M_{1+2} .... 3. *otagensis*
Wing without any trace of infuscation on *r-m;* vein M beyond *m-cu* about 1.5 length of vein M_{1+2} .... 4. *septentrionalis*

MALE GENITALIA

(2. *philpotti* and 4. *septentrionalis* not included)

1. Tergite IX short, with 3-5 bristles on each side .... 1. *campbelli*
Tergite IX longer, with about 14 bristles on each side .... 3. *otagensis*

PUPAE AND LARVAE

Insufficiently known, see under species

1. Nothodixa campbelli (Alexander)

Figs. 31-34

1922. *Dixa campbelli* Alexander, Insecutor Inscitiae Menstruus 10:20–21. TYPE: holotype ♂, Charteris Bay, Banks Peninsula, Canterbury, New Zealand, Sept. 4, 1921, J. W. Campbell (ALEX).

Dixa (*Nothodixa*) *campbelli* of Edwards (1930*a*:101; 1932:11); Taylor (1934:7); Nowell (1951:233).

Dixa campbelli of Alexander (1922*b*:147); Tonnoir (1924*b*:224–225, 231–232); Tillyard (1926:352); Martini (1931:199, 203); Cooper and Rapp (1944:249); Miller (1950:45).

FEMALE (figs. 32, 34).—*Wing:* 3.3–3.5 mm. *Forefemur:* 1.2–1.4 mm. *Abdomen:* about 2.0 mm. General coloration yellow marked with dark brown; legs yellow with tips of femora and tibiae and entire tarsi dark; wing with brown streak on M, a large blotch on *r-m* not reaching base of Rs, and brown infuscations along R_{2+3}, R_{4+5}, M_{3+4}, and Cu and its branches. *Head:* integument short-pilose but shining, dark brown above, lighter below and on genae; mouthparts brown, lighter below; antennal torus dark brown, flagellum lighter; flagellar segments 1–3 as figured (fig. 32). *Thorax:* integument long-spiculate but shining throughout; mesonotum with ground color yellowish, a broad median dark stripe on anterior half, sometimes prolonged as a narrower streak caudad and usually indistinctly split by a very narrow pale median vittata, a pair of broad lateral dark stripes beginning about halfway between scutal angle and origin of wing and extending to scutellum, prescutellar space darkened; mesonotal bristles light in color; scutellum yellowish, sometimes with infuscated margins, bristles light in color; postnotum entirely dark; paratergite light; pleuron yellowish, conspicuously and extensively striped and blotched with brown, upper anterior part largely yellowish except for variable infuscation on upper anterior part of *ppn,* infuscated *apn, ppl,* and *ssp,* remainder largely dark except for conspicuous yellowish stripe from forecoxal base across *stp* and *mep* to metapleuron and for light area around suture of *stp* and under wing base; *apn* long-pilose; *stp* with 1,2 very short bristles on dark portion below suture; *mep* with several short bristles in upper posterior part of dark portion; other bristles as indicated for genus. *Legs:* forecoxa infuscated, midcoxa and hindcoxa yellowish; trochanters light; femora and tibiae yellowish and with conspicuously infuscated or blackened apices, tibiae sometimes darker; tarsi uniformly brown; claws small, slightly unequal. *Wing:* venation and color pattern as figured (fig. 34); membrane with faint grayish tinge except for distinctly yellow anterior portion basad of arculus; vein M with a variable brown blotch or streak near its middle and extending a variable distance into cell R; vein Cu and its branches margined with brown; *r-m* with a large brown blotch extending a variable distance on Rs before and beyond crossvein, but not reaching base of Rs, and extending on M down to middle of *m-cu;* R_{4+5} margined with brown for entire length and R_{2+3} only to furcation; M_{3+4} margined with brown; anal angle with variable infuscation; vein R_{2+3} moderately arched. *Haltere:* entirely pale yellowish. *Abdomen:* dark brown on tergites, lighter at base and sternites. *Genitalia:* sternite IX broadly connected to lobe of tergite IX.

MALE.—Similar to female in most respects except for sexual differences; coloration usually somewhat lighter.

MALE GENITALIA (fig. 33).—*Segment IX:* tergite with 3–5 bristles on each side on apical half; sternite with 6,7 bristles on expanded dorsolateral portion. *Sidepiece:* about twice as long as median width; uniformly spiculate, dorsal surface without bristles except near subapical lobe, ventral and lateral surfaces with moderately long bristles; subapical lobe with a group of about 10 small bristles dorsally and a large number of much shorter hairs mesally; basal lobe with numerous short hairs and several larger ones. *Clasper:* about as long as sidepiece; smoothly curved and only slightly narrowed to just before apex, which is gently but acutely rounded; uniformly spiculate and with numerous bristles and hairs of varying size on all surfaces. *Phallosome:* largely membranous and apparently eversible; membrane with areas of microspicules; at base apparently 2 pairs of large sclerites which are withdrawn into base of sidepiece at rest and from which arise the following rodlike capitate processes (all of which are apparently developments of the basal piece): (1) a pair of slender ventral submedian, (2) another pair of larger, more lateral and dorsal capitate rods, and (3) a dorsal median, more or less cordate sclerotization, either articulating with the lateral rods or developed from their apices; capitula of rods with roughened areas. *Proctiger:* cercus in form of a large prominent lobe with numerous bristles of varying sizes.

PUPA (fig. 34).—Insufficiently described for identification; outline of trumpet figured from Tonnoir (1924*b*, fig. 12E).

LARVA (fig. 34, after Tonnoir, 1924*b*:231).—Coloration yellowish green with indefinite blackish markings; head ochraceous, bordered posteriorly with black, especially on the sides and ventrally. *Head:* mouthbrushes not much longer than the antenna (?); mandible with 1 terminal internal tooth and one relatively long external terminal hair; maxilla triangularly produced externally and about as long as maxillary palpus, which bears spinules similar to those of antenna; labial plate without teeth, ending in a rather sharp point (?). *Antenna:* with triangular spinules only; hair 1-A near apex. *Thorax, Abdomen,* and *Terminal Segments:* as indicated above in generic diagnosis.

MATERIAL EXAMINED.—3♀; 6♂; no immature stages.

SYSTEMATICS.—This species, the type of *Nothodixa,* appears to be closely related to *philpotti;* for a discussion of relationship and differences, see the latter. There is very marked variation in the coloration of the head and thorax of *campbelli.* Some specimens are predominantly brown instead of yellow, and all intergradations exist between this coloration and the more typical yellow. The infuscations of the wing are also quite variable; this is especially true of the one on vein M, which may be in the form of a narrow long streak, as in the majority of specimens, or more rarely in the form of a blotch, as in the type and a few other specimens. These variations have no correlation with geographical distribution, and, unfortunately, no information is available on ecological differences.

BIONOMICS.—Adults of *campbelli* have been collected in small swarms over a stream (Alexander, 1922*a*:21). There is no information available as to the swiftness of the water in such streams; from the structure of the larva, one would expect a strong current. The pupal stage lasts about 3 or 4 days (Tonnoir, 1924*b*:231).

DISTRIBUTION (fig. 31).—*New Zealand:* widely distributed; North Island (Wellington); South Island (Nelson, Westland, Canterbury). Not known elsewhere.

2. Nothodixa philpotti (Tonnoir)

Figs. 31, 34

1924. *Dixa* (*Dixa*) *philpotti* Tonnoir, Canterbury Mus., Rec. 2:227–228. TYPE: holotype ♀, Nelson, South Island, New Zealand, sweeping along mountain creek, Dec. 15, 1922, A. L. Tonnoir (NELSON).

Dixa (Nothodixa) philpotti of Edwards (1932:11); Taylor (1934:7); Nowell (1951:239).
Dixa philpotti of Cooper and Rapp (1944:251); Miller (1950:46).

FEMALE (fig. 34).—*Wing:* 3.5 mm. Similar to *N. campbelli* in all respects except as follows. *Thorax:* yellowish color of mesonotum rather orange, brown stripes more extensive; pleuron largely dark, with a faint yellowish marking above hindcoxae. *Legs:* femora infuscated in the middle and with a subterminal ring of distinctly lighter color; tibiae and tarsi brown. *Wing* (fig. 34): more strongly and extensively marked; blotch on *r-m* larger and extending to base of Rs; vein M proximad of *m-cu* with a large quadrate blotch; vein R_{2+3} with a large square or roundish blotch extending well into cell R_1; veins M_{3+4} and Cu and its branches with wider and more intense marginal infuscations; base of 1A and anal angle of wing infuscated; Rs distad of *r-m* longer; vein R_{2+3} more strongly arched and usually provided with a small stump vein near its middle; portion of vein Cu_1 beyond *m-cu* more strongly curved.

MALE, PUPA, and LARVA.—Unknown.

MATERIAL EXAMINED.—1 ♀.

SYSTEMATICS.—*N. philpotti* is undoubtedly closely related to *campbelli* and may prove to be an ecological race of the latter. It is very similar in coloration to darker specimens of *campbelli.* Its wing markings appear to be distinctive, but, except for the blotch on R_{2+3}, they are merely an intensification of the condition found in *campbelli.* The venational differences are also along lines of variation found in the latter. All these differences may be associated with the different habitats of the two forms.

No striking variations were noted by Tonnoir. His figure of the wing does not show a stump vein on R_{2+3}; this was also absent on the single specimen examined at the British Museum (Nat. Hist.).

BIONOMICS.—Tonnoir (1924*b*:228) collected adults of this form "by sweeping the plants along mountain creeks with a much swifter flow of water than in those where *Dixa* larvae usually breed."

DISTRIBUTION (fig. 31).—*New Zealand:* South Island (Nelson). Not known elsewhere.

3. Nothodixa otagensis (Alexander)

Figs. 31, 32, 34

1922. *Dixa otagensis* Alexander, Insecutor Inscitiae Menstruus 10:147. TYPE: holotype ♂, Ben Lamond, Otago, South Island, New Zealand, Dec. 30, 1921, G. Howes (ALEX).

Dixa (Nothodixa) otagensis of Edwards (1932:11); Taylor (1934:7); Nowell (1951:239).
Dixa (Dixa) otagensis of Tonnoir (1924*b*:225–226).
Dixa otagensis of Cooper and Rapp (1944:251); Miller (1950:45).

FEMALE (figs. 32, 34).—*Wing:* 5.0–5.1 mm. *Forefemur:* 1.9–2.0 mm. *Abdomen:* about 2.5 mm. General coloration blackish brown with a few lighter areas; wing with or without a faint cloud on *r-m,* no other infuscations; in general as in *campbelli* except as noted. *Head:* integument blackish brown, lighter below. *Thorax:* mesonotum largely dark brown, lighter laterally, stripes broader and blackish; mesonotal bristles larger and dark; scutellum pale brown, bristles dark; paratergite brown; pleuron brown except for blackish *apn,* part of *ppn, ssp,* and *stp* below suture; *apn* and *ppn* with several short but heavy dark bristles; *stp* below suture with about 6 short, heavy dark bristles; *mep* with about 10 conspicuous dark bristles in upper part. *Legs* (fig. 32): coxae and trochanters light brown, those of hindlegs lighter; femora brown, lighter below and with darker apex; tibiae and tarsi dark brown. *Wing* (fig. 34): membrane with a very faint brownish gray tinge, without lighter basal portion; veins brown, not margined with infuscations; *r-m* with a very faint small cloud (absent in most dry specimens); vein Sc ending on C just before origin of Rs; vein R_{2+3} variable in length, from 0.25 to 0.4 of R_2; vein M beyond *m-cu* at most equal in length to M_{1+2}. *Haltere:* brown, lighter at base, darker on apex. *Abdomen:* tergites brownish black, sternites lighter. *Genitalia* (fig. 32): sternite IX narrowly connected by 2 bars to lobe of tergite IX.

MALE.—Similar to female in most respects except for sexual characters; coloration somewhat lighter.

MALE GENITALIA.—Very similar to *campbelli;* tergite IX longer and with about 14 long bristles on each side, not restricted to apical half.

PUPA and LARVA.—Unknown.
MATERIAL EXAMINED.—1 ♀, 2 ♂.

SYSTEMATICS.—*N. otagensis* and *septentrionalis* form a distinct complex quite different from *campbelli* and *philpotti,* although superficially they share with the latter a number of characters and also have quite similar male genitalia. *N. otagensis* and *septentrionalis* are extremely similar; I have seen some specimens from near the type locality of *otagensis* (as well as some from farther north) which might be considered intermediate between the two, except for size. For a discussion of the differences, see *septentrionalis.*

There is the usual variation in the coloration of the thorax and legs. The cloud on *r-m* is practically invisible in old dried specimens; it appears that it may be variable in fresh material. A great deal of variation is found in the wing venation. I have not seen any specimens with R_{2+3} and M beyond *m-cu* as short as figured by Tonnoir; usually they are both considerably longer and approach the condition found in *septentrionalis.*

BIONOMICS.—Nothing is known of the bionomics of *otagensis.* The immature stages have not been collected.

DISTRIBUTION (fig. 31).—*New Zealand:* South Island (Canterbury, Westland, Otago). Not known elsewhere.

4. Nothodixa septentrionalis (Tonnoir)
Figs. 31, 34

1924. *Dixa* (*Dixa*) *septentrionalis* Tonnoir, Canterbury Mus., Rec. 2:226–227. TYPE: holotype ♂, Te Aroha, Auckland, North Island, New Zealand, from rock at foot of waterfall, Feb. 28, 1923, A. L. Tonnoir (NELSON).

Dixa (*Nothodixa*) *septentrionalis* of Edwards (1932:11); Taylor (1934:7); Nowell (1951:239).

Dixa septentrionalis of Cooper and Rapp (1944:251); Miller (1950:46).

FEMALE.—Unknown.

MALE (fig. 34).—*Wing:* 3.5 mm. Very similar to *otagensis,* differing only in the following respects; thorax dull, uniformly brown, without trace of darker stripes; head, scutellum, and abdomen nearly black; coxae yellowish; no trace of spot or cloud on *r-m;* vein R_{2+3} about half as long as vein R_2; vein M beyond *m-cu* about 1.5 length of vein M_{1+2}.

MALE GENITALIA.—Similar to *otagensis;* insufficiently described for separation.

PUPA and LARVA.—Unknown.
MATERIAL EXAMINED.—1 ♂.

SYSTEMATICS.—*N. septentrionalis* differs from *otagensis* chiefly in size. The differences in coloration and wing venation may not hold when more material is examined, since even in the small number of specimens of *otagensis* which were examined, intermediate conditions in these characters were noted. It is possible that *septentrionalis* is a geographical race of *otagensis,* as suggested by Tonnoir; however this cannot be determined until more material of both forms is available.

BIONOMICS.—The type material was collected on rocks at the foot of a waterfall.

DISTRIBUTION (fig. 31).—*New Zealand:* North Island (Auckland). Not known elsewhere.

Genus NEODIXA Tonnoir

1924. *Dixella* Tonnoir, Canterbury Mus., Rec. 2:230, Dec. 4. TYPE SPECIES: *D. minuta* Tonnoir, 1924, New Zealand; original designation.—Preoccupied by *Dixella* Dyar and Shannon, Oct. 22, 1924.

1925. *Neodixa* Tonnoir, Canterbury Mus., Rec. 2:311. TYPE SPECIES: automatically *Dixella minuta* Tonnoir, 1924, New Zealand.—Substitute name for *Dixella* Tonnoir preoccupied by *Dixella* Dyar and Shannon.

In the words of Tonnoir (1924*b*:230), "this genus is characterized by the radial sector having only two branches." *Neodixa* is known from a single male. Except for the aberrant wing venation, all the described characters are consistent with those of *Nothodixa* (see below under specific diagnosis). It has been suggested that the venational characters are individual aberrations and that *minuta* should be transferred to *Nothodixa.* However, I prefer to retain the genus *Neodixa* with the original characterization until the type is reëxamined and additional specimens are available for study. *N. minuta* is distinct from all described *Nothodixa;* it may very well be that the venational characters are genetic and not individual aberrations at all.

KEYS TO SPECIES

See keys to tribes and genera, p. 97

1. Neodixa minuta (Tonnoir)

Figs. 31, 33, 34

1924. *Dixella minuta* Tonnoir, Canterbury Mus., Rec. 2:230. TYPE: holotype ♂, Nelson, South Island, New Zealand, from low shrub along creek, Oct. 18, 1923, A. L. Tonnoir (NELSON).

Neodixa minuta of Tonnoir (1925); Tillyard (1926:352); Edwards (1932:15); Taylor (1934:7); Cooper and Rapp (1944:252); Miller (1950:46); Nowell (1951:241).

FEMALE.—Unknown.

MALE (fig. 34, after Tonnoir).—*Wing:* 2.5 mm. Body completely black, head and thorax shining and with very short and inconspicuous pilosity, abdomen dull and somewhat velvety. *Head:* maxillary palpus with segment 5 about twice as long as segment 4; antenna about as long as head and thorax together, first 7 segments of flagellum more or less fusiform and fairly distinct from one another, the following ones filiform. *Legs:* yellowish except for tips of femora and tibiae and the end of the tarsi, which are blackish; base of hindtarsal segment 1 ventrally with a spinelike bristle; claws toothed (pectinate?). *Wing:* hyaline and unspotted, base and anterior border yellowish; vein Sc ending on C somewhat basad of middle of wing and well before origin of Rs; vein R_{2+3} unbranched and not strongly arched; base of vein M_{3+4} obliterated. *Haltere:* yellowish.

MALE GENITALIA (fig. 33, after Tonnoir).—Similar to *Nothodixa* as far as can be determined from Tonnoir's figure. *Segment IX:* tergite long and with numerous bristles. *Sidepiece* and *Clasper:* simple. *Phallosome:* structure indistinct. *Proctiger:* simple and without spines; cercus very prominent and with numerous bristles.

PUPA and LARVA.—Unknown.

MATERIAL EXAMINED.—None.

SYSTEMATICS.—*Neodixa minuta* is undoubtedly a distinct species belonging to the tribe

Dixini. It is distinct from all the described New Zealand *Nothodixa.* As mentioned above, it has been suggested that the unusual venation may be an individual aberration. The other characters are apparently similar to those of *Nothodixa,* particularly the antennal structure, the presence of a spinelike bristle on hindtarsal segment 1, the short vein Sc, and the male genitalia. However, the majority of these characters are described in very general terms, and it is impossible to tell whether or not generic differences actually exist.

BIONOMICS.—The single known male was swept from low shrubs in a wet part of a track along a creek.

DISTRIBUTION (fig. 31).—*New Zealand:* South Island (Nelson). Not known elsewhere.

Genus PARADIXA Tonnoir

1924. *Paradixa* Tonnoir, Canterbury Mus., Rec. 2:222. TYPE SPECIES: *Dixa* (*P.*) *neozelandica* Tonnoir, 1924, New Zealand; the first of 2 included species, selection of Edwards (1930*a*:101).—As subgenus of *Dixa.*

FEMALES.—*Head:* antenna about twice as long as head and thorax together; flagellar segments all elongate, cylindrical or filiform, densely covered with short hairs and without heavier, longer bristlelike hairs at base, segment 1 at least 9 times as long as greatest width; clypeus slightly wider than long, with a more or less distinct impression at base; frons between antennae in form of a narrow sharp ridge. *Thorax:* scutal and scutellar bristles moderate in size; *apn* and *ppn* with a few short bristles; *stp* usually bare, occasionally with 1,2 short hairs in lower part; *mep* without bristles; no other pleural bristles apparently present. *Legs:* hindtibia strongly swollen apically and with a narrow longitudinal ridge proximad of comb near dorsal margin, apparently consisting of fused spicules; claws of all legs simple. *Wing: r-m* always distad of fork of Rs; vein M setose for only a short distance basad of *m-cu. Genitalia:* tergite IX long, dorsal part strongly or weakly sclerotized, lobe very long; sternite IX articulating near base of lobe of tergite; postgenital plate strongly sclerotized; bursa copulatrix present or absent.

MALES.—Essentially as in the females. *Legs:* hindtarsal segment 1 without a heavy short bristle near base ventrally; claws of foreleg and midleg pectinate, those of hindleg simple.

MALE GENITALIA.—*Segment VIII:* tergite and sternite about half as long as corresponding sclerite of segment VII. *Segment IX:* completely sclerotized as a ring; tergite much wider than sternite, its boundary indicated by an internal ridge on each side, median dorsal part of tergite produced caudally as a more or less distinct median lobe. *Sidepiece:* with or without processes. *Clasper:* irregular; with spiniforms. *Phallosome:* very complex and with strong sclerotizations; parameres very strong, with large free spines. *Proctiger:* complex, with strong ventrolateral basal sclerotization produced into hooked spine or spines; cercus developed as a small strongly sclerotized projection with 2,3 bristles.

PUPAE.—Unknown.

LARVAE.—*Antenna:* with hairlike spicules in distal half ventrolaterally, in addition to triangular spinules elsewhere; hair 1-A near middle of shaft. *Thorax:* ventral prothoracic bristles about 2.0 of head capsule. *Abdomen:* prolegs present on segments I,II; abdominal tergites without rosettes of plumose spinules, instead with uniform vestiture of slender hairlike spicules; sternites V-VII with armature of spines; tergites V,VI with 1 pair of the bristles long, VII with 4 pairs, VIII with 2 pairs. *Spiracular Apparatus:* spiracles close together; a V-shaped sclerite on midline between spiracles caudad of hairs 3-5-S; basal sclerotizations of posterolateral lobes connected by strongly sclerotized median plate which lacks long caudal hairlike marginal spicules; posterolateral lobe apparently without toothlike apical ventral process. *Anal Segment:* 2 of the hairs 4-X very long; caudal process very long, projecting well beyond end of posterolateral lobe; hairs 1-3-X very long, inconspicuously plumose (barbed?).

SYSTEMATICS.—In describing the subgenus *Paradixa,* Tonnoir included 2 species, *neozelandica* and *fuscinervis,* both new, but failed to designate a type species. Edwards (1930*a*:101) was apparently the first to select *neozelandica* as the type species of *Paradixa.* At the present time, a miscellaneous assemblage of species from all parts of the world is referred to *Paradixa.* The majority of these are apparently not congeneric with *neozelandica* on the basis of male genitalia, wing venation, or larval characters. The Paradixini appear to be a very complex group which will have to be separated into several genera, more than are recognized at present. It is also likely that 2 or more subgenera will have to be recognized in the genus *Paradixa* itself. Lane (1951:336) synonymizes *Paradixa* with *Dixella,* but it is evident that *lirio* Dyar and Shannon, 1924, the type species of *Dixella,* is not congeneric with *neozelandica.*

In the South Pacific, *Paradixa* is represented by 3 species confined to New Zealand. It is difficult to determine the relationships of the 3 species, as the various characters of male and female genitalia and wing markings do not appear to be correlated and as all 3 species are quite distinct. It may be advisable eventually to recognize 3 subgenera for these species, but such action must await study of additional material. The New Zealand species are quite different from the several species from Tasmania and southeast Australia (Tonnoir, 1924*a*).

BIONOMICS.—The immature stages of this

genus occur most frequently in small rivulets with a moderate flow of water (Tonnoir, 1924*b*:229).

DISTRIBUTION (figs. **30, 31**).—*Paradixa* in the broad sense is apparently worldwide in distribution. I have seen North American forms which appear to be congeneric with *neozelandica.* However, as indicated above, the majority of species now referred to *Paradixa* are very different from this species in basic genitalic or larval characters; for example, *californica* Johannsen, 1923, figured by Nowell (1951, fig. 85), should be referred to *Dixella,* according to larval characters used by this author.

KEYS TO SPECIES

(Keys to tribes and genera, p. 97)

ADULTS

1\. Distinct infuscations along all veins in distal part of wing .... 3. *fuscinervis*
No infuscations along veins in distal part of wing 2
2(1). Veins Cu and Cu_2 with light marginal infuscations; cloud on *r-m* large, extending well into cell R_1; pleuron uniformly dark . . 2. *harrisi*
Veins Cu and Cu_2 without marginal infuscations; cloud on *r-m* small, barely extending into cell R_1; pleuron with a light band extending caudad from base of forecoxa across *stp* .... 1. *neozelandica*

FEMALE GENITALIA

(3. *fuscinervis* not included)

1\. Bursa copulatrix not developed .... 1. *neozelandica*
Bursa copulatrix strongly developed .... 2. *harrisi*

MALE GENITALIA

1\. Sidepiece with a long fingerlike basal process .... 1. *neozelandica*
Sidepiece without long fingerlike basal process 2
2(1). Cercus in the form of a small, strong hooked tooth with 3 small bristles before apex; a claspettelike lobe on each side of phallosome .... 2. *harrisi*
Cercus in the form of a smaller truncate process with 2 apical bristles; claspettelike lobes not developed .... 3. *fuscinervis*

PUPAE

Unknown

LARVAE

(2. *harrisi* not included)

1\. Pecten with 2 very large spinelike teeth basoventrally in addition to the smaller teeth elsewhere .... 1. *neozelandica*
Pecten with all teeth small, no larger spinelike teeth basoventrally .... 3. *fuscinervis*

1. Paradixa neozelandica (Tonnoir)

Figs. **31-34**

1924. *Dixa* (*Paradixa*) *neozelandica* Tonnoir, Canterbury Mus., Rec. 2:228–229. TYPE: holotype ♂, Aniseed Valley, Nelson, South Island, New Zealand, from small rivulet, Mar. 21, 1922, A. L. Tonnoir (NELSON).

Dixa (*Paradixa*) *neozelandica* of Tonnoir (1925); Edwards (1932:14); Taylor (1934:7); Nowell (1951:238).
Dixa neozelandica of Cooper and Rapp (1944:251); Miller (1950:45).

FEMALE (figs. **32, 34**).—*Wing:* 3.0–4.25 mm. *Forefemur:* 1.4–1.75 mm. *Abdomen:* about 1.75–2.25 mm. General coloration dark brown with restricted yellow markings; legs dark except at base; wing subhyaline with a weak cloud on *r-m,* veins without distinct marginal infuscations. *Head:* integument shining black; clypeus uniformly dark; mouthparts light brown; maxillary palpus black or dark brown; antenna dark brown, torus lighter; flagellar segment 1 about 14 times as long as wide, segment 2 slightly less than 0.6 of segment 1 (fig. **32**). *Thorax:* mesonotum largely dark brown, only the humeral angle and extreme sides light or yellowish; scutellum and postnotum brown; scutal and scutellar bristles dark; paratergite largely light; pleuron largely dark, with membranous areas lighter and a yellowish band extending from base of forecoxa to metapleuron. *Legs* (fig. **32**): forecoxa infuscated, midcoxa and hindcoxa light; trochanters light; femora light at base and ventrally, brown dorsally, and with blackened apex; tibiae and tarsi dark. *Wing* (fig. **34**): coloration as described above; vein R_{2+3} about one-half length of vein R_2; vein M beyond *m-cu* variable in length. *Haltere:* base light, apical portion dark. *Genitalia* (fig. **32**): sternite VIII with apical margin sinuate, no strong lateral lobe; lateral lobe of tergite IX very large and strongly sclerotized; postgenital plate with median sclerotization ending in a sharp point; bursa copulatrix not developed.

MALE.—*Wing:* 3.0–3.3 mm. *Forefemur:* 1.4 mm. Similar to female in most respects except sexual differences; coloration usually somewhat lighter.

MALE GENTALIA (fig. **33**).—*Segment IX:* tergite shallowly and broadly emarginate in middle, with numerous bristles on lateral portions as well as in middle; sternite with about 6 bristles on each side. *Sidepiece:* short, only slightly longer than basal width; integument strongly spiculate, with sparse bristles on dorsal, lateral, and ventral surfaces; a long mesal basal fingerlike process with a long apically pointed spiniform; a shorter apical mesal process, broad and poorly sclerotized dorsally at base and narrower and strongly sclerotized ventrally, with 2–4 apical and subapical spiniforms. *Claspette:* see below under phallosome. *Clasper:* about as long as sidepiece; irregular but more or less triangular in outline and with a small narrow apical process; uniformly strongly spiculate, with sparse bristles on dorsal, lateral, and ventral surfaces; numerous short, blunt spiniforms on internal angular projection and toward apex on mesal surface. *Phallosome:* most mesal structures not discernible in mount but apparently similar to those of *harrisi;* a pair of large spiculate claspettelike ventral lobes between mesal structures and sidepieces, apparently developed from basal pieces; paramere with a long narrow anterior spine and a much broader, shorter posterior spine. *Proctiger:* a very long spine completely recurved at base arising from basolateral sclerotization; cercus in form of a long sclerotized spine hooked apically and with 3 hairs proximad of hook.

PUPA.—Unknown.

LARVA (fig. **34**, from Tonnoir, 1924*b*:232–233).—*Total length:* 6.7 mm. As described for genus. *Head:* ochraceous, with a black posterior margin except on frontoclypeus and on middle of ventral surface. *Spiracular Apparatus:* "edge of the basal part of the lateral plates when seen from the side shows a row of small hairs ending with two conspicuous dark teeth" (Tonnoir); I interpret this to mean the large detached basoventral pecten teeth similar to those found in some North American Paradixini.

MATERIAL EXAMINED.—4 ♀, 2 ♂.

SYSTEMATICS.—*P. neozelandica,* the type species of *Paradixa,* differs in many respects from the other two New Zealand species of the genus, particularly in the male genitalia, which have a much more poorly developed paramere, quite different basolateral spine of the proctiger, and a very strong fingerlike basal mesal process on the sidepiece. The mesal structures of the male phallosome could not be discerned in the single mount available for study, but it appears that they might be similar to those of *harrisi.* The structure in *neozelandica* interpreted as the claspettelike lobe of the male genitalia is actually quite different in appearance from the structure so named in *harrisi.* Furthermore, *harrisi* has very different male parameres and possesses a bursa copulatrix in the female. Therefore it seems very unlikely that these two species are closely related. *P. fuscinervis* is even more distinct on male genitalic structures but shares with *neozelandica* the absence of the bursa copulatrix in the female.

This is apparently an extremely variable species since great variation in size, coloration, and venation was noted in the few specimens available for examination. Even in the genitalia of a single male, there was much variation in the 2 sides, particularly in the number and distribution of spiniforms on the apical lobe of the sidepiece and on the clasper.

BIONOMICS.—The larvae of this species have been collected in small rivulets with a moderate flow of water (Tonnoir, 1924*b*:229).

DISTRIBUTION (fig. 31).—*New Zealand:* North Island (Auckland, Wellington); South Island (Nelson, Canterbury). Not known elsewhere.

2. Paradixa harrisi (Tonnoir)

Figs. 31-34

1925. *Dixa (Paradixa) harrisi* Tonnoir, Canterbury Mus., Rec. 2:311. TYPE: holotype ♂, Ohakune, Wellington, North Island, New Zealand, Mar., 1923, T. R. Harris (CANT, *fide* Miller, 1950).

Dixa (Paradixa) harrisi of Edwards (1932:14); Taylor (1934:7); Nowell (1951:235).

Dixa harrisi of Cooper and Rapp (1944:250); Miller (1950:45).

FEMALE (figs. 32, 34).—*Wing:* 3.00 mm. *Forefemur:* 1.25 mm. *Abdomen:* about 1.75 mm. In general, similar in external characters to *neozelandica,* from which it differs chiefly in the following respects. *Head:* apical half of clypeus light; mouthparts yellowish; torus of antenna dark; flagellar segment 1 slightly less than 10 times as long as wide, segment 2 about 0.7–0.9 of segment 1. *Thorax:* prescutellar space rather light, said to be orange by Tonnoir; pleuron almost completely dark, without the light stripe from forecoxa. *Legs:* hindfemur lighter; hindtibia yellowish in the middle. *Wing* (fig. 34): *r-m* with a larger and more intense cloud; apex of vein Cu and all of Cu_2 faintly margined with brown; vein R_{2+3} almost as long as vein R_2. *Haltere:* largely light, apical portion only slightly darkened. *Genitalia* (fig. 32): sternite VIII deeply excavated in middle and with prominent lateral lobes bearing long bristles; lateral lobe of tergite IX large but not conspicuous; postgenital plate with median sclerotization truncate apically but with a sharp conical projection dorsad of it; bursa copulatrix developed as a spiculate sac projecting into posterior end of segment VII and bearing within complex platelike and spinelike sclerotizations, which probably engage some of the male structures in copulation; internally, ventrad of bursa and possibly part of it, is a group of fingerlike processes extending into lateral lobe of sternite on each side (perhaps colleterial gland ducts).

MALE.—*Wing:* 3.0 mm. *Forefemur:* 1.25 mm. Similar to female in most respects except for sexual differences; palpal segment 2 apparently slightly shorter than in female.

MALE GENITALIA (fig. 33).—*Segment IX:* tergite with a strong median lobe which is broadly but shallowly emarginate apically, bristles in 2 groups on each side of midline, 5,6 bristles in lateral group and 20 or more nearer midline and chiefly on lobe; sternite with 3 bristles on each side. *Sidepiece:* short, less than twice as long as median width, broad apically; uniformly spiculate throughout and with rather long bristles dorsally, laterally, and ventrally; a very small but distinct dorsomesal basal lobe with 2,3 rather large and 1 or more small bristles; a very small, knoblike mesal apical lobe bearing 2,3 small bristles. *Claspette:* see below under phallosome. *Clasper:* about as long as sidepiece; irregular in outline, with a strong mesal process in basal half which bears 4 heavy blunt spiniforms on its distal margin; shaft beyond lobe with 3,4 heavy blunt spiniforms on mesal margin, mostly near apex; integument spiculate except on dorsal surface of lobe, with numerous bristles of varying sizes on all surfaces. *Phallosome:* a pair of claspettelike lobes with short triangular spicules on ventromesal surface, developed apparently from basal pieces which also form a median ventral process between these lobes; a pair of dorsomesal processes, at the apex of which is a small median sclerite; basal plates produced into another pair of more external and dorsal processes which articulate with the parameres; paramere strongly developed, with two long free spines near anterior (dorsal) end, more interior spine slender, slightly curved caudad, the other heavier and sharply bent caudad just beyond its middle. *Proctiger:* basolateral sclerotization strong, with a long curved spine which has a heavy base and a ventral spinule; cercus in form of a heavily sclerotized spine hooked apically and bearing 3 hairs proximad of hook.

PUPA and LARVA.—Unknown.

MATERIAL EXAMINED.—2 ♀, 3 ♂.

SYSTEMATICS.—*P. harrisi* is a very distinct species. It is unique in the development of a large bursa copulatrix in the female. Its male genitalia are also distinctive, although there appear to be a few superficial similarities with those of *neozelandica.* Only 3 males and 2 females have been examined from a single locality; these show no striking variations.

BIONOMICS.—Nothing is known of the bionomics of the adults, and the immature stages have not been collected.

DISTRIBUTION (fig. 31).—*New Zealand:* North Island (Wellington). Not known elsewhere.

3. Paradixa fuscinervis (Tonnoir)

Figs. 31, 33, 34

1924. *Dixa* (*Paradixa*) *fuscinervis* Tonnoir, Canterbury Mus., Rec. 2:229–230. TYPE: holotype ♂, Nelson, South Island, New Zealand, from small rivulet, Sept. 5, 1922, A. L. Tonnoir (NELSON).

Dixa (*Paradixa*) *fuscinervis* of Edwards (1932:14); Taylor (1934:7); Nowell (1951:234).

Dixa fuscinervis of Cooper and Rapp (1944:249); Miller (1950:45).

FEMALE (fig. 34).—*Wing:* 4.4–4.7 mm. *Forefemur:* 1.7–1.9 mm. *Abdomen:* about 2.2–2.5 mm. Generally similar to *neozelandica,* from which it differs chiefly in the following respects. *Head:* clypeus yellowish apically; mouthparts yellowish; antennae more widely separated, torus dark; flagellar segment 1 about 11 times as long as broad, segment 2 about 0.6–0.66 of segment 1. *Thorax:* mesonotum variable, sometimes extensively yellow on humeral angles and laterally above paratergite; pleuron variable, sometimes with wide light stripe from base of forecoxa. *Legs:* tibiae light brown, darkened apically. *Wing* (fig. 34): membrane with a slight brownish tinge; a large conspicuous dark blotch on *r-m* extending across furcation of Rs into cell R_1 and almost touching vein R_1; veins R_1, Rs, R_{2+3} and its branches, R_{4+5}, M beyond *m-cu* and its branches, Cu and its branches, and base of 1A all margined with brown; anal angle of wing infuscated. *Haltere:* yellowish, apical portion slightly infuscated. *Genitalia:* not studied in detail, apparently very similar to *neozelandica.*

MALE.—*Wing:* 3.5–3.9 mm. *Forefemur:* 1.5–1.6 mm. Similar to female in most respects except for sexual differences as for genus.

MALE GENITALIA (fig. 33).—*Segment IX:* tergite with median lobe large and truncate apically, bristles numerous and distributed over entire surface, including lateral areas; sternite with about 7 bristles on each side, chiefly on lateral lobes but reaching almost to midline. *Sidepiece:* short and broad, less than 1.5 as long as median width, scarcely narrowed apically; uniformly and densely spiculate throughout and with rather long bristles dorsally, laterally, and ventrally; no basal lobe; a small but distinct, knoblike, mesal apical lobe bearing 1 spiniform and 3,4 small bristles; mesal surface below this lobe poorly sclerotized for about 0.5 of distance to base. *Claspette:* not developed. *Clasper:* about as long as sidepiece; irregular in outline; a strong dorsomesal lobe in basal half, bearing about 10 short blunt spiniforms, majority of which are heavy; shaft beyond lobe without short spiniforms but with a ventral mesal row of 3 specialized bristles about halfway to apex; apex narrowed into a small truncate process bearing a bristle apically; integument densely spiculate ventrally and laterally but not on dorsomesal surface; hairs and bristles of varying sizes numerous and well distributed. *Phallosome:* no claspettelike lobe; basal pieces of two sides greatly developed, ventrally forming a single median narrow process, dorsad of which is a pair of broad processes, the apical portions of which curve cephalad (in a flat preparation) and approach each other; parameres greatly developed, in form of large plates which articulate with basal plate just dorsad of posterior origin of dorsal process, dorsally (anteriorly) a very long slender strongly curved spine at level of spine of proctiger, another shorter and less curved spine arising ventrad of proctiger and curving caudad, a third still shorter spine arising from near ventral end of paramere. *Proctiger:* basolateral sclerotization with a long, slender, slightly curved spine; ventral surface lightly sclerotized; cercus in form of a very small, heavily sclerotized truncate lobe with long slender bristles on apex.

PUPA.—Unknown.

LARVA (fig. 34, after Tonnoir, 1924*b*:230).—Apparently similar to *neozelandica,* differing from it only in "the absence of the two teeth on the edge of the basal part of the lateral plates" of the spiracular apparatus (Tonnoir). This probably refers to the detached ventral teeth of the pecten, as mentioned above under *neozelandica.*

MATERIAL EXAMINED.—4 ♀, 3 ♂.

SYSTEMATICS.—*P. fuscinervis* is markedly different from the other *Paradixa* of New Zealand, not only in external characters but also in the male genitalia. Its female genitalia, however, are very similar to *neozelandica.*

The coloration of the thorax is quite variable in this species, more so perhaps than in any other form examined. The specimens from Ohakune show more extensive infuscation of the wings than the type series. This may indicate the presence of geographical races in this species, but much additional material is needed before these can be definitely recognized.

BIONOMICS.—This is the most abundant dixine in New Zealand. Its larvae can be found practically the whole year around in small rivulets with a moderate flow of water (Tonnoir, 1924*b*:229, 230).

DISTRIBUTION (fig. 31).—*New Zealand:* North Island (Wellington); South Island (Nelson, Marlborough, Westland, Canterbury). Not known elsewhere.

Genus DIXINA Enderlein

1936. *Dixina* Enderlein, Tierwelt Mitteleuropas 6(3)2(16):30. TYPE SPECIES: *Dixa obscura* Loew, 1849, Europe; monobasic.

This paradixine genus appears to be characterized by crossvein *r-m* placed before the furcation of Rs and by the presence of a filiform penis in the male genitalia. At least 3 Palaearctic species, *obscura* (Loew, 1849), *filicornis* (Edwards, 1926) and *subobscura* Takahashi, 1958, are definitely assignable to *Dixina.* The new species described below (*solomonis*) agrees with these species in the abovementioned characters in the adult stage and is therefore placed in *Dixina;* since the immature stages of the Palaearctic forms are undescribed, this assignment is provisional only. I have made no attempt to determine whether or not this genus occurs elsewhere in the world. It is possible that *Dixina* is closely related to *Dixella* Dyar Shannon, 1924 from the New World, but the type species of the latter (*lirio* Dyar Shannon, 1924) is insufficiently known. It is of interest to note that a similar type of venation is characteristic of *Nothodixa s. lat.* and that a filiform penis occurs in Patagonian and Chilean species assigned to this genus by Edwards but does not in *Nothodixa s. str.* from Australia, Tasmania, and New Zealand. All these forms, however, are dixines and have short antennae in the adult stage.

KEYS TO SPECIES

See keys to tribes and genera, p. 97

1. Dixina solomonis Belkin, n. sp.

Figs. **30, 35, 36**

TYPES.—*Holotype:* ♀ with associated larval and pupal skins and genitalia slide (JNB, 645-11), Natalia Springs, Poha River area, Guadalcanal, Solomon Islands, quiet pool in small stream, Sept. 11, 1944, J. N. Belkin (USNM, 64751). *Allotype:* ♂ with genitalia slide (JNB, 947-1001), same locality as holotype, Apr. 11, 1945, J. N. Belkin (USNM). *Paratypes:* 8♀, 1♂, 5 pupae, 32 larvae, all from same locality as holotype, as follows: 3♀, 2 pupae, 6 larvae (JNB, 645, 645-37, 56, 61), same date and collector as holotype; 1♀ (JNB, 661), Sept. 23, 1944, L. J. Lipovsky and M. Cohen; 1♀, 4 larvae (JNB, 662), Sept. 26, 1944, J. N. Belkin and M. Cohen; 3♀, 1♂, 1 pupa, 10 larvae (JNB, 863, 864), Feb. 12, 1945, J. N. Belkin *et al.;* 2 pupae, 3 larvae (JNB, 934), Apr. 1, 1945, J. N. Belkin; 9 larvae (JNB, 2039, 2045) May, 1945, J. N. Belkin.

FEMALE (fig. 35).—*Wing:* 2.0–2.5 mm. *Forefemur:* 0.8–1.0 mm. *Abdomen:* about 1.2–1.5 mm. Very small; rather uniformly brown and without wing markings; 2 or 3 strong bristles just above longitudinal suture of *stp. Head:* integument shining, brown or black with lighter areas caudad of antennae; vertex strongly produced cephalad between antennae, laterad of projection and caudolaterad of antennae a deep large pale-colored depression on each side; clypeus brown, without transverse depression at base, slightly longer than wide; mouthparts brown; maxillary palpus brown, segment 5 about 1.7 length of segment 4; antenna longer than entire body and almost as long as wing, uniformly brown; torus strongly swollen; flagellar segment 1 cylindrical, about 20 times as long as wide, segment 2 about 0.4 length of segment 1, segments 3–9 subequal to 2 and about the same diameter, segments 10–14 shorter and narrower, segment 14 about 0.5 of segment 13.

Thorax: integument rather dull; mesonotum projecting very strongly over head, variable in coloration, dark or light brown, sometimes with usual darker broad stripes, usually lighter on scutal angle and long median prescutellar streak; mesonotal bristles dark brown, acrostichals short and sparse in a single row, dorsocentrals strong, particularly caudad, about 3,4 strong anterior supraalars, 1 strong bristle caudad of scutal angle and about halfway between it and dorsocentrals, a few short humerals, other mesonotal bristles absent; scutellum light brown, darker above; scutellar bristles strong and black, in a single row, those near midline somewhat more caudal; postnotum light brown; paratergite light brown; pleuron brown, light on lower part of *ppn* and lower part of entire mesopleuron and metapleuron, darker on middle part of these sclerites; *apn* with 1,2 slender bristles on lower part; *ppn* usually with 2 long strong bristles; *stp* just above suture with 2,3 rather strong bristles; apparently no other bristles present; a small sense organ in upper part of mesothoracic spiracular depression. *Legs* (fig. **35**): coxae and trochanters light, latter somewhat infuscated; femora, tibiae, and tarsi usually uniformly brown, sometimes lighter but with apices of tibiae infuscated; apex of hindtibia only slightly swollen, a very narrow ridge of fused spicules just proximad of comb, "spur" barbed near base; claws all small, subequal, simple. *Wing* (fig. **35**): membrane with faint grayish tinge; no markings of any kind; veins light grayish brown, Cu slightly darker; vein M microsetose for more than half distance from *m-cu* to base; vein Sc ending on C just distad of origin of Rs; crossvein *h* slightly proximad of prearculus; *r-m* arising about 1.5 of its own length basad of furcation of Rs and slightly less than own length basad of *m-cu;* basal part of Rs absolutely straight, distal part forming an angle of about 120° with basal at *r-m*; vein R_{2+3} moderately arched, mostly at base, its length about 0.66 of vein R_2; vein M beyond *m-cu* about 1.4 length of M_{1+2}, which is distinctly curved; basal portion of Cu_1 proximad of *m-cu* about equal to *m-cu* and strongly pulled cephalad, distal portion only slightly curved and ending on margin distinctly before cell M_2; cell R_2 slightly narrowed at apex, its base nearer to wing base than that of cell M_2. *Haltere:* variable in color, base always light, dorsal surface of middle portion and apex dark, ventral surface light for variable distance from base. *Abdomen:* tergites blackish brown, sternites lighter. *Genitalia* (fig. **35**): tergite IX short, poorly sclerotized, and with small lateral lobe; sternite IX articulating with a narrow projection from lateral lobe of tergite IX; postgenital plate with a definite but poorly sclerotized median plate, which is sharply pointed apically.

MALE.—*Wing:* about 2.1 mm. *Forefemur:* about 0.8 mm. In general very similar to female except for sexual differences; claws on all legs small, subequal, and apparently simple; base of hindtarsal segment 1 without specialized seta.

MALE GENITALIA (fig. **35**).—*Segment VIII:* tergite about half as long as that of VII; sternite about as long as that of VII. *Segment IX:* tergite poorly sclerotized, separated from sternite by membrane, restricted to middle of dorsal surface, strongly curved on caudal margin and appearing as a median lobe, with long slender bristles on apex and in a band across from side to side at about one-third from base; sternite poorly sclerotized, larger than tergite, and with conspicuous dorsolateral lobe, to which the long slender bristles are restricted. *Sidepiece:* short and broad, length about 1.5 median width; uniformly and densely spiculate throughout and with slender bristles of varied sizes dorsally, laterally, and ventrally, a patch on ventral mesal surface subapically; a conspicuous long, slender, bare fingerlike submedian tergal process extending beyond apex of sidepiece; a very small knoblike lobe on mesal surface mesad of fingerlike process, bearing 2 slender hairs on apex. *Clasper:* about as long as sidepiece, regular in outline, strongly narrowed apically and ending in a slender, slightly curved, smooth, bluntly rounded, spinelike process; uniformly long-spiculate and with numerous short hairs. *Phallosome:* detailed structure difficult to see; apparently covered by a simple membrane; dorsally a broad, short, median sclerotized striated curtainlike membrane; laterad from each side of this a capitate process leading back to basal piece and curving ventromesad to join or form another slender curving sclerotization, which unites with its mate from the other side to form a large median ventral plate which narrows gradually as it projects cephalad into body and is continuous with a long very slender penis filament which recurves caudad in about the basal third of segment VIII; in about the middle of segment VIII the penis filament is constricted, caudad of this constriction it is covered with retrorse spinules; at level of dorsal striated membrane the penis filament loses the spinules and becomes split into 3 very slender, whiplike filaments which curve back cephalad and become greatly attenuated, this portion is difficult to follow but is apparently as long as the spiculate portion; other sclerotizations also present, probably including parameres, but impossible to identify in available mounts. *Proctiger:* largely unsclerotized and difficult to see; cercus represented by a large lobe with hairlike spicules topped by an area bearing about 8 very small blisterlike processes, each bearing a tiny hairlike process; membrane ventrad of cercus with a few very small, short triangular spicules; basolateral sclerotization not discernible in mounts.

PUPA (fig. **35**).—*Abdomen* (to end of segment VIII): 2.0–3.0 mm. *Trumpet:* 0.3–0.4 mm. *Paddle* (including segment IX): 0.58–0.7 mm.; smaller measurements in all instances refer to male. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly and moderately pigmented throughout, venation pattern indicated on wing case; dorsal surface strongly spiculate; all hairs single, small, darkly pigmented; hair 7-C arising from tubercle. *Trumpet:* index about 7.0; basal half blackish, apical light yellowish brown; internal trachea extending to 0.7, where it is constricted and then forms the funnellike inner wall with internal projections; external surface tracheoid in basal half where pigmentation is darker, reticulospiculate in apical half; apical fourth gradually widened; opening slightly oblique, its margin regularly crenulate. *Abdomen:* uniformly and lightly pigmented; integument with extensive spiculation; sclerotization very weak; hairs on all segments short and unbranched, moderately well pigmented; relative position, length, and degree of development as figured; dorsal sensillum present laterad of hair 3 on segments II-VII; spiracular sensilla present on I-VII. *Paddle:* external and internal margins serrate. *Male:* genital lobe split completely to apex of sternite IX. *Female:* genital and anal lobes not distinctly separated, only slightly cleft apically.

LARVA (fig. 36).—*Head:* 0.35–0.43 mm. *Posterolateral Lobe* (dorsally from hair 13-S to extreme apex): 0.25–0.30 mm. *Anal Segment* (dorsally from basal membrane to extreme apex): 0.10–0.12 mm.; in all instances the smaller figures refer to males. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* slightly longer than wide; pigmentation variable from moderate yellowish brown except for blackish incomplete collar to strongly blackish brown on entire dorsal surface; sculpturing indistinct; hair pigmentation light; hairs 2,3-C flattened, 2-C slightly longer than mouthbrushes, 3-C about one-third of hair 2; all hairs single except 11-C which is 2,3b near tip, 14-C which is 3,4b, and 15-C which is multiple. *Antenna:* slightly less than 0.5 of head capsule; uniformly pigmented, darker than head capsule; dorsal surface without distinct spicules; ventral surface in basal half with elongate triangular spinules, ventromesal surface in distal 0.67 with long, conspicuous hairlike spicules which become longer distally; hair 1-A single, simple, inserted just before the middle of shaft. *Thorax:* integument uniformly and densely long-spiculate, spicules hairlike, simple; long hairs darkly pigmented and with more or less distinct small, individual basal tubercles; smaller hairs poorly pigmented and without tubercles; all hairs single and simple; hairs 4-7,9-12,14-P all long, majority almost twice as long as head capsule; hairs 2,3-P,4,8,14-M and 4,8,10,13-T moderate; all other hairs small or minute, 9-12-M,T with a nonspiculate common basal area. *Abdomen:* integument in general as on thorax; prolegs present on I,II, their spines in 3 rows, those of outer row more slender and less heavily pigmented; spines present on sternites V-VII, in 2 rows, anterior heavier, a slight median sclerotization on midline between the submedian groups; relative position, length, and degree of development of hairs as figured; majority of hairs small, single, and simple, hair 0 usually 2b; hairs 11,12-VI,VII shorter than following segment; hair 4-VIII not reaching to apex of posterolateral lobe. *Spiracular Apparatus:* distance between inner margins of spiracles about 0.56 that between bases of hair 13-S; anterior median lobe with a large median horseshoe-shaped sclerotization with long caudal lobe extending to level of posterior border of spiracles, hair 3-S on each anterior process of this sclerotization, hairs 4,5-S laterad and with common small basal sclerotization, hair 5-S with a few weak branches; anterolateral lobe small, rounded apically, and with poorly sclerotized area dorsally leading in from hair 7-S; free portion of posterolateral lobe relatively short, rounded apically, with a small ventral bidentate toothlike process scarcely extending beyond apex, index (length from base of hair 13-S to apex: median width, on dorsal surface) about 3.6, hair 13-S about as long as free portion of lobe; median plate strongly sclerotized, continuous laterally with sclerotization of basal sessile portion of posterolateral lobe, caudal border of median plate with marginal hairlike spicules about half as long as length of plate; pecten with 12–14 teeth, each bearing 1,2 pairs of basal denticles, no enlarged detached ventral spines; hair 1-S with 2,3 branches. *Anal Segment:* saddle irregular, sparsely spiculate; unsclerotized integument long-spiculate; caudal process long-spiculate on ventral surface; hairs 1-3-X usually with barbs; hairs 4-X simple; gills subequal, slender; supraanal spicules about half as long as caudal process.

MATERIAL EXAMINED.—57 specimens; 9 ♀; 2 ♂; 6 pupae; 40 larvae; 1 individual rearing (larval).

SYSTEMATICS.—There is no question that *solomonis* is a paradixine, since the adults have the basal flagellar segment long and more or less cylindrical, the female genitalia have a lobe on tergite IX, and the larva lacks rosettes of branched spinules on the abdominal segments and has long prothoracic sternal hairs and slender hairlike spicules on the ventromesal surface of the antenna. This species differs most strikingly from typical *Paradixa* in the adults in the following characters: *r-m* placed a considerable distance before furcation of Rs; *stp* with 2,3 strong bristles above transverse suture; and a long filiform penis filament and claws all simple in the male. I believe that these characters are sufficiently important to place *solomonis* in a genus distinct from *Paradixa.* I am placing it provisionally in *Dixina,* the type species of which (*obscura*) is a paradixine, which agrees with *solomonis* in the filamentous aedeagus and in the position of crossvein *r-m.*

There is considerable variation in size and coloration, as is usual with dixa midges. The males are considerably smaller than the females, particularly so in the larval and pupal stages. The male pupae are so much smaller that superficially they appear to belong to a different species. The larvae show 2 color phases, one with a light yellowish body and lightly pigmented head capsule and the other with a dark brown or blackish body and very dark head capsule. These differences are not sexual.

BIONOMICS.—The immature stages of *solomonis* have been collected in slowly flowing small creeks, spring seepages, and stream bed and rock-hole pools, usually in dense shade. They are found in the typical paradixine attitude on the margins of these bodies of water or on vegetation and flotage in the pools. In association with them, I have collected *Bironella hollandi, Anopheles solomonis, A. nataliae,* and several species of *Culex* (*Lophoceraomyia*).

DISTRIBUTION (fig. 30).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

SUBFAMILY CULICINAE

The True Mosquitoes

ADULTS.—Mouthparts developed into a proboscis; head, thorax, legs, and wings with scales, abdomen usually with scales. *Head:* eyes above antennae contiguous or narrowly separated, inner anterior margin always strongly emarginate around antennal base; vertex and occiput with scales; clypeus short, always shorter than head capsule, usually bare, rarely scaled; mouthparts long, labium and labella developed into a porrect or recurved proboscis which is always longer than head capsule; maxillary palpus porrect, not incurved at rest, 1- to 5-segmented; antenna with scape usually poorly developed, without bristles but rarely with scales; torus (pedicel) moderately to strongly swollen, particularly in males, usually with basal flagellar segment deeply inserted; flagellum always 13-segmented, all segments usually with differentiated whorls of bristles, usually strongly plumose in males. *Thorax:* anterior pronotal lobes (*apn*) always narrowly connected; prealar sclerite usually indistinctly separated from sternopleuron; meron always distinctly separated; scutellum evenly rounded or more frequently more or less trilobed; mesonotal bristles and/or scales usually numerous and strongly developed; pleural bristles and/or scales usually strongly developed; upper anterior part of mesospiracular depression without sense organ but sometimes with setae. *Legs:* femora, tibiae, and tarsi always covered with broad scales, usually completely, and usually with rows of specialized setae; apical or subapical tibial "spurs" or combs developed; claws generally without spicules or hairs at base, with or without teeth in both sexes; pulvilli rarely well developed (*Culex*), usually rudimentary. *Wing:* membrane with uniform microtrichia, either distinct or very small; veins with distinct scales, usually decumbent (squame) and outstanding (plume); posterior border of wing with a fringe of plume scales of different lengths marginally and of squame scales on upper and lower surfaces; alula usually with marginal and/or dorsal scales, rarely bare; upper calypter (squama) with or without a marginal row of bristles or bristlelike scales; lower calypter bare; costal margin as strong basad of crossvein *h* as distad of it; vein Sc connected to R by prearculus basad of humeral crossvein and by another crossvein before separation of Rs from R_1; Sc ending on C distinctly distad of separation of Rs from R_1; Rs curved or transverse at base, then longitudinal, sometimes with a more or less distinct longitudinal basal spur; R_{2+3} in line with Rs, not distinctly arched; R_{4+5} transverse at base, sometimes with a basal spur. *Haltere:* not winglike, with basal bare stem and swollen distal knob which is covered with small broad scales. *Abdomen:* tergites and sternites usually largely covered with scales (except Anophelini), bristles usually numerous, particularly in male; spiracles present on II-VII. *Sexual Dimorphism:* usually marked; females usually with palpus shortened and antennal flagellum not plumose; males usually with palpus elongate, antennal flagellum plumose, and some of the claws enlarged, but exceptions numerous.

FEMALE GENITALIA.—*Segment VIII:* well developed, often partially retracted; sternite (subgenital plate) frequently with special features. *Segment IX:* highly modified, not studied in detail for most species; tergite variable in development; sternite forming the posterior cowl. *Genital Atrium:* usually complex, with 1 or more sclerotizations between the cowl and sternite VIII. *Proctiger:* variously developed; tergite usually poorly developed; sternite apparently forming the postgenital plate, which is characteristically modified in many groups; cercus strongly developed and highly modified. *Spermatheca:* usually 3, one smaller than the others, reduced to 2 or even 1 in some forms. *Bursa Copulatrix:* not developed.

MALE GENITALIA.—Always inverted beyond segment VII. *Segment VIII:* usually more or less modified, narrowed, shortened, constricted, or retracted. *Segment IX:* strongly modified; tergite varied, with or without bristles, latter usually restricted to distal or lateral part; sternite with bristles and/or scales, if present, restricted to distal part. *Sidepiece:* variously developed, often with lobes. *Clasper:* variously developed, usually with a spiniform. *Phallosome:* more or less complex; never joined by sclerite to or articulating with sternomesal margin of sidepiece; always with a distinct, more or less complex aedeagus, 1 or 2 pairs of parameres and a basal piece joined to or articulating with the mesal tergal angle of sidepiece. *Proctiger:* variously developed; usually with cercal setae.

PUPAE.—*Cephalothorax:* 9 pairs of hairs usually present. *Trumpet:* variable in position, usually not located on distinct tubercle; spiracular closing mechanism within body of cephalothorax, but a trachealike tube extends a variable distance into body of trumpet and forms its inner wall, which distally is provided with complex spicules or "cells" which appear to close the lumen of the trumpet; apex of trumpet wide or rarely narrowed. *Metanotum:* with a small haltere case; 3 pairs of hairs (10-12-C) always present. *Abdomen:* usually long and slender, strongly curved under cephalothorax; segments usually well sclerotized and with distinct lateral borders, often distinct intersegmental sclerites developed; tergites without submedian transverse ridges; segments I-VII with a spiracular sensillum; segments III-V generally with a dorsal sensillum; segment I generally with hair 1 developed as a large float hair with numerous dendritic branches, usually inserted mesad of a large membranous area, hairs 2-7,9-I dorsal and inserted near anterior border, hairs 10,11-I frequently present, ventral in position, hair 11 variable in size and lateral, 10 small, usually peglike and mesal, other hairs absent; segment II often with reduced chaetotaxy, hairs 8,10,11,14-II often not developed, hair 7 often dorsal in position; segments III-VII usually with complete complement of hairs 0,1-11,14. *Terminal Segments:* segment VIII usually with 4 pairs of hairs (0,4,9,14); tergite IX represented by a median lobe between paddles, hair 1-IX sometimes developed; a more or less distinct cercal lobe usually present, rarely with hair 1-X. *Paddle:* variously developed but always movable at base, generally with a distinct midrib and more or less distinct basal external buttress, with or without marginal fringe of spicules or denticles; hair 1-P and sometimes 2-P developed, sometimes both absent. *Females:* anal lobe single, only slightly cleft apically, usually extending only a short distance; cercal lobes generally distinct. *Males:* anal lobe consisting of a pair of lateral well-separated lobes, containing the developing sidepieces and extending a considerable distance caudad, and a more dorsal median lobe representing the phallosome and proctiger; cercal areas indistinct.

LARVAE.—*Head:* variable in size and shape; posterior tentorial pits usually small, variable in position, but never on dorsal surface; always with distinct mouthbrushes; maxillary sutures present or absent; mental plate usually present and toothed, rarely absent; cephalic border of labial plate usually not toothed; maxillary palpus variable; head capsule generally with 16 pairs of hairs but hair 2 often undeveloped and 0 difficult to see; sometimes with 2 pairs of spicules probably representing 2 additional hairs (16,17-C), possibly homologs of cervical hairs of Dixinae. *Antenna:* never prehensible; not segmented but occasionally with one or more joints beyond hairs 2,3-A. *Thorax:* segments compacted into a single mass wider than the abdomen; mesothoracic and metathoracic spiracular sensilla usually both present; hairs 9-12-P,M,T present, usually on common tubercles, hair 11 often very weak and difficult to see; prothorax with 15 pairs of hairs (0-14), often hair 13 not developed; mesothorax with 14 pairs of hairs (1-14); metathorax with 13 pairs of hairs (1-13). *Abdomen:* prolegs and spines absent; integument apparently smooth or more rarely distinctly spiculate; spiracular sensilla usually present on I-VII; dorsal sensillum usually present on III-V; segment I with hairs 0 and 8 not developed and frequently also with hair 12 also missing, otherwise with same chaetotaxy as others; segments II-VII generally with 15 pairs of hairs (0-14); segments I,II often with hair 14 not developed. *Segment VIII:* 7 pairs of hairs present (0,1-5,14); comb of spines usually present, absent in instars 2-4 in Anophelini. *Spiracular Apparatus:* sessile in Anophelini and on a siphon in all others; pecten teeth usually present, sometimes absent; spiracular valves usually well developed; anterior (dorsal) median valve with 3 pairs of minute hairs (3-5-S), one hair usually not developed; a pair of dorsolateral valves with hairs 6,7-S; a pair of ventrolateral valves with hairs 8-13-S; valves without spicules except on inner margins. *Segment IX:* never distinct. *Anal Segment:* more or less cylindrical; caudal process represented by basal tubercle of hairs 2,3-X; saddle variously developed, sometimes with small basal acus; supraanal spicules not developed; usually hair 1-X laterally on segment; accessory hairs (*x,y,z*) not developed except in some *Mansonia* and *Uranotaenia;* ventral brush (4-X) usually well developed, sometimes reduced or even absent; gills generally distinct and protruding; no ventral anal apparatus.

EGGS.—Variously developed; laid singly or in masses, free or attached to various objects, on water or outside of water; with or without diapause; undescribed for most species.

SYSTEMATICS.—The Culicinae, comprising the true mosquitoes, are sharply differentiated from the Dixinae and Chaoborinae only by the development of the proboscis in the adults. On the other hand, these 3 groups have in common other striking characters, such as the wing venation of the adults and the chaetotaxy of the immature stages. There is also strong indication of merging of both dixine and chaoborine characters in various groups of the Culicinae. Therefore, I regard these groups as forming 3 subfamilies of the Culicidae.

It has been customary to follow Edwards (1932) in recognizing only 3 tribes in the Culicinae: the Anophelini, the Toxorhynchitini (Megarhinini), and the Culicini. While admittedly the Anophelini and Toxorhynchitini are very distinct groups, this classification more or less assumes that the remaining mosquito genera are of monophyletic origin. This, I believe, is very far from being true. I am recognizing here a total of 12 coördinate groups or tribes within the subfamily. In the list below, an attempt is made to show relationships both for the tribes and for the genera within a tribe by placing the more generalized forms centrally and by having the more specialized and annectent forms radiate in both directions, usually in several lines, from the center. Thus adjacent tribes or genera are not necessarily derived from one another, and the list is not to be taken as a linear arrangement of progressive derivation. All the generally recognized genera of the Culicinae are included for the sake of completeness, but it is very likely that many of them will have to be rearranged in the future. The tribes and genera represented by indigenous species in the South Pacific are marked by an asterisk (*), the widespread ones are followed by (W), those restricted to the Old World by (O), and those restricted to the New World by (N).

*ANOPHELINI (W): *1. *Bironella* (O), *2. *Anopheles* (W), 3. *Chagasia* (N).
*URANOTAENIINI (W): *4. *Uranotaenia* (W).
*CULICINI (W): *5. *Culex* (W), 6. *Deinocerites* (N).
*AEDEOMYIINI (W): *7. *Aedeomyia* (W).
*HODGESIINI (O): *8. *Hodgesia* (O).
*CULISETINI (W): *9. *Culiseta* (W).
*FICALBIINI (O): *10. *Ficalbia* (O).
*MANSONIINI (W): *11. *Mansonia* (W).
ORTHOPODOMYIINI (W): 12. *Orthopodomyia* (W).
*AEDINI (W): *13. *Opifex* (O), 14. *Eretmapodites* (O), 15. *Zeugnomyia* (O), 16. *Udaya* (O), 17. *Ayurakitia* (O), *18. *Armigeres* (O), 19. *Heizmannia* (O), *20. *Aedes* (W), 21. *Haemagogus* (N), 22. *Psorophora* (N).
*SABETHINI (W): *23. *Malaya* (O), 24. *Topomyia* (O), *25. *Maorigoeldia* (O), *26. *Tripteroides* (O), 27. *Trichoprosopon* (N), 28. *Phoniomyia* (N), 29. *Wyeomyia* (N), 30. *Limatus* (N), 31. *Sabethes* (N).
TOXORHYNCHITINI (W): 32. *Toxorhynchites* (W).

In the South Pacific, 10 of the 12 tribes are represented by indigenous species and, in addition, the Toxorhynchitini have been introduced. Of the 23 genera (9 widespread and 14 restricted) occurring in the Old World, 15 occur naturally in the South Pacific and *Toxorhynchites* has been introduced; only the widespread *Orthopodomyia*, the Ethiopian *Eretmapodites*, and the Oriental or Indomalayan *Zeugnomyia, Udaya, Ayurakitia, Heizmannia,* and *Topomyia* are not represented.

BIONOMICS.—The immature stages of the Culicinae occupy the whole spectrum of aquatic environments utilized by the family. The majority of larvae feed on microörganisms and suspended matter, which they sweep from the water by means of the filamentous mouthbrushes. In several of the tribes, there are strictly predaceous forms which feed largely on the larvae and pupae of other mosquitoes, which they capture with thickened mouthbrushes or specially developed mandibles or maxillae. When food is scarce or crowding occurs, some forms resort to scavenging or cannibalism. It is possible to rear some forms on filtrates containing organic matter (Hinman, 1930). The immature stages of most Culicinae obtain their oxygen directly from the atmosphere by coming to the water surface from time to time. All species of *Mansonia* and some species of *Ficalbia* obtain their oxygen from the air vessels of aquatic plants, which they pierce with the specialized tips of the larval siphon or pupal trumpets. *Aedeomyia* species apparently use their antennae for respiration. Several species of Culicinae have the anal gills or papillae greatly enlarged and provided with large tracheae while these are greatly reduced in the siphon; such species seldom, if ever, come to the surface and undoubtedly obtain their oxygen from the water. While free water in the habitat is essential for completion of the life cycle, the larvae and pupae of many species are capable of surviving more or less prolonged periods out of water. In addition, many forms, particularly *Aedes* species, have diapausing eggs which are resistant to desiccation and enable the species to survive unfavorable environmental conditions.

Female Culicinae are the only bloodsucking mosquitoes. It should not be assumed, however, that all species require a blood meal for the formation of eggs. Females of many species apparently never take a blood meal, judging from the fact that they are never found to contain any trace of blood in the gut. At least some of the dominant species which are normally bloodsucking may produce viable eggs without a blood meal; this phenomenon of autogeny appears to be an adaptation to survival under unfavorable conditions and is probably much more prevalent than is recognized at present. A great deal of variation exists as to host specificity for the blood meal, but apparently only terrestrial vertebrates are normally used, although fish and even insects have been reported as occasional hosts (Horsfall, 1955:25). Relatively few forms attack man; others may feed on other mammals, on birds, reptiles, and amphibians, with varying degrees of preference. In general, it appears that the more primitive forms take no blood or feed on cold-blooded vertebrates, but undoubtedly secondary adaptations confuse this generalization. It is generally assumed, on the basis of only a few observations, that both males and females feed on plant juices: nectar, honeydew, fruits, and various exudations. The time of activity is usually quite specific for most forms both as regards mating and feeding; the remainder of the time is spent in favorable protected places. Some species are largely nocturnal or crepuscular in activity, others are diurnal.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—The Culicinae are the only mosquitoes which are vectors of human and animal pathogens. The list of diseases transmitted by mosquitoes is a very large one and the range of the etiological agents very wide, from viruses to filarial worms. In addition, the Culicinae are of great economic importance as bloodsucking pests.

Mosquito-borne diseases of the South Pacific are discussed in some detail in the section on Disease Relations and Economic Importance in the General Considerations. Mention is made of the specific disease relations and economic importance under the various tribes, genera, and species.

DISTRIBUTION.—The subfamily is the dominant group of the Culicidae and is found practically throughout the world, although it has by far the largest number of species restricted to the tropical regions. In the South Pacific it includes the bulk of species of mosquitoes, is found throughout the area, and is represented by indigenous species as far east as the Marquesas and the Society Islands.

KEYS TO TRIBES AND GENERA

(South Pacific only)

(Keys to subfamilies, pp. 90–91)

ADULTS

1. Abdominal tergites II-VI largely without scales 2
Abdominal tergites II-VI always with numerous scales, usually completely covered with scales 3

ANOPHELINI, p. 123

2(1). Veins R $_{4+5}$, M, and Cu$_1$ beyond *m-cu* all or some more or less distinctly sinuate .... BIRONELLA
Veins R$_{4+5}$, M, and Cu$_1$ all evenly curved .... ANOPHELES

TOXORHYNCHITINI, p. 527

3(1). Apical half of labium sharply recurved caudad ventrally and conspicuously more slender than basal half; posterior margin of scutellum evenly rounded ... TOXORHYNCHITES
Apical half of labium not sharply recurved caudad ventrally and more or less subequal in width to basal half, sometimes swollen or slightly narrower; posterior margin of scutellum more or less distinctly trilobed 4

URANOTAENIINI, p. 152

4(3). Cell R$_2$ always shorter than vein R$_{2+3}$; wing membrane without distinct microtrichia .... URANOTAENIA
Cell R$_2$ always at least as long as vein R$_{2+3}$; wing membrane with distinct microtrichia 5

5(4). Spiracular bristles or scales always present 6
Spiracular bristles and scales absent 9

CULISETINI, p. 282

6(5). Vein Sc with several conspicuous bristles at base ventrally (1. *tonnoiri*) .... CULISETA
Vein Sc without bristles at base ventrally 7

SABETHINI, p. 485

7(6). Labium with long hairs, apical part swollen and bent dorsad .... MALAYA
Labium without long hairs, apical portion not swollen and not bent dorsad 8

8(7). Acrostichal bristles present .. MAORIGOELDIA
Acrostichal bristles absent .. TRIPTEROIDES

AEDEOMYIINI, p. 273

9(5). Flagellar segments 12 and 13 relatively short and thick in both sexes (1. *catasticta*) .... AEDEOMYIA

Flagellar segments 12 and 13 normal, more or less elongate 10

HODGESIINI, p. 278

10(9). Dorsal plume scales of wing veins forked apically (1. *solomonis*) .... HODGESIA

Dorsal plume scales of wing veins rounded or pointed apically or not developed 11

11(10). Postspiracular bristles usually absent 12

Postspiracular bristles usually present .. 14

FICALBIINI, p. 287

12(11). Labium more or less distinctly swollen distally .... FICALBIA

Labium not distinctly swollen distally ... 13

CULICINI, p. 177

13(12). Claws of hindleg very small and inconspicuous; all pretarsi with more or less distinct spiculose pulvillus below each claw .... CULEX

MANSONIINI, p. 299

Claws of hindleg quite large and conspicuous; all pretarsi without pulvilli .... MANSONIA (COQUILLETTIDIA)

14(11). Dorsal wing scales very numerous, all broad and strongly asymmetrical .... MANSONIA (MANSONIOIDES)

Dorsal wing scales varied, if broad then not strongly asymmetrical 15

AEDINI, p. 317

15(14). Vein Sc with numerous hairs at base ventrally .... OPIFEX

Vein Sc without hairs at base ventrally 16

16(15). Clypeus with large patch of scales *and* mesonotum without lyre-shaped markings .... ARMIGERES

Clypeus without scales *or* when with scales (*aegypti*), with lyre-shaped markings on mesonotum .... AEDES

MALE GENITALIA

(*Culiseta* not included)

CULICINI, p. 177

1. Proctiger strongly developed, paraproct with a transverse crown of numerous apical spines, denticles, or spicules, nearly always more than 6 and usually very conspicuous; sidepiece with subapical lobe bearing specialized setae, clasper inserted in a vertical plane; phallosome usually complex .... CULEX

Proctiger variously developed, paraproct if distinct usually with not more than 5 spines projecting tergally; sidepiece without such a subapical lobe; clasper inserted in a horizontal or oblique plane; phallosome usually simple 2

2(1). Proctiger nearly completely membranous, without distinct paraproct 3

Proctiger with distinct sclerotizations, paraproct distinct and usually ending in a more or less sharp point or 1-5 spines, sometimes rounded apically 7

3(2). Aedeagus long and cylindrical except at base, apex with leaflets or a pair of long recurved forked slender processes 4

Aedeagus varied but never with apical leaflets or long recurved forked slender processes 5

ANOPHELINI, p. 123

4(3). Apex of aedeagus with leaflets; claspette short, simple, and with club-shaped fused setae .... ANOPHELES

Apex of aedeagus with long recurved forked slender process; claspette long and with complex processes and lobes and without club-shaped fused setae .... BIRONELLA

AEDEOMYIINI, p. 273

5(3). Spiniform of clasper pectinate (1. *catasticta*) .... AEDEOMYIA

Spiniform of clasper never pectinate, sometimes absent 6

URANOTAENIINI, p. 152

6(5). Clasper with distinct spiniform; aedeagus not surrounded tergally by folded membrane (URANOTAENIINI) .... URANOTAENIA

Clasper without spiniform; aedeagus surrounded tergally by folded membrane (AEDINI in part, see also couplet 14) .... AEDES (VERRALLINA)

HODGESIINI, p. 278

7(2). Caudal membrane of tergite VIII with a well-differentiated median sclerite bearing short broad spicules (1. *solomonis*) .. HODGESIA

Caudal membrane of tergite VIII without a distinct median sclerite 8

TOXORHYNCHITINI, p. 527

8(7). Segments VII and VIII with dense lateral tufts of long linear scales; tergite IX long, undivided, and with bristles restricted to sides . . . . TOXORHYNCHITES

Segments VII and VIII without dense lateral tufts of long linear scales; tergite IX varied but never long, undivided and with bristles restricted to sides 9

9(8). Sidepiece always simple and conical, sclerotized on mesal surface as elsewhere, at most with only a basal mesal lobe bearing several strong bristles, no distinct claspette, apical, or other lobes or specialized setae or scales; clasper long, simple, and with 1 distinct apical or subapical spiniform; paraproct with at least 1 distinct sharp apical spine, cercal bristles all subequal 10

Without this combination of characters: sidepiece with more or less distinct membranous area on mesal surface, usually strongly modified, with claspette, lobes, or specialized setae or scales; *or* clasper irregular, without any spiniform or with several spiniforms; *or* paraproct without distinct apical spine or cercal bristles of 2 types 13

FICALBIINI, p. 287

10(9). Tergite IX poorly developed, lobes not connected by distinct sclerotized bridge . . . . FICALBIA

Tergite IX strongly developed, lobes connected by distinct sclerotized bridge or continuous across midline 11

SABETHINI, p. 485

11(10). Phallosome complex; aedeagus surrounded tergally and laterally by distinct sclerotizations . . . . MAORIGOELDIA

Phallosome simple; aedeagus not surrounded by distinct sclerotizations 12

12(11). Aedeagus broad and broadly emarginate on apex in tergal aspect; sidepiece with 1,2 thickened bristles on mesal area distad of basal mesal bristles . . . . MALAYA

Aedeagus narrowed or produced apically and without broad apical emargination; sidepiece without thickened bristles on mesal area distad of basal mesal bristles . . . . TRIPTEROIDES

MANSONIINI, p. 299

13(9). Paraproct with at least 3 distinct spines . . . . MANSONIA

Paraproct usually with at most 1 distinct spine (AEDINI, see also couplet 6) 14

AEDINI, p. 317

14(13). Cercal setae of 2 types, short distally, long proximally . . . . OPIFEX

Cercal setae all subsequal or absent 15

15(14). Clasper with a regular comblike inner apical row of spiniforms . . . . ARMIGERES

Clasper usually with 1 or no spiniforms, if more than 1 present then not in a regular comblike row . . . . AEDES

PUPAE

(*Culiseta* not included)

1. Hair 9-IV-VII at or very near caudolateral angle of tergite, usually distinctly spiniform 2

Hair 9-IV-VII varied in position but always removed from caudolateral angle of tergite, sometimes spiniform but never on all segments 4

AEDEOMYIINI, p. 273

2(1). Paddle deeply cleft at apex of midrib and with 1 long heavy hair; trumpet not divided to near base (1. *catasticta*) . . . . AEDEOMYIA

Paddle rounded or slightly emarginate at apex of midrib, with 2 short hairs; trumpet divided to near base 3

ANOPHELINI, p. 123

3(2). Hair 3-VI laterad or at level of hair 1; sternites III-VII without distinct sublateral oblique ridges . . . . BIRONELLA

Hair 3-VI distinctly mesad of hair 1; sternites III-VII with more or less distinct sublateral oblique ridges . . . . ANOPHELES

MANSONIINI, p. 299

4(1). Hair 4-C absent, all cephalothoracic hairs very small; trumpet without pinna, apex specialized for piercing plant tissues . . MANSONIA

Hair 4-C always present, some of the cephalothoracic hairs usually moderately to very strongly developed; trumpet rarely without pinna (some FICALBIA) 5

TOXORHYNCHITINI, p. 527

5(4). Anal segment with conspicuous branched cercal hair (1-X) . . . . . TOXORHYNCHITES

Anal segment without any cercal hair (1-X) 6

HODGESIINI, p. 278

6(5). Trumpet without meatus, composed of 2 unequal parts separated to the base (1. *solomonis*) . . . . HODGESIA

Trumpet with cylindrical or conical meatus 7

7(6). Hair 6-C thickened, heavy, single, usually much stronger and larger than 7-C 8

Hair 6-C weak, single or branched, usually distinctly weaker and shorter than 7-C . . . 9

URANOTAENIINI, p. 152, and FICALBIINI, p. 287

8(7). Hair 1-IX strongly developed, usually at least half of length of tergite IX; paddle broad, inner part usually wider than outer . . . . URANOTAENIA

Hair 1-IX not developed; paddle usually narrow to very narrow, inner and outer parts subequal in width (trumpet without distinct pinna in subgenus MIMOMYIA) . . . . FICALBIA

9(7). Hairs 9-VII,VIII subequal, both large and with numerous branches *and* paddle small and without hairs *and* hair 1-IX not developed 10

Hairs 9-VII,VIII varied but rarely as above; when 9-VII with numerous branches and subequal to 9-VIII, then paddle long and usually with at least 1 hair *or* hair 1-IX present 12

SABETHINI, p. 485

10(9). Hair 2-III-V removed cephalad of caudal border of tergite . . . . TRIPTEROIDES

Hair 2-III-V on posterior border mesad of hair 1 11

11(10). Hair 6-VII cephalad of hair 9 and thickened; paddle without midrib or apical process . . . . MALAYA

Hair 6-VII caudomesad of hair 9 and weak; paddle with midrib and distinct apical process . . . . MAORIGOELDIA

CULICINI, p. 177

12(9). Hair 9-VIII usually removed distinctly cephalad from caudolateral angle on sternal surface; if rarely at angle then trumpet very long and narrow or the following; paddle often with both hairs 1,2-P present; hair 1-IX usually present, always a simple bristle . . . . CULEX

Hair 9-VIII usually at caudolateral angle; paddle with only hair 1-P present; hair 1-IX when present irregular 13

AEDINI, p. 317

13(12). Hair 9-VII ventral in position, simple, short, similar to 9-II-V; middorsal ridge of cephalothorax very prominent; trumpet about as broad as long . . . . OPIFEX

Hair 9-VII dorsal in position, markedly different from 9-II-V; middorsal ridge of cephalothorax normal; trumpet length at least 1.5 of maximum width 14

14(13). Paddle margins with long fringe of filamentous spicules *and* hair 4-VIII short, multiple . . . . ARMIGERES

Paddle margins varied, when with long fringe of filamentous spicules then hair 4-VIII long, single to triple . . . . AEDES

LARVAE

1. Siphon not developed; abdominal hair 1 distinctly palmate on at least II-VII 2

Siphon distinct; abdominal hair 1 never palmate 3

ANOPHELINI, p. 123

2(1). Inner clypeals (2-C) close together; hair 1-M palmate . . . . BIRONELLA

Inner clypeals (2-C) widely spaced; hair 1-M plumose . . . . ANOPHELES

MANSONIINI, p. 299

3(1). Median dorsal valve of siphon very long, fixed, and with serrated dorsal margin . . . . MANSONIA

Median dorsal valve of siphon short, movable, and never with serrated inner dorsal margin 4

4(3). Siphon with accessory ventrolateral or ventral hairs (1a-S) and sometimes with accessory dorsolateral hairs (2a-S) in addition to usual hairs 1,2-S; sometimes all these hairs short and difficult to see, then siphon very long 5

Siphon with a single pair of subventral (1-S) and subdorsal (2-S) hairs; usually both distinct, rarely 1-S indistinct, then siphon only moderately long 9

5(4). Siphon always with a distinct attached acus at base laterally; head hair 3-C always dorsal in position, when rarely absent, 2-C dorsal; hair 13-P always absent 6

Siphon without acus; head hair 3-C always ventral in position; hair 13-P always developed 7

CULICINI, p. 177, and CULISETINI, p. 282

6(5). Siphon with 1 pair of differentiated subventral hairs (1-S) at extreme base (1. *tonnoiri*) . . . . CULISETA

Siphon without a differentiated pair of subventral pairs at extreme base . . . . CULEX

SABETHINI, p. 485

7(5). Hairs 5,6-P both very large and multiple . . . . MALAYA

Hairs 5,6-P never both large and multiple, usually both single or only 5-P with a few branches 8

8(7). Comb a large triangular patch of 100 or more scales . . . . MAORIGOELDIA

Comb in a single more or less regular row, scales free or attached to plate . . . . TRIPTEROIDES

TOXORHYNCHITINI, p. 527

9(4). Dorsal and ventral abdominal hairs in groups of 3 to 5 on large common sclerotized plates; mouthbrushes reduced to about 10 broad flat simple filaments . . . . TOXORHYNCHITES

Dorsal and ventral abdominal hairs arising separately and without strong basal sclerotizations 10

AEDEOMYIINI, p. 273

10(9). Antenna greatly swollen from base to hairs 2-4-A (1. *catasticta*) . . . . . . AEDEOMYIA

Antenna never greatly, at most slightly, swollen proximad of hair 1-A 11

HODGESIINI, p. 278

11(10). Subventral hair (1-S) of siphon in basal 0.1 (1. *solomonis*) . . . . HODGESIA

Subventral hair (1-S) of siphon usually beyond basal 0.35, never in basal 0.1 12

12(11). Maxillary suture of head capsule at most barely indicated on anterior margin, never reaching posterior tentorial pit 13

Maxillary suture of head capsule always complete and reaching posterior tentorial pit 14

URANOTAENIINI, p. 152, and FICALBIINI, p. 287

13(12). Labial plate of head capsule long; head more or less elongate, antenna always shorter than head capsule . . . . URANOTAENIA

Labial plate of head capsule very short; head wide, antenna always longer than head capsule . . . . FICALBIA

AEDINI, p. 317

14(12). Metathoracic pleural group (9-12-T) very small, longest hair less than 0.5 of long hairs in mesothoracic pleural group . . . OPIFEX

Metathoracic pleural group (9-12-T) at most moderately reduced, longest hair more than 0.5 of long hairs in mesothoracic pleural group 15

15(14). Siphon without pecten teeth . . . . ARMIGRES

Siphon with pecten teeth . . . . AEDES

TRIBE ANOPHELINI

FEMALES.—*Head:* eyes relatively widely separated above antennae; frontal area with scales and a conspicuous tuft of long modified bristles or hairlike scales projecting forward over the antennae; decumbent scales very few or absent; some semierect or decumbent scales on orbital margins of frons; erect scales very numerous, varied in size; orbital row of bristles interrupted above before frontal area; a conspicuous ventral group of setae; clypeus somewhat longer than broad, rounded apically, bare; labium slender and flexible; palpus usually about as long as proboscis, sometimes markedly shortened, apparently always 5-segmented, even when shortened; antenna usually distinctly shorter than proboscis; torus quite small; flagellar segment 1 elongate, sometimes subequal to segments 2 and 3 combined. *Thorax:* mesonotum usually elongate and only slightly arched, sometimes shortened and moderately arched; scutellum usually rounded, rarely trilobed (*Chagasia*); postnotum without bristles or scales; paratergite varied, without bristles or scales; *apn* lobes small to moderate, widely separated; *pra* not separated by suture from *stp;* meron small to moderate, its upper edge above base of hindcoxa; mesonotal, scutellar, and pleural scaling usually restricted; acrostichal and dorsocentral bristles usually short, supraalars well developed; *apn* with bristles and sometimes scales; *ppn* bare or with scales and hairs; *ppl* usually with hairs; *sp* with or without hairs; *psp* without bristles; *pra* with or without hairs; *stp* with hairs and sometimes scales; upper *mep* with hairs, lower *mep* without, sometimes *mep* scales present; metameron bare. *Legs:* very long and slender; no distinct tibial bristles; all claws usually simple, sometimes with an indistinct toothlike projection at extreme base; pulvilli not developed. *Wing:* wing membrane with distinct microtrichia; vein scales varied; cell R_2 always longer than vein R_{2+3}; vein Rs with a more or less distinct basal spur; vein R_{4+5} right-angled at base, with a distinct spur, sometimes spur very long and with a line of scales; vein 1A ending well beyond fork of Cu; vein R without dorsal remigial bristles; vein Sc without distinct bristles below at base; plical area apparently without scales at base ventrally; alula apparently usually bare; upper calypter with long complete marginal row of long hairlike scales or bristles. *Abdomen:* tergites and sternites usually without scales, always with at least sternites largely devoid of scales; laterotergite without scales; tip of abdomen truncate. *Buccopharyngeal Armature:* frequently developed, sometimes absent.

FEMALE GENITALIA.—Not studied in detail; only 1 spermatheca.

MALES.—Essentially similar to the females, except for sexual characters. *Palpus:* usually about as long as proboscis, 5-segmented and with segments 4,5 swollen in form of a club; sometimes reduced in length as in some females. *Antenna:* torus usually strongly swollen and much larger than in females; flagellum usually strongly plumose, sometimes similar to that of females. *Legs:* claws of midleg and hindleg as in the females; foreleg usually with only 1 claw, which is enlarged and toothed.

MALE GENITALIA.—*Segment VIII:* usually simple and elongate. *Segment IX:* poorly developed, reduced; tergite and sternite both without bristles. *Sidepiece:* simple in structure; usually without distinct lobes; usually with differentiated setae dorsomesally near base and sometimes elsewhere; mesal surface sclerotized. *Claspette:* developed as a more or less complex structure at base of sidepiece and around phallosome. *Clasper:* long, slender, and simple; with a short apical or subapical spiniform. *Phallosome:* simple; aedeagus long, cylindrical or conical, and often with apical or subapical leaflets, spines, or recurved processes; only ventral paramere developed. *Proctiger:* conical; usually completely membranous and always without paraprocts; cercal setae always absent.

PUPAE.—*Cephalothorax:* middorsal ridge moderately developed; all hairs present and all rather short; hairs in groups 2,3-C and 6,7-C widely separated; 8,9-C far behind trumpet in lateral aspect. *Trumpet:* not placed on distinct tubercle; widely spaced, arising much nearer wing case than middorsal line; strongly flared and deeply divided to near base. *Abdomen:* hair 1-I usually strongly developed and dendritic; 1-I,II both widely separated middorsally; all normal hairs usually present; some of the larger dorsal hairs often plumose; hair 9-III-VII often spiniform or long, placed at or near posterolateral angle; 9-VIII often in similar position, usually plumose or spiniform. *Terminal Segments:* hair 1-IX present, short and usually irregular, not a simple seta; 1-X absent; cercal lobe of female well developed, projecting beyond apex of genital lobe; male genital lobe prominent and long. *Paddle:* relatively broad; external buttress usually more or less distinct; midrib usually long and dividing paddle into more or less equal inner and outer parts; both margins usually with a more or less distinct fringe of fine spicules, outer sometimes with strong denticles; usually with both hairs 1,2-P present, 2-P frequently removed cephalad from apical margin on ventral surface.

LARVAE.—*Head:* usually distinctly longer than wide; dorsal portion cephalad of antennae markedly triangularly produced; portion caudad of antennae only slightly swollen laterally; collar wider than distance between antennae; posterior tentorial pits at considerable distance from caudal border; maxillary sutures variable, rarely extending distad of posterior tentorial pits and never approaching collar; cephalic border of labial plate produced triangularly in front; aulaeum produced, without fine spicules but with sclerotized denticles; mental plate small, longer than broad, sclerotized and pigmented distally only; mouthbrushes never reduced to 10 flattened filaments on each side; hair 1-C small, arising on dorsal surface of labrum, not on anterior process; 2,3-C (inner and outer clypeals) both present, 2 always strongly developed, 3 variable but always distinct; 4-C (posterior clypeal) placed forward; 5-7-C (frontals) usually plumose and placed in a more or less transverse line caudad of antennae except in *Chagasia,* where hair 6 is apically frayed and placed cephalad; 11-C large and plumose; 13-C close to hair 11; 10,12-C approximated; 15-C usually close to anterior margin, always cephalad of mid distance between anterior and posterior borders; hairs 16,17-C apparently not developed. *Antenna:* simple but with spicules on shaft; shorter than head capsule; hair 1-A in basal half; 2,3-A spiniform or saberlike; 4-A usually long and branched (except in *Chagasia*); 5,6-A varied in development. *Thorax:* spiracular sensilla usually distinct; a "notched organ" caudomesad of hairs 5,6-P and bearing hair 0-P at its base; hairs 9-12-P,M,T usually on common tubercles, except in *Chagasia,* where 9-P is separate; 1-3-P separate or sometimes on a common basal plate; all hairs including 13-P present; hairs 8-P, 5,7,8-T long and strongly plumose; hair 1-M often plumose and with thickened shaft; hair 3-T often palmate. *Abdomen:* integument varied; spiracular and dorsal sensilla usually distinct; tergites usually with anterior mesal sclerotized plate of varied size and sometimes with smaller, more posterior small sclerotized accessory plates; hair 1 often palmate on several segments I-VII; hairs 6,7-I,II always long and strongly plumose; 6-III-VI varied in development; segment I with full complement of hairs except for hair 14. *Segment VIII:* comb scales not developed, except in first instar. *Spiracular Lobe:* siphon not developed, instead a pair of toothed lateral pecten plates present and connected caudally by a ventral bar; ventrolateral valve very strongly developed. *Anal Segment:* saddle always incomplete; without acus; median dorsal caudal process strongly developed; hair 1-X on or off the saddle, usually single; dorsal brush strongly developed, both hairs generally asymmetrically branched, hair 3-X generally hooked at apex; ventral brush very strongly developed, with 8 or more pairs of hairs arising from a grid which is prolonged cephalad as a strong long midventral sclerotized bar; accessory hairs (*x-z*) not developed; gills usually fingerlike.

EGGS.—Generally with exochorion developed into air floats; usually laid singly on water surface; usually not resistant.

SYSTEMATICS.—It is generally regarded that the anophelines are the most primitive group in the subfamily; it has even been suggested that they are intermediate between the Dixinae and the Culicinae and ancestral to the other tribes of the latter. There is little evidence to support either of these views. For instance, it is well known that the first instar anopheline larvae have a comb on abdominal segment VIII and that it is lost in subsequent instars; this character is retained in all instars of all other members of the Culicinae except the Toxorhynchitini. The pecten plates do not have to be regarded necessarily as the forerunner of the siphon but may just as well be interpreted as its remnants. Other larval, as well as some pupal, characters are indicative of specialization; for example, the development of palmate hairs, notched organs, and respiratory trumpets. Similarly, the genitalic characters of both males and females show few if any generalized features which might be interpreted as more primitive than, or ancestral to, those found in other Culicinae. Therefore I regard the Anophelini as a highly specialized and strongly differentiated tribe which is not ancestral in any way to the other tribes of the Culicinae. There are some rather striking general similarities between the Anophelini and some of the Dixinae. Whether these are genetic or convergent owing to the utilization of a similar habitat cannot be decided without much more detailed morphological work in both groups. However, I am inclined to regard them as indicative of actual relationship and suspect that the tribe arose through hybridization between ancient contemporaneous stocks of the Culicinae and Dixinae.

When and where the tribe arose is difficult to determine with our present knowledge of the family. The fact that the majority of the more generalized and the annectent forms of the Anophelini occur around the American Mediterranean Region would seem to indicate that the initial differentiation of the tribe took place in this area, probably at the same time that the other major groups of the Culicinae arose. The number of species of anophelines is not very large in this area, and many of the species do not feed on mammals; possibly more species are associated with birds. However, it is also possible that the New World received only the primitive stocks of the Anophelini, that these were able to differentiate there, without strong competition from other groups (as in the Sabethini), and that the early stocks of the tribe were not successful in the Old World until a later time. The flowering of the tribe is apparently associated with the great development of the mammals in the Old World and probably took place contemporaneously during the Tertiary.

Only 3 strongly differentiated genera are recognized in the tribe at present: the dominant *Anopheles,* with a nearly worldwide distribution, the Neotropical *Chagasia,* and the Papuan *Bironella. Chagasia* adults show several characters reminiscent of the "culicines": strongly arched mesonotum, trilobed scutellum, and bristles on *ppn;* the larvae have a peculiar chaetotaxy on the head and thorax, and the pupae are also aberrant. *Bironella,* on the other hand, is very similar to *Anopheles* in the immature stages and differs in the adults only in minor palpal, venational, and genitalic characters. The tribe is represented in the South Pacific by 1 species of *Bironella* and 6 species of *Anopheles.*

BIONOMICS.—An excellent general summary of the bionomics of anophelines is presented by Christophers (1933:59–67), and the more recent information on the subject is briefly reviewed by Horsfall (1955:45–51). Practically everything known about anophelines is limited to the genus *Anopheles;* the following generalizations apply to this genus only. The bionomics of *Bironella* are discussed under that genus, and a summary for *Chagasia* is given by Horsfall (1955:41).

Anophelines are predominantly breeders in ground waters, but a few forms are restricted to water in treeholes and even in the leaf axils of plants. The larvae of apparently all species are surface feeders. They attach to the surface film by the spiracular apparatus, palmate hairs, and the notched organs. In feeding the head is rotated through 180° so that its ventral surface is brought against the surface film, which is swept by currents produced by the mouthbrushes. Various structures on the ventral surface of the head anchor it to the surface film. The larvae have a tendency to rest their tail ends against an object intersecting the water surface and are therefore found in greatest numbers in areas with emergent or floating vegetation or against the margins of the breeding places. While the majority of anophelines utilize relatively still water, a number of forms are found in fast-flowing streams. Such species are often found resting at the edge of the water and even partially out of it, but of course surrounded by a film of water. Both larvae and pupae can survive out of water in a moist environment for a considerable period of time. The adults of the *Anopheles lungae* complex habitually emerge from pupae which have left the water. Anopheline eggs are laid singly on the water surface or, more rarely, heaped up on water margins or floating objects. Because of the characteristic development of the air floats, other developments of the exochorion, and differences in size and shape, the eggs of most species produce a characteristic miniscus by means of which they can be identified in the field. The eggs often become arranged in geometric patterns when laid or when concentrated in a small area, owing to surface currents. While in the majority of species, the egg hatches within a few days and can survive partial desiccation for only a short period of time, in at least a few forms, eggs stranded out of water for several weeks retain their viability and will hatch when flooded and produce normal adults (see *A. lungae* complex). The length of the aquatic cycle varies greatly in different species, being less than 1 week under optimum conditions in some temporary pool-breeders, several months in some treehole-breeders, and with the average for important tropical forms being probably about 10 days or less.

The adults of the majority of anophelines are nocturnal or crepuscular in activity, resting in favorable protected places during the daylight hours. Some species tend to concentrate in man-made shelters or are found in large natural shelters, such as hollow trees, caves, holes in river banks, and buttresses of jungle trees. Other species are difficult to locate during periods of inactivity; it is assumed that they do not congregate and that the individuals are scattered in various small resting places principally at or near the ground. Blood-feeding is apparently largely if not entirely restricted to warm-blooded vertebrate hosts; many species attack man and other large mammals; several species are known to feed largely on birds. The normal flight range is usually not more than 1 or 2 miles from the breeding sites if suitable hosts exist within that range. At times much longer flights may take place, at least in some species. Swarming is apparently a necessary preliminary to mating in most species. Great difficulties are usually encountered in establishing experimental colonies of anophelines, owing largely to failure of obtaining a strain which will take blood or mate under laboratory conditions. Apparently many species consist of numerous strains which vary in these characteristics as well as in many others, including morphological.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—The following remarks apply only to *Anopheles* since both *Chagasia* and *Bironella* seldom feed on man and are not known to transmit any human diseases.

Anophelines are known chiefly as the sole vectors of the human malarias, but, in addition, several species are effective vectors of human periodic filariases and some may be involved in the transmission of human encephalitides. Since many species of *Anopheles* attacking man often feed on other mammals and sometimes birds, they should not be neglected as potential vectors of pathogens from animals to man. Anophelines are vectors of probably numerous animal pathogens, including species of *Plasmodium* which do not affect man. This fact should be kept in mind when conducting surveys of natural infections in anophelines, particularly "wild" species which are not closely associated with man. It is difficult if not impossible to differentiate as to species the stages of the various parasites in the mosquito; therefore, the data from natural infections may be misleading since they may be based on animal parasites rather than human ones (see under *A. lungae*).

DISTRIBUTION (fig. 37).—The tribe has a nearly worldwide distribution, but the genera *Bironella* (Papuan) and *Chagasia* (Neotropical) have restricted ranges. In the South Pacific *Anopheles* is found in the Solomons, Santa Cruz Islands, and the New Hebrides; *Bironella* is known only from the Solomons.

KEYS TO GENERA AND SPECIES

(Keys to tribes, pp. 118–122)

FEMALES

1. Wing without contrasting pattern of dark and light scales; palpus about 0.3 of proboscis; veins R_{4+5}, M, and Cu_1 beyond *m-cu* all more or less distinctly sinuate (BIRONELLA, p. 129) .... 1. *hollandi*

Wing with contrasting pattern of dark and light scales; palpus about as long as proboscis; veins R_{4+5}, M, and Cu_1 beyond *m-cu* all evenly curved (ANOPHELES, p. 134) 2

2(1). Haltere dark-scaled on knob; mesonotum with a vestiture of broad decumbent whitish scales throughout (PUNCTULATUS COMPLEX) 3

Haltere light-scaled on knob; mesonotum with a vestiture of golden hairs, without conspicuous scales except on anterior promontory (LUNGAE COMPLEX) 5

3(2). Labium dark-scaled except for narrow inconspicuous pale ring at extreme apex and rarely a few pale scales ventrally on basal half .... 1. *farauti*

Labium with pale scales on apical third to half in addition to apical light ring 4

4(3). Labium extensively pale-scaled on apical third to half, usually pale scaling forming a complete subapical ring, but often interrupted by dark scales ventrally or dorsally; line of separation between light and dark scales basally not distinct .... 2. *punctulatus*

Labium with a restricted ventral subapical patch of light scales in distal third, sharply differentiated from dark scales ventrally, sometimes extended dorsally and distally to form incomplete ring .... 3. *koliensis*

5(2). Apical third or more of labium yellow-scaled, the separation between the dark and light scales sharp; a narrow preapical dark ring usually present .... 4. *lungae*

Apical fourth or less of labium with a patch or a more or less distinct ring of yellow scales, merging into dark scales without definite boundary on at least one surface; a narrow apical light ring always present 6

6(5). Preapical light scaling usually restricted to a patch on apical fifth of labium, sharply separated on dorsal surface at base from the dark scales, sometimes patch extended ventrally to form an indistinct ring ... 6. *solomonis*

Preapical light scaling more extensive but variable, sharply separated from dark scales on ventral surface .... 5. *nataliae*

MALES

The characters used to separate the males are not entirely satisfactory but will serve to separate the majority of specimens. The male genitalia do not appear to offer reliable diagnostic characters except for *Bironella* (see key to tribes, p. 119).

1. Wing without contrasting pattern of dark and light scales; veins R_{4+5}, M, and Cu_1 beyond *m-cu* all more or less distinctly sinuate (BIRONELLA, p. 129) . . . . 1. *hollandi*

Wing with contrasting pattern of dark and light scales; veins R_{4+5}, M, and Cu_1 beyond *m-cu* all evenly curved (ANOPHELES, p. 134) 2

2(1). Haltere dark-scaled on knob; mesonotum with a vestiture of broad decumbent whitish scales throughout (PUNCTULATUS COMPLEX) 3

Haltere light-scaled on knob; mesonotum with a vestiture of golden hairs, without conspicuous scales except on anterior promontory (LUNGAE COMPLEX) 5

3(2). Costa of wing without a small dark spot between basal and median dark spots . . . . 3. *koliensis*

Costa of wing with a small dark spot between basal and median dark spots 4

4(3). Labium entirely dark except for the very narrow extreme apical light ring . . 1. *farauti*

Labium with at least 2 or 3 ventral light spots, frequently with large light patches in addition to the very narrow extreme apical light ring . . . . 2. *punctulatus*

5(2). Apical fifth of labium with a dorsal patch or incomplete ring of bronzy yellowish scales, in addition to very narrow extreme apical light ring . . . . 6. *solomonis*

Labium entirely dark except for the very narrow extreme apical light ring . . . . 4. *lungae;* 5. *nataliae*

PUPAE

1. Hair 3-VI laterad or at level of hair 1; sternites III-VII without distinct sublateral oblique ridges (BIRONELLA, p. 129) . . 1. *hollandi*

Hair 3-VI distinctly mesad of hair 1; sternites III-VII with more or less distinct sublateral oblique ridges (ANOPHELES, p. 134) . . . 2

2(1). Paddle with a fringe of long slender hairlike spicules only (PUNCTULATUS COMPLEX) 3

Paddle with strong short denticles on most of the external margin (LUNGAE COMPLEX) 5

3(2). Trumpet pale, not contrasting with integument of cephalothorax; hair 1-II usually with 10 or more branches . . . . . . 2. *punctulatus*

Trumpet deeply pigmented and contrasting sharply with integument of cephalothorax; hair 1-II usually with less than 10 branches 4

4(3). Hair 9-IV of the same order of magnitude as 9-V,VI, usually at least 2 or 3 times as long as 9-III . . . . 3. *koliensis*

Hair 9-IV of the same order of magnitude as 9-III, usually less than 2 times as long as latter . . . . 1. *farauti*

5(2). Hair 9-V of the same order of magnitude as 9-VI,VIII, usually at least 2 or 3 times as long as 9-III . . . . 6. *solomonis*

Hair 9-V of the same order of magnitude as 9-III,IV, usually only slightly longer than 9-III 6

6(5). Trumpet with preapical line of deep pigmentation followed by unpigmented line; hair 9-VII acutely tapered, without branches or barbs . . . . 5. *nataliae*

Trumpet pigmented to apex; hair 9-VII usually branched or barbed. . . . . . 4. *lungae*

FOURTH INSTAR LARVAE

1. Inner clypeals (2-C) close together; hair 1-M palmate; segment VIII with large sclerotized saddle covering almost entire dorsal surface (BIRONELLA, p. 129) . . . . 1. *hollandi*

Inner clypeals (2-C) widely separated; hair 1-M plumose; segment VIII with small anterior tergal plate (ANOPHELES, p. 134) 2

2(1). Prothoracic pleural group (9-12-P) with all long hairs single (PUNCTULATUS COMPLEX) 3

Prothoracic pleural group (9-12-P) with 1 long hair branched (LUNGAE COMPLEX) 5

3(2). Hair 1-I usually a small true palmate tuft with broad flattened leaflets, sometimes notched; tubercles of 1-3-P usually fused . . . . 1. *farauti*

Hair 1-I not palmate, usually with slender or narrow hairlike branches, never notched; tubercles of 1-3-P usually not fused . . . 4

4(3). Aulaeum relatively broad and short, strongly pigmented; hair 1-P usually with slender stem; antenna lightly pigmented . . . . 2. *punctulatus*

Aulaeum relatively narrow and long, lightly pigmented; hair 1-P with stout swollen stem; antenna uniformly darkly pigmented . . . . 3. *koliensis*

5(2). Hair 1-II small, with lanceolate unnotched leaflets . . . . 4. *lungae*

Hair 1-II well developed, with notched leaflets 6

6(5). Hair 2-IV,V usually single; tubercles of hairs 1-3-P usually fused; head capsule darkly pigmented . . . . 5. *nataliae*

Hair 2-IV,V double or triple; tubercles of hairs 1-3-P never fused; head capsule lightly pigmented . . . . 6. *solomonis*

FIRST INSTAR LARVAE

(*A. nataliae* not included)

1. Subantennal hair (11-C) densely branched, dichotomously near apex; antennal shaft hair (1-A) longer than antenna; terminal antennal hair (4-A) usually 2-4b; frontal hairs (5-7-C) usually 2-6b; no lanceolate or linear hairs on thorax (BIRONELLA, p. 129) . . . . 1. *hollandi*

Subantennal hair (11-C) bifurcate near base; antennal shaft hair (1-A) less than 0.25 of antennal length; terminal antennal hair (4-A) and frontal hairs (5-7-C) all unbranched; some of the hairs of the thorax lanceolate or linear (ANOPHELES, p. 134) 2

2(1). Metathoracic hair 1-T lanceolate, similar to 3-T (PUNCTULATUS COMPLEX) 3

Metathoracic hair 1-T simple, unflattened or minute (LUNGAE COMPLEX) 4

3(2). Mesothoracic hair 2-M gradually attenuate and without conspicuous barbs . . . . 2. *punctulatus*

Mesothoracic hair 2-M with thickened basal half and conspicuous distal barbs . . . . 1. *farauti;* 3. *koliensis*

4(2). Hair 1-II linear, 0.5 or less of 1-III; hair 1-M linear, small; hair 1-VII linear . . 4. *lungae*

Hair 1-II lanceolate, at least 0.75 of 1-III; hair 1-M lanceolate, large; hair 1-VII lanceolate . . . . 6. *solomonis*

EGGS

(*A. nataliae* not included)

1. Frill restricted to a broad anterior collar (BIRONELLA, p. 129) . . . . 1. *hollandi*

Frill complete, extending on dorsal surface from anterior to posterior ends (ANOPHELES, p. 134) 2

2(1). Frill low; distance between frill edges dorsally at least as great as that between base of frill and upper edge of floats on each side (PUNCTULATUS COMPLEX) . . . . 1. *farauti;* 2. *punctulatus;* 3. *koliensis*

Frill high; distance between frill edges dorsally at most about half of that between base of frill and upper edge of float on each side (LUNGAE COMPLEX) 3

3(2). Frill approximated on midline so that upper surface is practically eliminated . . . . 4. *lungae*

Frill edges separated dorsally by an upper surface about half as wide as distance between base of frill and upper edge of float on each side . . . . 6. *solomonis*

Genus BIRONELLA Theobald

1905. *Bironella* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:69. TYPE SPECIES: *B. gracilis* Theobald, 1905, New Guinea; monobasic.

1930. *Brugella* Edwards, B. Ent. Res. 21:288. TYPE SPECIES: *Anopheles travestitus* Brug, 1928, Ceram; original designation.—As subgenus of *Bironella.*

FEMALES.—In general as an *Anopheles* except for the following striking differences; dark-colored; without distinct broad scales on thorax or abdomen; legs extremely long. *Head:* palpus from 0.2 to 0.8 of proboscis length; antenna short to very short. *Wing:* no distinct color pattern; veins R_{4+5}, M, and Cu_1 beyond *m-cu* all more or less distinctly sinuate; vein R_3 sometimes short and not connected to R_{2+3} (*papuae* series). *Genitalia:* not studied. *Buccopharyngeal Armature:* not developed.

MALES.—Essentially similar to the females. *Palpus:* from 0.15 to almost as long as proboscis; terminal 2 segments not conspicuously clubbed. *Antenna:* length as in the female; flagellum plumose or simple. *Legs:* foretarsal segment 5 shorter than segment 4, cylindrical, and without bristly enlargement at base, with 1 simple claw.

MALE GENITALIA.—In general as in *Anopheles* but poorly understood. *Sidepiece:* sometimes with a more or less distinct basal tergomesal lobe in addition to claspette. *Claspette:* quite varied in shape and development; the so-called basal arm of the sidepiece is probably a reduced claspette. *Phallosome:* aedeagus variously developed, often cylindrical, very long and slender, and with bizarre recurved apical or subapical processes.

PUPAE.—In general as in *Anopheles;* known in detail only for *hollandi* and *soesiloi sensu* Swellengrebel & Rodenwaldt, 1932; no oblique sublateral ridges on sternites III-VII; hair 3-VI laterad or at level of 1-VI, never distinctly mesad.

LARVAE.—In general as in *Anopheles. Head:* anterior border of labial plate acutely produced cephalad; aulaeum simple; mental plate small; maxillary sutures short, not reaching posterior tentorial pits; inner clypeals (2-C) close together; hair 15-C removed from cephalic border. *Antenna:* hair 1-A large and plumose or branched, arising from mesal surface; hair 4-A large and plumose or branched. *Thorax:* hair 4-P (the extra shoulder hair of authors) close to 1-3-P and smaller than 2-P; hair 1-M palmate; 7-M caudal; 8-M with a few branches, not plumose; 3-T palmate. *Abdomen:* anterior tergal plates large; segment VIII with a secondary sclerotization covering practically entire tergite, including the primary plate anteriorly and bearing hair 0-VIII laterally; small accessory tergal plates present on III-VII; hair 1 palmate on I-VII, sometimes weaker on I,II,VII, leaflets simple, never serrated or notched; hairs 6,7-I,II large and plumose, 6-III lightly and unevenly plumose, all on tubercles; hairs 6-IV,V single or sparsely branched. *Spiracular Lobe:* normal. *Anal Segment:* hair 2-X rather evenly plumose, relatively short; ventral brush (4-X) with 8 pairs of plumose hairs with rather even branches.

EGGS.—Described only for *hollandi* (see below).

SYSTEMATICS.—The very interesting genus *Bironella* is at present in a state of utter confusion. Of the 10 or more described forms, only 4 are known from more than 1 stage; even in these forms, the correlations are uncertain except in *hollandi.* There is apparently a great deal of individual variation in all stages, particularly in the so-called *papuae* series.

Bironella is an ancient anopheline complex whose relationships cannot be determined at present because of the lack of morphological studies in the genus. It shows a number of characters in common with the subgenus *Anopheles,* notably the absence of buccopharyngeal teeth in the female and the location and branching of antennal hair 1 in the larva. Several divergent lines are evident in *Bironella.* To date, only 2 subgenera have been recognized; the compact subgenus *Brugella,* with 2 or 3 species, and the typical *Bironella,* which includes a heterogeneous assemblage of forms. From the latter, at least the *papuae* series and the species *confusa* Bonne-Wepster, 1951 should be segregated into 2 separate subgenera.

In the South Pacific only the subgenus *Brugella* is represented. This subgenus is characterized by a very short palpus and a very short antenna in both sexes, a complex claspette in the male genitalia, and a more or less normal venation with cell R_2 well developed.

BIONOMICS.—The immature stages of *Bironella* are usually found in undisturbed areas, most frequently in dense shade, in swamps, margins of streams, and even temporary pools. The adults are seldom collected or seen in nature, and only the females of *gracilis* Theobald, 1905 have been reported biting man (Elsbach, 1937:1053; Lee and Woodhill, 1944:56).

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—As noted above, *Bironella* species do not appear to attack man habitually or readily. They have never been suspected of transmitting any human or animal disease, and it appears that they are entirely innocuous. Since the immature stages are very similar to those of *Anopheles,* great care should be exercised to differentiate them; otherwise much effort and time may be wasted in control operations.

DISTRIBUTION (figs. 37, 38).—The genus *Bironella* is known only from the Moluccas, New Guinea, Northern Australia, Bismarck Archipelago, and the Solomon Islands. The subgenus *Brugella* has a similar distribution except that it is not known from Northern Australia.

KEYS TO SPECIES

See keys to genera and species, pp. 126–128

1. Bironella (Brugella) hollandi Taylor

Figs. 39-42

1934. *Bironella (Brugella) hollandi* Taylor, Linn. Soc. N. S. Wales, Proc. 59:229–231. TYPE: lectotype ♂, Kavieng, New Ireland, from native village well; apparently selection of Lee and Woodhill, 1944:74 (SYDN).

Bironella (Brugella) hollandi of Taylor (1944:120–121); Knight, Bohart, and Bohart (1944:6, 60); Lee and Woodhill (1944:74–77); Belkin, Knight, and Rozeboom (1945:244–247); Dumbleton (1946); Smart (1948, 1956:152, 182); King (1949:516, 522); Bonne-Wepster and Swellengrebel (1953:72–73); Iyengar (1955:21); Laird (1956); Senevet (1958:12–13); Stone, Knight, and Starcke (1959).

Bironella hollandi of Russell, Rozeboom, and Stone (1943:140).

Bironella (walchi ?) of Belkin and Schlosser (1944:268, 272, 273).

FEMALE (fig. 40).—*Wing:* 2.9 mm. *Proboscis:* 1.9 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.3 mm. *Head:* a narrow orbital line of small broad decumbent white scales; vertex and occiput with very long narrow erect scales, those on anterior and median areas white and strongly curved, those on lateral areas dark, some deeply forked; frontal tuft white, lower scales long, upper shorter and more curved; labium dark-scaled, shaggy at base; labella light to dark brown; palpus dark-scaled, shaggy, with narrow scales at base, 5-segmented, length slightly more than 0.25 of proboscis; antenna about 0.5–0.6 of proboscis, scales absent. *Thorax:* mesonotal integument chocolate brown, lighter on humeral areas, with usual gray pollinose stripes and areas, bristles dark, some long slender golden hairs or hairlike scales; scutellum light brown, darker in center, bristles and scales as on mesonotum; postnotum black; paratergite light brown, bare; pleural integument variable, usually dark but lighter ventrad and caudad, scales absent, bristles reduced in size and number; *apn* with several bristles; *stp* with a more or less continuous row of about 6–8 bristles; *pra* with a few very short bristles; 1 upper *mep* bristle; other bristles absent. *Legs:* coxae and trochanters light; forefemur dark except for narrow central pale line on posterior surface from near base to apex and connected at base with a dorsal pale line which extends about half the length of segment, anterior surface with a few pale scales; midfemur dark except for narrow pale line from base to within 0.1 of apex on middle of posterior surface; hindfemur largely light on anterior surface, mottled on posterior and with a narrow pale line dorsoposteriorly in basal 0.5, remainder dark; foretibia and midtibia light on posteroventral surface except at base and apex, remainder dark; hindtibia similar except that light scaling is on anterior surface and more distinct; tarsi dark, lighter ventrally; claws simple and equal on all legs. *Wing* (fig. 40): scales light gray, darker and denser on costal border; venation as figured. *Haltere:* knob and upper part of stem with small dark scales. *Abdomen:* dark brown, without scales but with moderately dense vestiture of brown hairs on tergites and sternites, more numerous and lighter on distal segments. *Genitalia:* not studied in detail; cercus short.

MALE.—Generally as in the female except for sexual differences; erect scales of vertex and occiput less numerous; palpus about 0.15 of proboscis; mesonotal vestiture even less dense; foretarsal segment 5 shorter than segment 4, cylindrical and with one simple claw.

MALE GENITALIA (fig. **40**).—As figured; diagnostic characters as in the key. *Segment VIII:* short, tergite about 0.66 of tergite VII. *Segment IX:* tergite length about equal to width of one sidepiece, strongly swollen and without lobes; sternite a small short transverse sclerite. *Sidepiece:* short, stout, and strongly swollen, about twice as long as broad; dorsal, lateral, and ventral hairs rather short; a few narrow scales at base laterally, dorsally, and ventrally; a small rounded projecting dorsal basal lobe bearing 9–16 short but rather heavy hairs; ventrad of this lobe, on basal mesal surface a dense clump of about 20 or more very long and very slender drooping hairs. *Claspette:* a very prominent, complex erect structure surrounding phallosome; consisting of 2 lateral lobes supported ventrally by a strongly sclerotized median bar arising ventrally between sidepieces and with a shallow fork apically where it joins the 2 lobes; each lobe with a basal dorsal process with a dense vestiture of short hairs (possibly spicules); apex of lobe with a stout digitlike sclerotization and 2 membranous appendages with expanded tips. *Clasper:* long and slender, swollen at base, sharply curved and bent in distal 0.3; spiniform subapical, swollen distally, and usually not projecting beyond apex of clasper. *Phallosome:* aedeagus long and slender, surrounded to near apex by dorsal basal processes of the claspette; at apex a pair of long recurved and laterally produced forked appendages, the branches of which are coarsely serrate; paramere and basal piece not studied. *Proctiger:* conical at base and produced into a long slender apical spiculate process which extends beyond apex of claspette.

PUPA (fig. **40**).—*Abdomen:* 2.56 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* pigmentation variable from light to dark brown, rather uniform but with darker areas on mesonotum and appendage cases. *Trumpet:* uniformly darkly and brightly pigmented. *Metanotum:* darkened sublaterally. *Abdomen:* pigmentation variable as on cephalothorax, darker areas usually present sublaterally on tergites II-IV, larger and connected basally on tergites V-VII, mesal portion darker on tergite VIII; no diagonal ridges on sternites III-VII; hair 3-VI laterad or cephalad of 1-VI. *Terminal Segments:* female genital lobe extending to about 0.25 of paddle, cercal case projecting only slightly beyond its apex; male genital lobe extending to about 0.63 of paddle, anal lobe to 0.33. *Paddle:* uniformly lightly pigmented; external buttress short, weak; midrib well developed to apical 0.25; fringe of long slender spicules restricted to external margin; hair 1-P strong, 2-P weak, both long and marginal.

FOURTH INSTAR LARVA (fig. **41**).—*Head:* 0.52 mm. *Anal Saddle:* 0.29 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* pigmentation light yellowish brown in male, very dark blackish brown in female, rather uniform in both; integumentary sculpturing indistinct; maxillary sutures short, not reaching posterior tentorial pits; cephalic border of labial sclerite produced into a long triangular acute process; aulaeum simple, not formed into toothed plate; mental plate small, long-triangular and with a median and 2,3 lateral teeth on each side; tubercles of hair 2-C (inner clypeal) almost or quite contiguous; hair 3-C about 0.25–0.4 length of 2-C, both single and simple; 4-C very short, single or double; 15-C removed from cephalic border. *Antenna:* about 0.4 of head length; uniformly lightly pigmented in male, dark in basal half in female; spicules short, most numerous in mesal basal half, a few longer ones mesad near apex; hair 1-A long and plumose, arising on mesal surface usually in basal 0.33 or slightly beyond; hair 4-A unevenly plumose, 10-12b. *Thorax:* hair 1-P with short stem and 8–11 long radiating branches; 2-P with small basal tubercle, 12-16b; 4-P with small basal tubercle, 7-10b; 9-P with 2–4 terminal branches; hairs 1-M,T palmate, subequal to each other and to abdominal hair 1-I, with about 25 leaflets; 7-M caudad of 6-M; 8-M not plumose, 10-12b. *Abdomen:* palmate hairs (1) well developed on I-VII, those on I,VII somewhat smaller, leaflets smooth and very slender, 30 or more in 1-III; hair 2-IV,V single or 2-6f on apex; 6-III rather short, 10-15b; 6-IV,V usually single; large anterior tergal plates on I-VII and small rounded accessory tergal plates caudad of them on III-VII. *Segment VIII:* large sclerotized saddle covering almost entire dorsal surface and including the primary tergal plate anteriorly and bearing hair 0-VIII laterally, extending laterally to level of pecten plate; hair 3-VIII with 8–14 branches. *Spiracular Lobe:* spiracles large, close together; anterior median lobe small and with a narrow transverse heavy sclerotization; median plate with a long cephalic process which is acutely triangular. *Anal Segment:* saddle strongly sclerotized and pigmented, extending about halfway ventrad; hair 1-X single, about as long as saddle; 8 pairs of hairs in 4-X.

FIRST INSTAR LARVA (fig. **42**).—Chaetotaxy as figured; diagnostic characters as in the key. *Head:* hairs 2-C close together or about as far apart as the distance between one of them and 3-C on same side; 5-7-C usually 2-5b; 11-C plumose and secondarily branched, with more than 10 primary brances from a long stout stem; all other hairs usually single and simple. *Antenna:* stout, shorter than fully developed collar, and less than 0.4 of head length to collar; hair 1-A inserted at base and longer than entire antenna; hair 4-A usually double. *Thorax:* hairs 1,2-P, 1-M, 1,3-T all simple, not lanceolate. *Abdomen:* hair 1-I-VII lanceolate linear. *Segment VIII:* comb usually composed of 4 sharply pointed spines. *Spiracular Lobe:* pecten usually composed of about 8 short, sharply pointed spines. *Anal Segment:* very sparse covering of slender spicules.

EGG (Belkin, Knight, and Rozeboom, 1945, fig. 7).—Broad anteriorly, tapering posteriorly; color black; approximately 0.55 x 0.20 mm. including floats. *Floats:* large, almost as long as body of egg, 15–20 float ridges. *Frill:* broad and collarlike at anterior end. *Exochorion:* with fine reticulations forming an irregular polygonal pattern.

MATERIAL EXAMINED.—3,380 specimens; 333 ♀; 232 ♂; 175 pupae; 2,640 larvae; 105 individual rearings (103 larval, 2 pupal).

SYSTEMATICS.—Lee and Woodhill (1944:76) examined the genitalia of the male type of *hollandi* from Kavieng, New Ireland, and found them to agree with those of specimens from the Solomons. Therefore it appears that the *Bironella* (*Brugella*) of the Solomons is conspecific with *hollandi.* Whether or not racial differences exist in this complex cannot be determined without careful study of much additional material from all localities, but it seems likely that they will be found.

B. hollandi is a typical *Brugella* and superficially is very similar to *B. travestita* Brug, 1928, the type species of the subgenus. The 2 species can be told apart quite readily by the male genitalia. In *travestita,* there are 2–5 parabasal spines that are about as long as the lateral bristles of the sidepiece but distinctly heavier, and these apparently do not arise from a distinct basal lobe. In *hollandi,* on the other hand, there is a group of 8–16 rather heavy hairs that are less than one-third as long as the lateral bristles, and these arise from a distinct dorsal basal lobe which also carries on its ventral aspect a group of about 25 very long fine hairs. Additional differences in the sidepiece, clasper, and claspette are apparently present, judging from the published figures of *travestita.* The larvae of the 2 species are very similar and at present cannot be separated. The supposed difference in the number of branches of hair 1-P (Bonne-Wepster and Swellengrebel, 1953:72) does not hold, as this hair in *hollandi* has 8–16 branches and in *travestita* is stated to have 13–16 branches.

In the adults there is considerable variation in the amount of white scaling on the head and also in the pigmentation of the thorax. The most significant variation is in the number of bristles on the basal lobe of the male genitalia, but this is not correlated with variation in any other character in the adults or the immature stages.

In the immature stages the hair branching is more variable than in other anophelines of the South Pacific. Frequently hairs which are normally single will show multiple fraying or branching on the apices. There is strong sexual dimorphism in the larval stage, male larvae being yellowish brown and the female blackish brown or almost black in color. This dimorphism was noted by Belkin, Knight, and Rozeboom (1945:247) but was not related to sexual differences. No striking geographical variation is evident from a superficial examination of material from different islands in the Solomons.

BIONOMICS.—The immature stages of *hollandi* are very commonly found in undisturbed, permanent or semipermanent bodies of water such as streams, swamps, and dense coastal lagoons at the mouths of rivers. Some of the smaller temporary breeding sites—such as road ruts, hog wallows, and even artificial containers—are sometimes utilized. The larvae and pupae occur most frequently in deep shade; even when breeding occurs in more exposed situations, the immature stages are found deep in the vegetation where there is little light. This species tolerates water with a high content of organic matter but occurs most frequently in cool, clear, clean water. In the Solomons, the most frequently associated anophelines are *A. lungae, A. nataliae,* and *A. solomonis,* less frequently *A. farauti,* and very rarely *A. punctulatus.* Among other mosquitoes, *Dixina solomonis,* species of *Culex* (*Lophoceraomyia*), *Uranotaenia civinskii,* and *U. barnesi* were frequently associated with *hollandi* on Guadalcanal.

Larvae of *hollandi* can be easily separated in the field from those of other anophelines on Guadalcanal by the light coloration of abdominal segment IV, which stands in sharp contrast to the uniformly darker coloration of the rest of the abdomen even in the lighter-colored male larvae. The pupae are smaller than those of the other anophelines of the Solomons and have shorter and more widely flared trumpets.

B. hollandi is not easily reared under artificial conditions, and the development of the immature stages under laboratory conditions is slow, requiring 10–14 days from the first instar to pupation and 2–3 days for the pupal stage.

Adults of *hollandi* have never been collected in nature. Reared specimens are extremely delicate and difficult to keep alive in captivity. They exhibit the usual anopheline resting position but because of their extremely thin body and excessively elongate legs, they resemble small craneflies.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—*B. hollandi* is of no economic importance directly because the females do not bite man. However, the larvae of this species are sometimes very numerous in undisturbed jungle areas, as on Guadalcanal, and they can be mistaken very readily for *Anopheles* larvae. Therefore it is very important to identify the larvae before control measures are undertaken.

DISTRIBUTION (fig. 39).—*Solomon Islands:* Bougainville; Treasury; Vella Lavella; New Georgia; Russell; Guadalcanal. Also known from *New Ireland* (Kavieng, type locality, Taylor) and reported from *New Guinea* (Serui, Hollandia; Bonne-Wepster and Swellengrebel, 1953:73).

Genus ANOPHELES Meigen

1818. *Anopheles* Meigen, System. Beschr. Europ. Zweifl. Insekten 1:10. TYPE SPECIES: *A. maculipennis* Meigen, 1818, Europe; 1 of 3 included nominal species; fixed by International Commission on Zoological Nomenclature, Opinion 547 (1959).

1902. *Grassia* Theobald, J. Trop. Med. 5:181–182. *TYPE SPECIES: *Anopheles rossi* Giles, 1899, India; original designation.—Preoccupied by *Grassia* Fisch, 1885.

1902. *Howardia* Theobald, J. Trop. Med. 5:182. TYPE SPECIES: *Anopheles costalis* Loew, 1866, So. Africa; original designation.—Preoccupied by *Howardia* Berlese & Leonardi, 1896 and *Howardia* Dalla Torre, 1897.

1902. *Cellia* Theobald, J. Trop. Med. 5:183, June 16; 1903, Monog. Culicidae 3:107, June 27. *TYPE SPECIES: *Anopheles pharoensis* Theobald, 1901, Egypt; original designation.

1902. *Myzomyia* Blanchard, Soc. de Biol., Compt. Rend. 54:795; July 4. *TYPE SPECIES: automatically *Anopheles rossi* Giles, 1899, India.—Substitute name for *Grassia* Theobald, 1902, preoccupied by *Grassia* Fisch, 1885.

1910. *Neomyzomyia* Theobald, Monog. Culicidae 5:29. *TYPE SPECIES: *M. elegans* James *in* Theobald, 1903, Karwar, India; monobasic.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—With all the varied development of the tribe except for the following. *Head:* palpus normally about as long as proboscis, always at least 0.7 of proboscis length; neck projecting directly forward and supported by long cervical sclerites. *Thorax:* mesonotum elongate, rather flat, and not strongly arched dorsally; scutellum evenly rounded and with a more or less even and continuous row of bristles on posterior border; *apn* more or less prominent and with bristles and sometimes scales; *ppn* without bristles or scales; *ppl* usually with bristles; *sp* with or without bristles; *stp* with upper and posterior bristles short, no hairs in the middle. *Legs:* dark or variously ornamented; tarsal segment 5 of all legs somewhat longer than segment 4, without bristly swelling ventrally at base, and with 2 small equal simple claws, sometimes with an indistinct tooth at extreme base. *Wing:* with or without distinct markings; vein R_3 always connected to R_{2+3} at base; cell R_2 always at least as long as vein R_{2+3}; only vein Cu_1 beyond *m-cu* rarely sinuate. *Abdomen:* scaling absent or restricted. *Genitalia:* not studied. *Buccopharyngeal Armature:* present or absent.

MALES.—Essentially as in the females, except for sexual characters. *Palpus:* segments 4 and 5 forming a conspicuous club and usually turned upward. *Antenna:* flagellum strongly plumose. *Legs:* segment 5 of foretarsus longer than or subequal to segment 4, with a bristly swelling at base ventrally and bearing only 1 enlarged claw with a submedian tooth and usually a basal tooth also; tarsal segment 5 and claws of other legs as in the female.

MALE GENITALIA.—*Segment IX:* tergite and sternite forming a very narrow but complete ring at base of sidepieces; tergite sometimes with a posterolateral lobe on each side. *Sidepiece:* simple, without distinct lobes; with 1–5 heavy bristles at base dorsally (parabasal spines) and sometimes with 1,2 mesosternal submedian internal heavy bristles (internal spines). *Claspette:* strongly and variously developed. *Clasper:* long and simple, with terminal spiniform. *Phallosome:* aedeagus variously developed, usually long and narrow, and with "leaflets" near apex; paramere and basal piece not studied in most species. *Proctiger:* truncate conical, largely membranous, and with slight lateral sclerotizations.

PUPAE.—Sternites III-VII with submarginal oblique ridges; hair 2-III-VII not spiniform; 3-VI distinctly mesad of 1-VI.

LARVAE.—*Head:* anterior border of labial plate obtusely produced cephalad; aulaeum a toothed plate; mental plate moderate to small; maxillary sutures often reaching posterior tentorial pits; clypeal hairs (2-4-C) varied in position and development but always in front and never spiniform; frontal hairs (5-7-C) in a more or less transverse line caudad of antennae, usually plumose; 13-C much smaller than 11-C and never strongly plumose; hair 15-C varied in position. *Antenna:* hair 1-A single or branched, varied in position; 4-A with a few branches at base or at most slightly pinnate. *Thorax:* hair 4-P nearer 5-P than 1-3-P; 1-M never palmate, usually with swollen stem and numerous lateral branches; 7-M cephalic; 8-M long and strongly plumose; 3-T simply branched or palmate; prothoracic pleural group (9-12-P) with all hairs on a common tubercle; metathoracic pleural group (9-12-T) with only 2 hairs long. *Abdomen:* tergal plates varied but segment VIII never with tergite largely covered by plate; hair 1 usually developed into a palmate tuft on at least some of the segments I-VII, rarely simple or branched; hairs 6,7-I,II large and plumose; 6-III strongly plumose; 6-IV,V varied, single, branched or plumose. *Spiracular Lobe:* anterior median lobe small, not prolonged into a slender process; posterolateral lobe without a fringe of long bristlelike spicules.

EGGS.—Varied in form, usually with lateral or dorsal floats.

SYSTEMATICS.—Because of its relation to human malarias, *Anopheles* has been the subject of more taxonomic work than any other mosquito genus. Unfortunately, practically all the studies have been local or regional in scope, and no attempt has been made to date to monograph the genus from a world standpoint. There is little agreement at present regarding the internal classification of the genus, although at least 4 subgenera are uniformly recognized: *Stethomyia* (Neotropical), *Anopheles* (widely distributed), *Nyssorhynchus* (Neotropical), and *Cellia* (Old World). In the Neotropical fauna, recent workers have recognized several additional subgenera. It is evident that in the American Mediterranean Region there are several annectent groups. Until these are thoroughly studied and evaluated, there is little basis for a natural classification of the genus. For the present I am following the system of Edwards (1932), as modified by subsequent workers, for the Old World fauna.

In the South Pacific only the group *Neomyzomyia* of the subgenus *Cellia* (=*Myzomyia*) is represented. This group is 1 of the 2 most generalized in the subgenus and is characterized as follows:

NEOMYZOMYIA.—*Females:* buccopharyngeal armature consisting of a single row of teeth; *apn* with tuft of scales; *ppl* with 1 or more hairs; *sp* bristles absent; femora and tibiae usually speckled or ringed; wings pictured, usually with numerous small dark areas on all the veins; abdomen without lateral scale tufts. *Male genitalia:* sidepiece with 4 parabasal spines and 1 accessory spine. *Pupae:* characters not studied. *Larvae:* hairs 2-C usually well separated; hair 1-A always short and single and usually on outer surface; long hairs of pleural groups usually all single or at most with 1 prothoracic and 1,2 metathoracic with a few branches.

Two complexes of 3 closely related species each are represented in the South Pacific: the *punctulatus* complex (*punctulatus, farauti, koliensis*) and the *lungae* complex (*lungae, nataliae, solomonis*). The characteristics of these complexes are given preceding the discussion of the included species.

BIONOMICS.—The general bionomics of *Anopheles* are briefly reviewed above under the tribe. Specific information on the South Pacific forms is given below for the 2 complexes and their included species. Members of the *punctulatus* complex attack man readily, while those of the *lungae* complex are sylvan species which apparently feed largely on birds. In general, the latter breed in undisturbed jungle, while the former reach their highest densities in close association with man in relatively open areas.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—Generalities have been briefly reviewed above under the tribe. Specific information on South Pacific forms will be found below under the 2 complexes and the individual species. All 3 members of the *punctulatus* complex are vectors of human malarias and periodic filariasis, but *farauti* is the most important because of its much wider distribution. The *lungae* complex is apparently not important in disease transmission.

DISTRIBUTION (fig. 37).—*Anopheles* is widely distributed through most of the world, but it is conspicuously absent from the majority of the islands of the Pacific, including the large ones of New Zealand, Fiji, and New Caledonia, where representatives of practically all the major and ancient tribes of the Culicidae are found. The apparent absence of *Anopheles* or any anopheline from New Zealand (and New Caledonia) is particularly significant, I believe. Suitable breeding sites for anophelines are numerous in New Zealand, and they must have existed when this group was populated by ancient culicid stocks, judging by the presence of several paradixines, which frequently use the same type breeding sites as anophelines. Furthermore, paradixines probably have even more limited powers of dispersal than anophelines. Therefore it is possible that anophelines were not present in the surrounding areas when the New Zealand group became isolated. However, negative evidence of this kind is not at all reliable, and it is possible that anophelines exist but have been overlooked in New Zealand, as well as in New Caledonia, that they have become extinct in these areas, or that they were represented in the past in adjacent areas by stocks which were not able to colonize New Zealand and New Caledonia. The present distribution of

Anopheles in the South Pacific appears to be the result of relatively recent (geologically) dispersal from the New Guinea area by way of the Solomons arcs and has not been extensive. In the South Pacific *Anopheles* occurs only in the Solomons, the Santa Cruz Islands, and the New Hebrides. *A. farauti* is found throughout this range, but all the other species, as well as *Bironella hollandi,* are restricted to the Solomons proper.

KEYS TO SPECIES

See keys to genera and species, pp. 126–128

PUNCTULATUS COMPLEX

FEMALES.—Medium in size, wing usually 3–4 mm. *Head:* integument dark throughout; erect scales rather short and broad, white in center of disc, dark laterally; frontal tuft of very long slender white scales; labium variable in ornamentation but always with a very narrow extreme apical light ring; labella light brown; palpal segments 4 and 5 light-scaled except for narrow basal black-scaled ring on each, segment 3 variable in ornamentation, segment 2 with an apical light ring, remainder usually dark but sometimes with variable number of lighter scales dorsally near base; antennal torus with a few small white scales; flagellar segment 1 with a patch of elongate white scales, subequal in size to segments 2 and 3 combined. *Thorax:* mesonotum light yellow brown to dark brown, darker "eye spots" anterior to scutal angle and a dark prescutellar space; anterior promontory with sparse elongate erect white scales in center, somewhat shorter and broader scales in lateral tufts, light above and dark below; remainder of mesonotum with vestiture of moderately broad decumbent yellowish white scales and golden hairs, scales somewhat longer in front and above wing base; scutellar disc dark, with a few whitish scales smaller than on mesonotum; paratergite light brown; mesonotal and scutellar bristles golden brown; pleural integument dark brown, with usual gray pollinose light areas and darker areas; *apn* with a dorsal patch of broad erect dark scales and numerous dark bristles; *ppl* usually with 2,3 bristles (1–6); 4–6 *pra* bristles; upper *stp* with 5–7 bristles and a patch of 6,7 broad decumbent light scales, lower *stp* usually with 4 bristles and a patch of 5,6 similar scales; 4–10 upper *mep* bristles; all pleural bristles rather light, no scales or bristles elsewhere on pleuron. *Legs:* coxae and trochanters light brown; remainder of legs with light brown to black scales and with yellowish white scale markings; forefemur swollen in basal half, light at base, speckled and blotched with light scales along anterior and posterior surfaces; midfemur and hindfemur speckled with light scales; foretibia with evenly spaced small light spots on dorsal surface, ventral surface light, anterior dark, posterior speckled with light areas, the majority of which connect with light ventral area; midtibia and hindtibia speckled with light, more extensively on ventral surface; segment 1 of all tarsi with light apex and a variable number of light spots, which expand laterally and ventrally reducing the dark areas on ventral surfaces; foretarsal segments 2 and 3 light at base and apex, central dark area often reduced ventrally, segment 4 light at base and usually apex, dark central area of segments 2–4 sometimes with light spots, segment 5 light or dark, all segments usually much lighter ventrally; midtarsal and hindtarsal segments 2–4 with narrow apical light bands, segments 2 and 3 frequently with 1 or more light spots in dark area, segment 2 usually lighter on ventral and posterior surfaces, segment 5 usually all dark; claws normal. *Wing* (fig. **43**): as figured but extremely variable; C with 4 large dark spots in addition to 3 small humeral dark spots; small sectoral dark spot present or absent between basal and median dark spots; small dark spots on R_1 below median dark spot and also below subapical dark spot may coalesce, giving a much darker appearance to wing; all veins caudad of R and R_1 with numerous dark spots; light scales yellowish white, yellowish tinge stronger on C; fringe dark but with light spots at apices of all veins. *Haltere:* light at base, dark-scaled on knob. *Abdomen:* integument dark brown; vestiture of golden hairs denser on posterior segments; scales absent on tergites I-V and sternites I-VI, a few scales on tergites VI,VII and sternite VII, rather dense scaling on tergite and sternite VIII. *Genitalia:* not studied; cercus with dark scales at base and light on apex. *Buccopharyngeal Armature* (fig. **43**): consisting of several teeth of similar character in a single row; apex of tooth deeply serrate; base of tooth with a bulla and a stout denticle on each side.

MALES.—Essentially as in the females, except for usual sexual characters.

MALE GENITALIA.—Apparently very uniform in complex and apparently indistinguishable from the *lungae* complex. *Segment IX:* tergite deeply and broadly emarginate on caudal border, which is distinctly sclerotized across from side to side, no distinct tergite lobes. *Sidepiece:* with usual scales; parabasal setae in a lower group of 3 followed by a single heavy seta about halfway between this group and the more slender accessory seta; several short but rather heavy setae ventrad of parabasal group. *Claspette:* club formed from 4–6 apically fused setae; apical seta only slightly longer than club; 2–4 smaller bristles near apical seta. *Clasper:* strongly and evenly curved; a row of short evenly spaced hairs from base to near apex, some longer hairs near apex; spiniform slender, apical. *Phallosome:* aedeagus moderately slender, with 8–10 smooth leaflets.

PUPAE.—External margin of paddle with fringe of fine long setiforms; impossible to determine group characters since very few *Cellia* pupae have been fully described or figured.

FOURTH INSTAR LARVAE.—*Head:* maxillary sutures not quite reaching posterior tentorial pits; inner clypeals (2-C) widely separated; outer clypeal (3-C) extending at least half its length beyond front margin of head; posterior clypeal (4-C) single or double; 15-C placed far forward. *Antenna:* spicules small; hair 1-A minute, single, arising near base on outer surface; 4-A with a few branches. *Thorax:* all long hairs in pleural groups (9–12) single; hair 1-M with thickened shaft; 3-T with lanceolate leaflets or simple branches, never strongly palmate. *Abdomen:* anterior tergal plates small; hair 1 palmate on at least II-VII, leaflets usually notched and serrate on those of middle segments at least.

FIRST INSTAR LARVAE.—*Head:* hairs unbranched except 11-C, which is bifurcate from near base; hair 2-C sometimes slightly barbed. *Antenna:* hair 1-A single, less than 0.25 of shaft length; 4-A single. *Thorax:* hairs 1,2-P, 1-M, 1,3-T lanceolate.

EGGS.—Apparently quite similar in *punctulatus, farauti,* and *koliensis;* studied in the field only, available preserved material not adequate for detailed description. *Frill:* complete and low; the two edges of the frill on dorsal surface widely separated, distance between them in middle of dorsal surface as great as or greater than between the frill and upper edge of float on each side.

SYSTEMATICS.—There has been a great deal of controversy and confusion regarding this complex, both taxonomically and nomenclaturally. Rozeboom and Knight (1946:95–131) studied the complex in greater detail and over a wider area than anyone else and came to the conclusion that it consists of 4 distinct species: *punctulatus, farauti, koliensis* (the latter 2 =*moluccensis* of authors), and *clowi* Rozeboom & Knight, 1946. Their investigations show that there is considerable geographical variation in the first 3 species. The conflicting reports on the bionomics of these 3 forms from different areas are a further indication of the existence of geographical races.

On Guadalcanal, where *punctulatus, farauti,* and *koliensis* all occur, numerous rearings of progenies of individual wild-caught females of all 3 forms have clearly established the fact that *koliensis* does not consist of intermediate individuals which are produced by hybridization between the other 2 forms (as has been suggested by some workers) but is really a distinct species (Belkin, Knight, and Rozeboom, 1945). There is considerable variation—individual, ecological, and geographical—within each of these species; specimens of *punctulatus* may rarely be confused with *koliensis,* the latter with *farauti,* and some *farauti* may be mistaken for *koliensis.* However, in such instances the similarity is in 1 character and 1 stage only, indicating, I believe, overlapping of extreme variation of that particular character in 3 distinct but closely related species. The view that the 3 forms are distinct species is supported also by field evidence from various areas where *koliensis* occurs but where no *farauti* or *punctulatus* are found. On the northwest coast of Guadalcanal, *farauti* and *punctulatus* are found together rather frequently in the same breeding site, but no true *koliensis* has ever been collected there. On the other hand, on the north-central coast of Guadalcanal, *farauti* and *koliensis* are frequently found together, but *punctulatus* has been found associated with them only once.

My impression is that *koliensis* is a good species of hybrid origin between *farauti* and *punctulatus.* This hybridization probably took place relatively recently between 2 forms which originally occupied different ranges. Perhaps in some areas, under certain ecological conditions, hybrid individuals are produced between *farauti* and *punctulatus;* this does not alter either the fact that *koliensis* is a true species capable of maintaining itself independently or the fact that *farauti* and *punctulatus* are also good species. On the basis of the geographical relations, I suggest that *farauti* is the oldest of the 3 species, that *punctulatus* differentiated at a later date in the New Guinea area, and the *koliensis* was formed relatively recently in the same general area when the former 2 species came together.

A. punctulatus is very distinctly different from *koliensis* and *farauti* in all stages, although occasional difficulties may be encountered in separating its larvae and pupae from those of the others. On the other hand, *koliensis* and *farauti* are much more similar, and, because *farauti* exhibits considerable geographical variation in the immature stages, these are often difficult to tell apart in some areas, even in the Solomons.

Much more work is needed on the taxonomy, ecology, and zoögeography of the *punctulatus* complex. What has been done so far gives us only a glimpse of a most interesting problem whose solution may contribute to a better understanding of evolutionary processes and speciation in tropical regions. I have made no attempt to study in detail the great amount of valuable material accumulated during World War II. To analyze it carefully would take several years of intensive work. Almost one-fourth of all the mosquito specimens examined from the South Pacific for this study belong to this complex, as do all the progeny rearings and more than half of the individual rearings. Most of this material is in the collections of the U.S. National Museum and the University of California, Los Angeles.

The affinities of the *punctulatus* complex have not been studied, but it appears that the nearest relative is *annulipes* Walker, 1856, which is dominantly Australian.

BIONOMICS.—The 3 important members of the complex are found breeding most abundantly in open situations, reaching their highest densities in sunlit pools in close association with man. Although all 3 species may be found together in the same breeding site, *punctulatus* is usually found in the interior and in narrow valleys while *farauti* and *koliensis* are both found predominantly along coasts and broad low-lying valleys. At least *punctulatus* and *farauti* are sometimes found in fair numbers considerable distances away from man in undisturbed partially shaded breeding sites.

Females of *punctulatus, farauti,* and *koliensis* attack man very readily. All 3 species are most inconspicuous and wary when approaching to feed; their bites are usually not felt at all. *A. punctulatus* and *farauti* also feed readily on a variety of domestic and probably wild mammals and on birds. There is a great deal of difference in the feeding and resting habits not only in the 3 different species but also in different populations of the same species. These are discussed under each species below.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—*A. farauti, punctulatus,* and *koliensis* are undoubtedly the most important vectors of human malarias and periodic filariasis wherever they occur. Because of its wider range, *farauti* is the most important, and sometimes the only, vector in the South Pacific.

DISTRIBUTION (figs. 38, 39).—The *punctulatus* complex is represented by 1 or more species from the Moluccas (and possibly Celebes), on the west, through New Guinea and adjoining islands south of the equator, to the Santa Cruz group and the New Hebrides, to the east, and to the north and northeast Australia to the south. In the South Pacific *punctulatus, farauti,* and *koliensis* have been reliably reported from the Solomons but only *farauti* from the Santa Cruz Islands, the Banks Islands, and the New Hebrides. Elsewhere, the published records and distribution maps of individual species are not reliable because of the confusion in the taxonomy and nomenclature in this complex. I have made no attempt to verify all the records outside the South Pacific but find glaring errors in the published distribution maps of Lee and Woodhill (1944:139), U.S. Navy (1946:17, 29), King (1949:506), and Bonne-Wepster and Swellengrebel (1953:358).

1. Anopheles (Cellia) farauti Laveran

Figs. 39, 43-45, 48

1902. *Anopheles farauti* Laveran, Soc. de Biol., Compt. Rend. 54:908–909. TYPES: syntypes, 6 ♀ on 3 slides, Faureville, Efate, New Hebrides, Jan., 1902, Dr. Faraut (PASTEUR, *fide* Reid, 1947:90).

1920. *Nyssorhynchus annulipes* var. *moluccensis* Swellengrebel and Swellengrebel de Graaf, Burgerl. Geneeskundig Dienst in Nederland.-Indië, Meded. 8(9) Addendum, p. 1; Geneeskundig Tijdschr. Nederland.-Indië 60:29–33; B. Ent. Res. 11:78–81. TYPES: syntypes, 5 ♀, 3 ♂, Moluccas and New Guinea (location unknown, probably lost).—Synonymy with *farauti* by Knight and Farner (1944).

Anopheles (Cellia) farauti of Stone, Knight, and Starcke (1959).
Anopheles (Myzomyia) farauti of Belkin, Knight, and Rozeboom (1945:258–261);

Perry (1946:12–13); Rozeboom and Knight (1946); Knight and Chamberlain (1948; figs. 3, 31); Smart (1948, 1956:154, 182); Penn (1949*a*:18–19); King (1949:511–512); Bick (1951:398–399); Bonne-Wepster and Swellengrebel (1953:346–349); Iyenger (1955:22); Laird (1956); Rageau (1958*a*:877); Rageau and Vervent (1958:15); Senevet (1958:87–88); and numerous authors.

Anopheles (*Myzomyia*) *farauti farauti* of Knight, Bohart, and Bohart (1944:11, 57).

Anopheles (*Myzomyia*) *punctulatus farauti* of Knight and Farner (1944) and authors.

Anopheles (*Myzomyia*) *punctulatus moluccensis* of Ross and Roberts (1943:11, 12); Lee and Woodhill (1944:140–146); and authors.

Anopheles punctulatus moluccensis of Russell, Rozeboom, and Stone (1943:139).

Anopheles (*Myzomyia*) *punctulatus* of Edwards (1924:354–355; 1932:49; both in part); Buxton and Hopkins (1927:67–69); Paine and Edwards (1929:304); and authors.

Anopheles punctulatus var. *moluccensis* of Edwards (1921*a*:71); Taylor (1934:10).

FEMALE (fig. 43).—*Wing:* 3.5 mm. *Proboscis:* 1.9 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.5 mm. As for the complex, with the following diagnostic features. *Labium:* entirely dark-scaled except for a very narrow extreme apical light ring. *Palpus:* segment 3 usually less extensively white-scaled than in *punctulatus,* sometimes completely dark, apical or subapical light rings usually both reduced. *Wing:* usually a small dark sectoral spot on vein C between basal and median dark spots. *Buccopharyngeal Armature:* as figured.

MALE.—Essentially as in the female, except for sexual characters, as for the complex. *Labium:* entirely dark-scaled except for a very narrow extreme apical light ring.

MALE GENITALIA (fig. 44).—As figured; apparently indistinguishable from other members of the complex.

PUPA (fig. 44).—*Abdomen:* 2.88 mm. *Trumpet:* 0.42 mm. *Paddle:* 0.75 mm. Chaetotaxy as figured; diagnostic characters as in the key; pigmentation usually strong and uneven, with darkened areas. *Trumpet:* orange brown, strongly contrasting with lighter portions of integument of cephalothorax. *Abdomen:* hairs 9-II-IV progressively longer but of the same order of magnitude; 9-V usually 2.0 or more length of 9-IV; 9-V-VII usually barbed or frayed; 9-VIII usually shorter than median tergal lobe of IX; 1-II usually less than 10b.

FOURTH INSTAR LARVA (fig. 45).—*Head:* 0.67 mm. *Anal Saddle:* 0.34 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* strongly and unevenly pigmented, usually with conspicuous pattern of dark areas; aulaeum narrow apically, with a single large median tooth and with lateral teeth small and indistinct except for subapical pair; hair 2-C usually strongly barbed or even forked; 3-C usually more than half length of 2-C, frequently barbed; 4-C usually 1,2b and extending beyond tubercles of 2,3-C; 8-C long, usually 1,2b; 9-C rather short, usually 1-4b. *Antenna:* strongly pigmented, usually uniformly but frequently with apex darkened. *Thorax:* tubercles of 1-P and 2,3-P strong, heavily pigmented, and usually fused; stem of 1-P usually strongly swollen; hair 3-T usually with lanceolate leaflets. *Abdomen:* hair 1-I usually distinctly palmate, always with distinct flattened leaflets, sometimes notched; 1-II-VII all small palmate hairs, 1-II only slightly smaller than 1-III and with leaflets serrate and pigmented; 2-IV,V usually forked apically; 6-IV,V usually double. *Anal Segment:* saddle usually broader and more heavily pigmented than in *punctulatus;* hair 1-X arising some distance dorsad of ventral margin.

FIRST INSTAR LARVA (fig. 48).—Indistinguishable from *koliensis;* hair 2-M with somewhat thickened basal part and with long distal barbs or forks.

EGG.—See under *punctulatus* complex above.

MATERIAL EXAMINED.—12,249 specimens; 2,514 ♀; 1,495 ♂; 1,895 pupae; 6,345 larvae; 1,110 individual rearings (1,096 larval, 14 pupal).

SYSTEMATICS.—*A. farauti* shows relatively little variation in adult female characters. The ornamentation of the labium appears to be absolutely constant throughout the entire range of the species. However, the palpal and wing ornamentation is quite variable; this is noticeable even in the different populations from the South Pacific (Rozeboom and Knight, 1946:102–103).

The immature stages of *farauti* are extremely variable. There are indications of strongly marked geographical races not only in widely separated areas (Rozeboom and Knight, 1946) of the very wide range of the species but sometimes in populations occupying nearby islands. Frequently these variations involve characters which are diagnostic elsewhere in the range; this makes it difficult to identify *farauti* by a single set of larval or pupal characters. It is also evident that, at least in some areas, there is a great deal of individual variation, some of which appears to be correlated with the type of breeding site. No attempt has been made to analyze carefully the samples of various populations available for this study. However, the following random notes are presented here to call attention to some obvious larval differences observed in some populations from the South Pacific:

(1) *Bougainville populations:* Outer clypeals (3-C) extremely variable, from short and heavily barbed to very long and sparsely barbed; inner clypeals (2-C) frequently lightly barbed or simple.

(2) *New Georgia populations:* Outer clypeals (3-C) rarely short and apically forked.

(3) *Guadalcanal populations:* Inner clypeals (2-C) weakly barbed, rather frequently simple; tubercles of prothoracic shoulder hairs (1-3-P) sometimes not fused; abdominal hair 1-I often with leaflets not notched. Larvae from more shaded habitats, usually some distance from human dwellings, are more heavily pigmented and have strongly branched anterior clypeals (2,3-C), very heavy fused shoulder hair tubercles (1-3-P), and hair 1-I very strongly developed.

(4) *Santa Cruz populations:* On the island of Temotu (Malo), the palmate hairs usually have very long leaflets which are often not at all notched, while in the nearby Graciosa Bay area of the island of Santa Cruz, the palmate hairs are "normal."

(5) *New Hebrides populations:* Inner clypeals (2-C) nearly always strongly barbed or forked.

BIONOMICS.—*A. farauti* is the dominant species of the complex in the South Pacific and has the widest range of breeding sites. Its natural breeding places consist primarily of river and stream margins with vegetation, springs, seepage areas, ponds, lagoons, and temporary ground pools of all sizes, all in open coastal areas or in wide river valleys. Even when these breeding areas are reduced, *farauti* does not invade densely shaded habitats, such as canebrake marshes or jungle swamps filled with floating and emergent vegetation. This species is remarkably tolerant to organic pollution and may occur in brackish water with a salinity up to 70 per cent that of sea water. It reaches its highest densities in areas occupied by man and is particularly abundant in wells, taro gardens, ditches, and temporary rain pools in open coastal areas. When this species is denied breeding areas on the ground, or when it becomes extremely abundant, it will breed in artificial containers to a limited degree. It has been reported from boats, canoes, tanks, oil drums, water collections in canvas, and even in small tin cans. However, it does not utilize water collections in or on plants or plant parts, such as treeholes, leaf or frond axils, coconut shells, or cacao pods. *A. farauti* has a definite preference for open sunlit areas but is frequently found in large numbers under partial shade. In almost all instances, breeding in extensive water areas is associated with flotage and emergent or surface vegetation. The aquatic cycle appears to be considerably longer than in *punctulatus* and is probably in the neighborhood of 10 days under favorable conditions.

A. farauti apparently can obtain blood from a variety of warm-blooded vertebrates from birds to man. There is some indication that there exist strains which have a preference for certain of these hosts; for instance, on Guadalcanal females reared from breeding places in areas distant from human occupation would not feed on man. Blood-feeding activity usually begins at dusk and probably continues through the night to dawn. Occasional attacks in the daytime have been reported not only in shaded areas but even in bright sunlight. Females feed most commonly in the open but will enter dwellings readily; some remain there after the blood meal. They are not attracted but are rather repelled by artificial lights; therefore their density cannot be determined by the use of light traps. Many different types of mechanical or animal-baited traps for this species and other anophelines in the Solomons were tried, but all were completely unsuccessful. The diurnal resting places for males and females apparently consist of nearly any cool, moist, and shaded spot. Rarely is this species found concentrated in any natural resting place, but blooded females are sometimes found in moderate numbers in human dwellings. Therefore the only reliable method of determining adult densities of this species is by means of night hand catches in selected areas.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—Although it is quite evident on epidemiological grounds that *farauti* is a most important vector of human malarias probably everywhere it occurs, there are no published data on natural infection rates of this species in the South Pacific. On Guadalcanal, over a thousand females of *farauti* from various sources were dissected, but none were found to harbor *Plasmodium* sp. However, these surveys were carried out at a time when the control program was effective and, in addition, included only some 200 specimens from native villages. There can be no question that *farauti* is the malaria vector in the New Hebrides and the Santa Cruz group, where it is the only *Anopheles* present. In the Solomons, it is the only or the dominant *Anopheles* in most native villages with the highest incidence of malaria and is undoubtedly the important vector in these situations. In some other areas in the Solomons, notably the north coast plain of Guadalcanal, *koliensis* and *punctulatus* may occur in addition to *farauti*. There has been some question as to which of the 3 was the chief vector of the malaria epidemic during the early period of occupation of Guadalcanal by American troops in World War II. Owen (1945:240) emphasized that *koliensis* had a greater preference for entering human dwellings than the 2 other species. This, coupled with the fact that at this same time difficulties were encountered in making *farauti* feed on man and no natural infections could be shown in this species, led to the interpretation that *farauti* was not an important malaria vector on Guadalcanal, that *koliensis* was the chief vector, and that where it had been controlled elsewhere on the occupied parts of the island malaria transmission had been eliminated. Such a view is not consistent with the fact that *farauti* was the dominant species collected during the early period of occupation as well as in pre-World War II collections from Guadalcanal. I believe that *farauti* is the most important malaria vector on Guadalcanal, as elsewhere in the Solomons. However, both *koliensis* and *punctulatus* are undoubtedly important vectors, at least in some localities.

A. farauti is an efficient vector of human periodic filariasis. Schlosser (1949:740) found 24 per cent of 195 female *farauti* naturally infected with microfilaria of the *Wuchereria bancrofti* type in a native village on Guadalcanal. He also infected experimentally Guadalcanal *farauti* reared from eggs with *W. bancrofti* from San Cristobal natives and obtained a heavy rate of infection and complete development of the worms. Byrd and St. Amant (1959) report a natural infection rate of 13.72 per cent of 1,239 *farauti* in the New Hebrides and 51.9 per cent of 655 *farauti* on Guadalcanal. In addition, Schlosser (*loc. cit.*) found what appeared to be *Dirofilaria immitis* larvae in *farauti* from a native village on Guadalcanal.

DISTRIBUTION (figs. 38, 39).—*A. farauti* is the only species found throughout the entire range of the *punctulatus* complex and has the only wide distribution in the South Pacific; part of its distribution in the South Pacific is undoubtedly owing to dispersal through human agency. *Solomon Islands:* Bougainville; Treasury; Kolombangara; New Georgia; Roviana; Santa Isabel; Russell; Florida; Tulagi; Savo; Guadalcanal; Malaita; San Cristobal; Malaupaina; Ontong Java; Sikiana; Rennell; Bellona. *Santa Cruz Islands:* Santa Cruz; Temotu; Tikopia. *Banks Islands:* Pakea; Vanua Lava; Santa Maria. *New Hebrides:* Espiritu Santo; Aore; Malo; Malekula; Ambrym; Emae; Efate; Tana; Aneityum. Also known from the *Bismarck Archipelago, Admiralties, New Guinea* and adjacent islands, *Australia* (Queensland, Northern Territory), *Moluccas, Peleng,* and *Banda Islands.*

2. Anopheles (Cellia) punctulatus Doenitz

Figs. 39, 43, 46-48

1901. *Anopheles punctulatus* Doenitz, Insektenboerse 18:36: TYPES: syntypes, ♂ and ♀, Stephansort (near Bogadjim), New Guinea, and Bismarck Archipelago (BERLIN).

Anopheles (*Cellia*) *punctulatus* of Stone, Knight, and Starcke (1959).

Anopheles (*Myzomyia*) *punctulatus* of Belkin, Knight, and Rozeboom (1945:253–258); Rozeboom and Knight (1946); Smart (1948, 1956:154, 182); Penn (1949*a*:16–18); King (1949:510–511); Bick (1951:400–402); Bonne-Wepster and Swellengrebel (1953:338–346); Iyengar (1955:22); Laird (1956); Senevet (1958:88).

Anopheles (*Myzomyia*) *punctulatus punctulatus* of Ross and Roberts (1943:11, 12); Knight, Bohart, and Bohart (1944:11, 58); Lee and Woodhill (1944:134–138); and authors.

Anopheles punctulatus punctulatus of Russell, Rozeboom, and Stone (1943:138–139).
Anopheles (*Myzomyia*) *punctulatus* in part of Edwards (1932:49).
Anopheles (*Myzomyia*) *punctulatus* var. *moluccensis* of Edwards (1924:354).

FEMALE (fig. 43).—*Wing:* 3.3 mm. *Proboscis:* 1.8 mm. *Forefemur:* 1.6 mm. *Abdomen:* about 2.3 mm. As for the complex, with the following diagnostic features. *Labium:* apical third to half usually entirely pale-scaled except for a narrow subapical dark ring and scattered dark scales ventrally; separation between pale portion and dark basal portion not sharply marked; sometimes a few to numerous dark scales dorsally on pale portion; subapical dark ring occasionally absent. *Palpus:* segment 3 usually with narrow apical light ring and a broad subapical light band separated by a narrow dark ring, occasionally the 2 pale areas fused to form a very broad apical pale band. *Wing:* usually a small dark sectoral spot on vein C between basal and median dark spots. *Buccopharyngeal Armature:* as figured.

MALE.—Essentially as in the female, except for sexual characters, as for the complex. *Labium:* with at least 2 or 3 ventral pale-scaled spots, usually with large patches of light scales.

MALE GENITALIA (fig. 46).—As figured; apparently indistinguishable from other species of the complex.

PUPA (fig. 46).—*Abdomen:* 2.62 mm. *Trumpet:* 0.39 mm. *Paddle:* 0.74 mm. Chaetotaxy as figured; diagnostic characters as in the key; pigmentation very light throughout. *Trumpet:* pale, not contrasting with integument of cephalothorax. *Abdomen:* hairs 9-II-IV all of the same order of magnitude; 9-V usually at least 3.0 length of 9-IV; 9-V-VII long, slender, and rarely barbed or frayed; 9-VIII long and slender, distinctly longer than median tergal lobe of IX; hair 1-II at least 10b, usually 12-15b.

FOURTH INSTAR LARVA (fig. 47).—*Head:* 0.65 mm. *Anal Saddle:* 0.30 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* lightly pigmented; aulaeum rather broad apically, with a single large median tooth and with lateral teeth large and distinct; hair 2-C usually simple; 3-C simple, usually half or less of 2-C in length; 4-C single, usually reaching level of tubercles of 2,3-C; 8-C long, usually 1,2b; 9-C long, usually 1-3b, rarely 4b. *Antenna:* uniformly lightly pigmented. *Thorax:* tubercles of 1-P and 2,3-P small, unpigmented, and usually separate; stem of 1-P usually slender but rarely swollen; hair 3-T usually with simple branches, not at all lanceolate. *Abdomen:* hair 1-I with short simple branches; 1-II-VII all small palmate hairs, 1-II distinctly smaller than 1-III and with leaflets more slender, not pigmented; 2-IV,V usually 3,4b from base; 6-IV,V usually triple. *Anal Segment:* saddle usually poorly pigmented; hair 1-X arising at or very near its ventral margin.

FIRST INSTAR LARVA (fig. 48).—Hair 2-M gradually attenuate to apex, not thickened markedly in basal half, and without long distal barbs.

EGG.—See under *punctulatus* complex above.

MATERIAL EXAMINED.—10,145 specimens; 2,582 ♀; 2,117 ♂; 2,242 pupae; 3,204 larvae; 466 individual rearings (458 larval, 8 pupal).

SYSTEMATICS.—As pointed out by Rozeboom and Knight (1946), *punctulatus* appears to be remarkably free of conspicuous differences in the diagnostic characters mentioned above even in the two widely separated populations from Hollandia, New Guinea, and Guadalcanal, in the Solomons. However, individual variation on Guadalcanal is considerably greater than mentioned by these authors. This is particularly noticeable in the light scaling of the female labium, which is frequently obscured by a variable number of somewhat darker scales. Usually almost half of the labium is light-scaled, but rarely this may be reduced to about a third. However, there is never any difficulty in separating even these extremes from the most strongly marked *koliensis.* Although a careful analysis was not made of larval characters, it is evident that considerable variation is present. It is sometimes quite difficult to separate some *punctulatus* larvae from *koliensis* on the basis of the development of hair 1-P; quite frequently this hair is considerably thickened in *punctulatus* and indistinguishable from that of *koliensis;* similarly the tubercles of hairs 1-P and 2,3-P are frequently very much alike in the 2 species. I find that *koliensis* and *punctulatus* on Guadalcanal can be more easily distinguished on the basis of the development of the aulaeum and pigmentation of the antenna, as indicated in the key.

BIONOMICS.—"On Guadalcanal, the species is restricted to the valleys of the larger streams and rivers, usually occurring in the vicinity of native villages away from the coast. Larvae have been collected most frequently exposed to sunlight in road ruts and other temporary pools such as depressions and footprints in native trails. The margins of streams and sloughs in exposed situations and potholes in drying stream beds are also utilized occasionally, particularly during the dry season. The pools in which this species occurs may be entirely free of vegetation and flotage and infrequently are very muddy, or may have marginal herbaceous vegetation and dense algal growth. *A. punctulatus* has a very decided preference for breeding in sunlight, but is also found in partial shade. During periods of dry weather this species almost disappears as its chief breeding places are greatly reduced. At such times it resorts to breeding in streams. After an occasional heavy rain it appears in large numbers in temporary pools. During the rainy season *punctulatus* extends its range into the coastal plain near the mouths of the rivers and utilizes the same breeding places as *farauti*." (Belkin, Knight, and Rozeboom, 1945:257).

The development of the immature stages of *punctulatus* appears to be more rapid than that of the other members of the complex. The entire aquatic cycle may be completed in less than a week. Eggs apparently may be laid on moist soil, and hatching takes place in less than 2 days after oviposition. In a given batch of eggs, all the first instar larvae appear to hatch within an hour, and development proceeds at a strikingly uniform rate throughout the aquatic cycle. Therefore *punctulatus* may reach very high densities in very short periods of time when favorable environmental conditions are present.

A. punctulatus feeds very readily on man and domestic animals in New Guinea (Horsfall, 1955:276), but its blood-feeding habits, resting habits, and periods of activity are apparently quite variable in different areas. Unfortunately little specific information is available for most areas. Belkin, Knight, and Rozeboom (1945:258) reported the scarcity of adults of *punctulatus* in areas of high larval densities of this species on Guadalcanal. Later, investigations were carried on in these same areas around the Poha River villages. No adults were collected in the evenings or at night up to 2 A.M., but large numbers of females were found the following mornings in bed nets but not in the huts in the native villages. It seems very likely therefore that, on Guadalcanal at least, *punctulatus* is active during the early hours of the morning and that normally it does not remain in human dwellings during the day. Diligent searches for diurnal resting places in the neighborhood of these villages failed to reveal *punctulatus* anywhere in the vicinity, including moist stream banks such as were found to harbor this species in New Guinea (Horsfall and Porter, 1947:555–556).

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—*A. punctulatus* is an efficient vector of human malarias in New Guinea; in some areas it is apparently the most important vector (Horsfall, 1955:277). It is also undoubtedly involved in the transmission of human periodic filariasis, as it has been found naturally infected in native villages where this disease was prevalent (Horsfall, 1955:190).

In the Solomons, *punctulatus* may not be as important as *farauti* in the transmission of human pathogens, chiefly because it does not seem to have as wide a distribution. However, this may be misleading, for most of the data on the distribution of anophelines in the Solomons were obtained from coastal areas occupied by American troops during World War II and largely only after control measures had been in effect. More recent surveys by Laird (summarized in 1956:30–36) suggest that under more natural conditions *punctulatus* is much more prevalent and more widely distributed even along the north-central coast. In addition, it is also probably the dominant anopheline in villages of the interior. As far as I have been able to determine, *punctulatus* is the only anopheline found to be naturally infected by *Plasmodium* of probably human origin on Guadalcanal by American entomologists who dissected over a thousand specimens (Schlosser, 1949:740). In the Poha villages 15 per cent of 200 female *punctulatus* were also found to harbor filarial worms which were probably *W. bancrofti* (Schlosser, 1949:740).

DISTRIBUTION (fig. 39).—*Solomon Islands:* Bougainville; Savo; Guadalcanal; the distribution in the Solomons may be much greater than our present records indicate, as has been suggested in the preceding paragraph. *A. punctulatus* has been reported in literature from the entire range of *farauti*, but the majority of these records appear to be in error owing to the confusion in the nomenclature and taxonomy of the complex. It is not known in the South Pacific outside the Solomons and does not occur in Australia. Apparently the only other reliable records are from the *Bismarck Archipelago* and *New Guinea*. The distribution maps in Lee and Woodhill (1944:139), U.S. Navy (1946:29), King (1949:506), and Bonne-Wepster and Swellengrebel (1953:358) do not appear to be reliable, although I have made not attempt to verify all the records.

3. Anopheles (Cellia) koliensis Owen

Figs. 39, 43, 48-50

1945. *Anopheles koliensis* Owen, J. Parasitol. 31:326–240. *TYPE: holotype ♂, Koli area, Guadalcanal, Solomon Islands, from temporary ground pool, Aug. 6, 1944, W. B. Owen (USNM, no type number).

Anopheles (*Cellia*) *koliensis* of Stone, Knight, and Starcke (1959).

Anopheles (*Myzomyia*) *koliensis* of Belkin, Knight, and Rozeboom (1945:261–262); Rozeboom and Knight (1946); Smart (1948, 1956:154, 182); Penn (1949*a*:20–21); King (1949:512–513); Bonne-Wepster and Swellengrebel (1953:349–352); Iyengar (1955:22); Laird (1956); Senevet (1958:88); and authors.

Anopheles farauti moluccensis of Knight, Bohart, and Bohart (1944:11, 57) and authors.

Anopheles punctulatus, intermediate form, of King (1949:512) and authors.

FEMALE (fig. 43).—*Wing:* 3.0 mm. *Proboscis:* 1.7 mm. *Forefemur:* 1.5 mm. *Abdomen:* about 2.3 mm. As for the complex, with the following diagnostic features. *Labium:* dark-scaled except for extreme apical light ring and a restricted ventral subapical patch of light scales in distal third, sharply differentiated from dark scales ventrally, sometimes extended dorsally to form incomplete light ring. *Palpus:* segment 3 intermediate between *punctulatus* and *farauti*, usually with both apical and subapical light rings. *Wing:* usually without a separate sectoral dark spot on vein C between basal and median dark spots. *Buccopharyngeal Armature:* as figured.

MALE.—Essentially as in the female, except for sexual characters, as for the complex. *Labium:* variable, usually dark-scaled except for a very narrow extreme apical light ring, sometimes with a few light scales ventrally.

MALE GENITALIA (fig. 49).—As figured; apparently indistinguishable from other members of the complex.

PUPA (fig. 49).—*Abdomen:* 2.66 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.62 mm. Chaetotaxy as figured; diagnostic characters as in the key; pigmentation usually strong and rather uniform, as in *farauti. Trumpet:* orange brown, strongly contrasting with lighter integument of cephalothorax. *Abdomen:* hair 9-IV not of the same order of magnitude as 9-II,III, usually at least 3.0 length of 9-III and only slightly shorter than 9-V; 9-IV-VII usually somewhat thickened, rarely with barbs; 9-VIII about as long as median tergal lobe of IX; hair 1-II usually less than 10b.

FOURTH INSTAR LARVA (fig. 50).—*Head:* 0.58 mm. *Anal Saddle:* 0.29 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* rather lightly and uniformly pigmented, usually without conspicuous pattern of dark areas; aulaeum narrow apically, usually with a pair of median teeth and with lateral teeth small and inconspicuous; hair 2-C frequently lightly barbed; 3-C usually at least half length of 2-C, frequently barbed; 4-C usually single, nearly always short, not reaching tubercles of 2,3-C; 8-C usually short and 2-4b; 9-C rather short, usually 4-6b. *Antenna:* uniformly and rather lightly pigmented but frequently with apex darker. *Thorax:* tubercles of 1-P and 2,3-P quite strong, but usually lightly pigmented, separate or fused; stem of 1-P usually swollen; hair 3-T usually with lanceolate leaflets. *Abdomen:* hair 1-I always with simple branches, not at all flattened; 1-II-VII all small palmate hairs, 1-II distinctly smaller than 1-III but with leaflets distinctly serrate and pigmented; 2-IV,V usually forked apically (2,3f); 6-IV,V usually 2b or 3f. *Anal Segment:* saddle about as in *farauti;* hair 1-X arising some distance dorsad of ventral margin.

FIRST INSTAR LARVA (fig. 48).—Indistinguishable from *farauti;* hair 2-M with somewhat thickened basal part and with long distal barbs or forks.

EGG.—See under *punctulatus* complex.

MATERIAL EXAMINED.—2,711 specimens; 537 ♀; 421 ♂; 952 pupae; 801 larvae; 491 individual larval rearings.

SYSTEMATICS.—As pointed out above, the adults of *koliensis* are quite variable in the ornamentation of the labium in both sexes and of the palpus in the female. The labium of the female, however, is characteristically marked and rarely, if ever, can be confused with that of *farauti* or *punctulatus;* the light markings are discrete and sharply marked ventrally and may be variously extended dorsad to form a more or less complete subapical light ring, which, however, is always more restricted than in *punctulatus.* The absence of the small sectoral costal dark spot of the wing in both sexes is a very characteristic feature of this species; unfortunately, this character is somewhat variable in *farauti* and *punctulatus*.

The immature stages of *koliensis* are also quite variable. The larva appears somewhat intermediate between *punctulatus* and *farauti* in several characters and is difficult to separate from these. However, the aulaeum appears to be characteristically developed in all 3; when all the characters are compared, it is usually possible to differentiate *koliensis* with a fair degree of accuracy. The pupa is apparently quite constant in the development of hair 9-IV.

A. koliensis of Guadalcanal is not markedly different from that of Hollandia (Rozeboom and Knight, 1946) except for the fact that the tubercles of the shoulder hairs of the larva are usually separate instead of fused.

BIONOMICS.—The immature stages of *koliensis* have been collected in the South Pacific only in the Koli area of Guadalcanal. Here the larvae were found in temporary pools in grasslands and along the edge of the jungle and were exposed to sunlight.

Owen (1945:240) found *koliensis* to be the dominant anopheline resting in tents and in native huts in the Koli area on Guadalcanal. About 90 per cent of 500 females collected in tents during a period of several weeks were *koliensis*, while only about 10 per cent of the larvae in the surrounding area were of this species. Females were active from about 9:00 P.M. until daylight but showed the greatest activity after midnight. Diurnal resting sites were not discovered but are probably similar to those of other members of the complex in this area.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—*A. koliensis* is undoubtedly an efficient vector of human malarias and periodic filariasis, but little specific data on natural infections are available. It is likely, however, that some of the natural infections recorded for other members of the complex in New Guinea actually apply, at least in part, to *koliensis*. Byrd and St. Amant (1959:61) report 4.84 per cent of 351 *koliensis* from Guadalcanal naturally infected with *W. bancrofti*.

DISTRIBUTION (fig. 39).—*Solomon Islands:* Guadalcanal. In the South Pacific, *koliensis* has been found only on the north coast of Guadalcanal. Owen discovered it in June, 1944, near the Koli Bomber Field, which had considerable traffic with New Guinea. This led to the speculation that it may have been introduced by air to Guadalcanal (Rozeboom and Knight, 1946:117). Specimens of this species had been collected in the same general area earlier and prior to the establishment of air traffic with New Guinea, but these were unfortunately lost. During the present study, I have seen 2 specimens of *koliensis* which establish beyond any doubt that this species is native and not introduced on Guadalcanal. One was collected by A. G. Carment in 1923 at Rere on the north coast far to the east of Koli. The other was collected in late 1942 or early 1943 in a tent near the Ilu River by A. H. Thompson. Elsewhere *koliensis* is definitely known only from the *Bismarck Archipelago* and *New Guinea*.

LUNGAE COMPLEX

FEMALES.—Medium in size, wing 3–4.5 mm.; in general as in the *punctulatus* complex. *Head:* labium unusually long, variable in ornamentation but always with a very narrow extreme apical light ring and a more or less extensive subapical ring or patch of light scales, remainder dark, light scales yellowish; palpus about as long as labium, segments 4 and 5 largely white but with variable basal dark rings, segments 3 and 2 largely dark but with very narrow apical light rings and frequently with lighter scales dorsally in middle of segments; antennal torus at most with a few minute whitish scales, flagellar segment 1 with a large patch of elongate white scales. *Thorax:* mesonotum light yellowish brown to grayish brown with gray pollinose lines and areas, conspicuous dark brown "eye spots" at scutal angle and dark prescutellar space; anterior promontory scaling as in the *punctulatus* complex, remainder of mesonotum with short golden hairs but without broad scales except sometimes in a few restricted lateral areas; scutellum without scales; *apn* with a small dorsal patch of erect dark scales; *ppl* with 4–6 bristles; *stp* without scales. *Legs:* essentially as in the *punctulatus* complex but apparently somewhat longer; femora and tibiae speckled, with numerous rather evenly spaced pale spots; segment 1 of all tarsi with numerous light spots and light apex; segments 2,3, and 4 of foretarsus with broad basal and apical light bands, segments 2 and 3 often with additional light spots in center, segment 5 dark except at apex; segments 2,3, and 4 of midtarsus and hindtarsus with narrow apical light bands, occasionally with light spots centrally, segment 5 as on foretarsus. *Wing:* as figured for *lungae* (Belkin and Schlosser, 1944:270) and *solomonis* (Belkin, Knight, and Rozeboom, 1945:

263) and essentially as in the *punctulatus* complex; vein C with only 3 large dark spots, the usual subapical dark spot reduced or broken up, a small sectoral dark spot present or absent between basal and median dark spots; small dark spots on R_1 below median spot frequently fused; light scales with a strong yellowish tinge. *Haltere:* light throughout and with white scales on knob. *Abdomen:* no scales on segments 1-VII, a few on VIII and beyond. *Genitalia:* not studied; cercus with a few dark scales. *Buccopharyngeal Armature:* teeth variable in length and in number of denticles.

MALES.—Essentially as in the females except for usual sexual characters.

MALE GENITALIA.—Essentially as in the *punctulatus* complex; apparently indistinguishable from the latter and without significant differences in the various species.

PUPAE.—External margin of paddle with strong serrations instead of fine spicules except near apex; otherwise as in the *puctulatus* complex.

FOURTH INSTAR LARVAE.—In general as in the *punctulatus* complex except for following features; hairs of thorax and abdomen very strongly pigmented, their tubercles deeply pigmented and very conspicuous. *Head:* collar very heavily pigmented, usually a deep black; maxillary sutures not reaching posterior tentorial pits; inner clypeals (2-C) widely separated, simple or barbed; outer clypeals (3-C) varied in length, simple or barbed; posterior clypeals (4-C) single or branched; hair 15-C placed far forward. *Antenna:* uniformly pigmented and with spicules usually strong; hair 1-A minute, arising in basal third on outer surface; hair 4-A usually 4-10b. *Thorax:* 1 long hair branched in prothoracic pleural group (9-12-P); both long hairs in mesothoracic pleural group (9-12-M) usually single; 1 or both of the long metathoracic pleural hairs (9-12-T) sometimes branched or forked; hair 1-M with swollen shaft, at least near base; 3-T palmate but with leaflets lanceolate. *Abdomen:* anterior tergal plates small; hair 1 palmate and moderate to large on II-VII, those of at least III-VII with notched pigmented leaflets.

FIRST INSTAR LARVAE.—*Head:* hairs unbranched except 11-C, which is bifurcatae from near base; hair 2-C usually distinctly barbed. *Antenna:* hair 1-A single, less than 0.25 of shaft length; 4-A single. *Thorax:* hairs 1,2-P, 1-M, 3-T lanceolate or linear, 1-T simple or minute.

EGGS.—*Frill:* complete and high; the 2 edges of the frill on dorsal surface close together, distance between them in the middle of dorsal surface at most 0.5 that between the frill and upper edge of float on each side.

SYSTEMATICS.—The *lungae* complex appears to show close affinities with *longirostris* Brug, 1928, *annulatus* de Rook, 1930, *tessellatus* Theobald, 1901, *kalawara* Stoker & Waktoedi, 1949, and *orientalis* Swellengrebel & Swellengrebel de Graaf, 1920, the only other Oriental and Australasian species of *Neomyzomyia* with entirely white halteres and scutal scales restricted largely to the anterior promontory. The 3 forms comprising the *lungae* complex are restricted to the Solomons. The record of *lungae* from New Guinea (King and Hoogstraal, 1946*a*:155–156) is erroneous; the specimens in question represent an undescribed species intermediate in some respects between *lungae* and *longirostris.* When all the above-mentioned species are thoroughly studied, it seems probable that a single large complex of closely related species will be recognized and that more species will be found in intermediate areas.

The *lungae* complex presents much the same problem in systematics found in the *punctulatus* complex. The 3 forms appear to be distinct species. On Guadalcanal progeny rearings of wild-caught females of *lungae* and *solomonis* always produced only the respective parental types, but unfortunately no gravid females of *nataliae* were ever obtained, so that it is not known whether this form breeds true as well as the others. *A. solomonis* and *nataliae* correspond to *farauti* and *koliensis* in the *punctulatus* complex. It appears likely that 1 of these is a species formed through hybridization of the other with *lungae.* At present it is difficult to determine which of the 2 is the other parental type since *nataliae* shows intermediate characters in the female labium, while in other adult features, as well as in larval characteristics, it exhibits the extreme departure from *lungae.* There is considerable geographical variation in the complex, particularly in *lungae,* and it is very likely that additional forms will be found.

BIONOMICS.—All 3 members of the complex are typically breeders in undisturbed deeply shaded jungle. Small streams, springs, seepages, margins of dense swamps, and even shallow temporary forest pools are utilized as breeding sites. The immature stages are well adapted to living in sites where frequent flooding and flushing takes place. In the laboratory, eggs survived for several weeks out of water, and in every clutch placed on the water surface, some eggs did not hatch until after the first adults emerged. In the field, larvae have been observed to crawl out of water and rest on the banks or flotage in the breeding site; it is often difficult to find larvae of these species because of this habit. The pupae also leave the water and in the laboratory habitually rest on the sides of the rearing containers, sometimes half an inch above the water surface. Usually emergence of adults takes place from pupae resting above the surface film. The larvae of this complex are easily distinguished in the field by their short and broad bodies and by the characteristic coloration, some being clear yellowish in color and translucent (*lungae* and *solomonis*) and others strongly pigmented a black, reddish, or bluish color (*nataliae*). The only anopheline normally found associated with members of this complex is *Bironella hollandi*. Members of the *punctulatus* complex almost never utilize the same breeding sites. However, at least *lungae* is at times flushed out of its normal breeding sites during the rainy season and may be found temporarily associated with *punctulatus* and *farauti*. The aquatic cycle is prolonged, the larval stage requiring about 10 days and the pupal 2 to 3 days.

No member of the complex normally feeds on man, but when large populations of *lungae* are flushed to the coast, an occasional female may come to man and probe. The normal hosts are probably birds and reptiles but pigs, bats, and marsupials may be used as sources of blood meals. The adults become active at dusk and do not return to their diurnal resting places until daylight. Large numbers of unfed, blooded, and gravid females, as well as males, are often found resting on buttresses or trunks of large trees in the jungle in the vicinity of breeding sites; others may be found at the base of various herbaceous plants. These diurnal resting habits are in sharp contrast to those of the *punctulatus* complex.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—The *lungae* complex is probably of no significance at all in the transmission of human pathogens. None of the species of the complex normally feed on man and all breed in undisturbed jungle areas usually a considerable distance from humans. Although a possibility exists that, when large populations are built up in proximity to man owing to flushing of immature stages to the coast, some feeding on man may take place, it seems very unlikely that disease transmission would occur, since so few individuals come to man even under these extreme conditions. Unpublished wartime reports of natural malaria infections in *lungae* almost certainly were based on *Plasmodium* of animal rather than human origin.

DISTRIBUTION (fig. 38).—The *lungae* complex has been reported only from the Solomons; *lungae* and *nataliae* range from Bougainville to Guadalcanal, and *solomonis* is known only from Guadalcanal and Bougainville. The report of *lungae* from Hollandia, New Guinea (King and Hoogstraal), is erroneous, as indicated above under systematics.

4. Anopheles (Cellia) lungae Belkin & Schlosser

Figs. 39, 51-53, 58

1944. *Anopheles* (*Myzomyia*) *lungae* Belkin and Schlosser, Wash. Acad. Sci., J. 34:269–271. *TYPE: holotype ♀ (JNB, 1031), Tassafaronga swamp, Guadalcanal, Solomon Islands, resting on tree trunk, Jan. 28, 1944, J. N. Belkin (USNM, 57177).

Anopheles (*Cellia*) *lungae* of Stone, Knight, and Starcke (1959).
Anopheles (*Myzomyia*) *lungae* of Stone (1944); Lee and Woodhill (1944:175–180); Belkin, Knight, and Rozeboom (1945:251–253); Smart (1948, 1956:153, 181); King (1949:520, 522; in part); Bonne-Wepster and Swellengrebel (1953:313–319); Iyengar (1955:22; in part); Laird (1956); Senevet (1958:85).

FEMALE (fig. 51).—*Wing:* 3.6 mm. *Proboscis:* 2.2 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 2.6 mm. As for the complex, with the following diagnostic features. *Labium:* apical third or more golden yellow except for preapical dark ring, boundary between black and yellow sharply marked all around at base, rarely a few light scales in basal two-thirds. *Palpus:* usually about as long as entire proboscis; segment 4 with dark ring usually restricted to basal 0.20. *Mesonotum:* scales extending only a short distance caudad from middle of anterior promontory; no scales on fossa; scales in front of wing root very narrow and few in number. *Wing:* usually with a dark sectoral spot on vein C between basal and median dark spots. *Buccopharyngeal Armature:* usually with 6 well-developed teeth, each tooth usually somewhat tapered distally and with a few short apical denticles but without lateral spines.

MALE.—Essentially as in the female except for sexual characters. *Labium:* entirely dark-scaled except for narrow extreme apical light ring.

MALE GENITALIA (fig. 52).—As figured; apparently indistinguishable from other members of the complex; phallosome leaflets usually serrate.

PUPA (fig. 52).—*Abdomen:* 2.85 mm. *Trumpet:* 0.35 mm. *Paddle:* 0.62 mm. Chaetotaxy as figured; diagnostic characters as in the key; general coloration yellowish brown. *Trumpet:* dark yellowish brown, without a darker preapical line. *Abdomen:* hairs 9-II-V very short, of the same order of magnitude; 9-V usually less than 0.25 of 9-VI; 9-VI,VII long, usually barbed.

FOURTH INSTAR LARVA (fig. 53).—*Head:* 0.59 mm. *Anal Saddle:* 0.38 mm. Chaetotaxy as figured; diagnostic characters as in the key; in life body clear and translucent. *Head:* general color light yellowish with variable number of dark brown spots and bands; hair 2-C heavy and rather short, usually not barbed; 3-C variable in size, single, simple or barbed; 4-C variable in size, single or branched; 8,9-C short, usually 2-4b. *Thorax:* tubercles of 1-P and 2,3-P always separate; stem of 1-P always at least stout, sometimes swollen; 9-P usually 3,4b (2–6); 9-M single; 9-T usually single; 10-T single. *Abdomen:* hair 1-II a small palmate tuft with leaflets usually lanceolate and unpigmented; 1-III-VII moderate to large, with notched, rather slender, strongly pigmented leaflets; 2-IV,V usually 4-6b; 6-IV,V usually 3,4b (1–5). *Pecten:* about 4 very large teeth sharply differentiated from very small teeth, none of intermediate size. *Anal Segment:* saddle dark brown.

FIRST INSTAR LARVA (fig. 58).—Hair 1-T minute; 1-M linear; 1-II linear, about 0.5 length of 1-III; 1-VII linear.

EGG.—Frill zipperlike, its two edges closely approximated on dorsal surface so that practically no upper surface is visible between them.

MATERIAL EXAMINED.—7,637 specimens; 1,450 ♀; 1,315 ♂; 1,654 pupae; 3,218 larvae; 323 individual rearings (320 larval, 3 pupal).

SYSTEMATICS.—There are 2 strikingly different larval types in *lungae*, 1 on Bougainville and the other on New Georgia and Guadalcanal. Unfortunately there are no individual rearings, no pupae, and very few adults from Bougainville; I therefore refrain from naming this form, which appears to be worthy of at least subspecific rank. Material from other islands is also very scanty, and it is impossible to assign it to one or the other form. The two forms are characterized as follows:

Southern form (Guadalcanal, New Georgia).—*Larva:* hair 3-C very short, often barely extending beyond anterior border of head capsule; 4-C very short, usually 1,2b, never reaching tubercle of 3-C; leaflets of palmate hairs III-VII rather slender. *Female:* pale scaling of labium apparently more extensive than in the majority of specimens of the northern form.

Northern form (Bougainville).—*Larva:* hair 3-C long, often 0.5 length of 2-C, with heavier base and often barbs; 4-C long, usually branched apically, always projecting beyond tubercle of 2-C; leaflets of palmate hairs III-VII usually distinctly broader. *Female:* pale scaling of labium variable, but since no individual rearings are available, no definite association is possible and the variants may actually be *nataliae* or *solomonis;* a few specimens show very extensive pale scaling without sharp differentiation from the dark scaling at base.

BIONOMICS.—This species has the widest range of breeding sites in the complex and at times may become very abundant. The larvae and pupae are most commonly found in dense shade in the jungle in seepage areas, stream margins, rockholes and potholes in stream beds, dense jungle swamps, and temporary pools of various kinds, including hog wallows, hoofprints, and footprints. Occasionally *lungae* may be found in containers on the ground. During the rainy season, the larvae and pupae may be flushed in large numbers to open coastal areas.

Females of *lungae* very seldom come to man and rarely if ever bite, even when large populations are present and normal hosts are not abundant. Birds appear to be the preferred hosts, but native or introduced mammals, such as marsupials, bats, and pigs, may be used (possibly also reptiles). Large concentrations of unblooded, blooded and gravid females, as well as males, are often found in the daytime on buttresses of trees in the jungle. Adult activity is largely limited to the hours between 6:30 P.M. and 6:30 A.M. (Belkin, Knight, and Rozeboom, 1945:252–253; Belkin and Schlosser, 1944:271–272).

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—Unpublished wartime reports on natural malaria infection rates of *lungae* on Guadalcanal undoubtedly were based on *Plasmodium* of birds, reptiles, or mammals other than man, since they were obtained from material collected on tree buttresses in the jungle where it was later shown that 70 per cent of the blood meals contained nucleated erythrocytes and the remaining 30 per cent with nonnucleated erythrocytes appeared not to be of human origin. There is no evidence that *lungae* is ever a vector of human malarias or periodic filariasis, and apparently it will not attack man in numbers even when its populations are very high

(Belkin, Knight, and Rozeboom, 1945:253; Belkin and Schlosser, 1944:271).

DISTRIBUTION (fig. 39).—*Solomon Islands:* Bougainville; Treasury; New Georgia; Roviana; Florida; Guadalcanal. To date *lungae* is known only from the Solomon Islands; the report from Hollandia, *New Guinea* (King and Hoogstraal, 1946*a*:155–156), is based on an undescribed species which appears to be intermediate between *lungae* and *longirostris.*

5. Anopheles (Cellia) nataliae Belkin

Figs. 39, 51, 54, 55

1945. *Anopheles* (*Myzomyia*) *nataliae* Belkin, J. Parasitol. 31:315–317. *TYPE: holotype ♀ with associated larval and pupal skins (JNB, 873-104), Natalia springs, Poha River valley, Guadalcanal, Solomon Islands, from densely shaded seepage area with clear running water, Feb. 18, 1945, J. N. Belkin (USNM, no type number).

Anopheles (*Cellia*) *nataliae* of Stone, Knight, and Starcke (1959).
Anopheles (*Myzomyia*) *nataliae* of Smart (1948, 1956:153, 181); King (1949:520, 522); Iyengar (1955:22); Laird (1956); Senevet (1958:86).

FEMALE (fig. 51).—*Wing:* 3.45 mm. *Proboscis:* 2.15 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 2.5 mm. As for the complex, with the following diagnostic features. *Labium:* apical 0.10–0.25 golden yellow except for preapical dark ring, boundary between black and yellow sharply marked at base ventrally but not dorsally where the light scales gradually merge into dark; preapical dark ring often interrupted dorsally. *Palpus:* usually reaching only to base of labella; segment 4 with ring usually extending to 0.25 or 0.30. *Mesonotum:* scales extending caudad for about 0.25 length of mesonotum from middle of anterior promontory; fossa usually with several small broad recumbent translucent scales; conspicuous long narrow whitish scales mixed with hairs in front of wing root. *Wing:* the small dark sectoral spot of vein C frequently not developed; dark fringe spots more numerous than in the other species. *Buccopharyngeal Armature:* usually with 5 well developed broad teeth, each tooth with broad apex bearing numerous short denticles and one long median spine, lateral spines well developed.

MALE.—Essentially as in the female except for sexual characters. *Labium:* variable, with patches of light scales or entirely dark-scaled except for narrow extreme apical light ring.

MALE GENITALIA (fig. 54).—As figured; apparently indistinguishable from other members of the complex.

PUPA (fig. 54).—*Abdomen:* 2.76 mm. *Trumpet:* 0.35 mm. *Paddle:* 0.65 mm. Chaetotaxy as figured; diagnostic characters as in the key; general coloration dark brownish yellow; head shield, mesonotum and metanotum deep brown. *Trumpet:* dark yellowish brown, a preapical line of deep brown pigmentation. *Abdomen:* hairs 9-II-V short, of the same order of magnitude but progressively longer; 9-V usually less than 0.3 of 9-VI; 9-VI,VII long, slender, acutely tapered, and without barbs.

FOURTH INSTAR LARVA (fig. 55).—*Head:* 0.57 mm. *Anal Saddle:* 0.37 mm. Chaetotaxy as figured; diagnostic characters as in the key; in life body opaque black, reddish or bluish. *Head:* general color dark brown with blackish spots and bands, these largely confluent in the female larvae; hair 2-C very long, usually with minute barbs; 3-C long, 0.35–0.45 length of 2-C, usually simple, rarely with minute barbs; 4-C long, usually reaching level of tubercles of 2,3-C, usually 2,3f (1–4); 8,9-C short, usually 3,4b (1–5). *Thorax:* tubercles of 1-P and 2,3-P usually fused, always very large, and at least closely approximated; stem of 1-P distinctly swollen; 9-P usually 5,6b (4–8); 9-M single; 9-T single, occasionally 2b; 10-T single. *Abdomen:* hair 1-II a medium-sized palmate tuft, with notched, very broad, strongly pigmented leaflets; 1-III-VII large, with similar leaflets; 2-IV,V usually single, rarely forked apically; 6-IV,V usually 2,3b. *Pecten:* large teeth variable in number and not sharply differentiated from the others, which grade from small to intermediate. *Anal Segment:* saddle very heavily pigmented, dark brown to black.

FIRST INSTAR LARVA and EGG.—Unknown.

MATERIAL EXAMINED.—398 specimens; 91♀; 54♂; 59 pupae; 194 larvae; 40 individual rearings (33 larval, 7 pupal).

SYSTEMATICS.—*A. nataliae* as here understood appears to be an extremely variable species. On Guadalcanal it cannot be confused with *lungae* or *solomonis* in any stage, but females from Bougainville are intermediate in the ornamentation of the labium between *solomonis* and *lungae* and those from New Georgia appear very similar to *solomonis*. However, larvae from all 3 islands are very similar and can be very easily separated from those of *lungae* and *solomonis*. Therefore I am considering all these populations as constituting a single species for the present. With more detailed study of additional material, and with progeny rearings, it may be possible eventually to recognize subspecific taxa for the populations from Bougainville and New Georgia.

In the ornamentation of the female labium and the development of hairs 9-II-V of the pupa, *nataliae* can be considered to be in general intermediate between *lungae* and *solomonis*; in the larval stage, however, it definitely shows the extreme development of the shoulder hairs, palmate hairs, and hairs 2-IV,V. These features remain constant whatever the breeding site and therefore appear to be genetically controlled rather than environmentally modified.

BIONOMICS.—The immature stages of *nataliae* have been collected on Guadalcanal in springs, seepage areas, and small creeks, all densely shaded and all located in the coral foothills of the north coast. The female larvae generally have a coal black body with densely pigmented black head and saddle; the male larvae have a reddish brown body, dark brown head, and black saddle. The larvae are extremely active and rest normally on top of floating vegetation or debris and on the margins of the creeks where the current is fairly swift. Usually their resting position is parallel to the object rather than at right angles to it, as with most anophelines. On New Georgia the immature stages were collected in cool jungle streams at the point of emergence from coral caves. These larvae had a characteristic opaque coloration, the entire thorax being bluish white and abdominal segments II-VII having longitudinal bluish white bands. On Bougainville the larvae were apparently found along the margins of jungle streams.

Nothing is known about the blood feeding or resting habits of *nataliae*. All the adults in collections were reared from larvae or pupae.

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—*A. nataliae* is apparently a rather rare wild species with specialized breeding sites and therefore is not likely to be a vector of human pathogens.

DISTRIBUTION (fig. 39).—*Solomon Islands:* Bougainville; New Georgia; Guadalcanal. Not known elsewhere.

6. Anopheles (Cellia) solomonis Belkin, Knight, & Roseboom

Figs. 39, 51, 56-58

1945. *Anopheles* (*Myzomyia*) *solomonis* Belkin, Knight, and Rozeboom, J. Parasitol. 31:247–251. *TYPE: holotype ♀ with associated larval and pupal skins (RKL, 105.9), Poha River tributary, Guadalcanal, Solomon Islands, from deeply shaded small rocky stream, Sept. 10, 1944, L. E. Rozeboom (USNM, no type number).

1948. *Anopheles* (*Myzomyia*) *solomonensis* Smart, Handbook Identif. Insects Med. Impt., ed. 2, pp. 153, 181.—Invalid emendation.

Anopheles (*Cellia*) *solomonis* of Stone, Knight, and Starcke (1959).

Anopheles (*Myzomyia*) *solomonis* of King (1949:520, 522); Iyengar (1955:22); Laird (1956); Senevet (1958:88).

Anopheles solomonensis of Smart (1956:153, 181).

FEMALE (fig. 51).—*Wing:* 3.6 mm. *Proboscis:* 2.3 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 2.6 mm. As for the complex, with the following diagnostic features. *Labium:* dark-scaled except for the narrow extreme apical light ring and a small dorsal yellowish bronzy patch in apical 0.1–0.15, this patch not sharply separated but occasionally expanded ventrad. *Palpus:* usually not reaching to tip of proboscis; segment 4 with dark ring usually extending to 0.25 or 0.30 from base. *Mesonotum:* scales extending only a short distance caudad from middle of anterior promontory; rarely 1,2 scales on fossa; scales in front of wing root very narrow and few in number. *Wing:* usually with 1 or more small dark sectoral spots on vein C between basal and median dark spots. *Buccopharyngeal Armature:* usually with 5 teeth intermediate in character between *lungae* and *nataliae,* rather narrow but with numerous longish apical denticles, lateral spines poorly developed or absent.

MALE.—Essentially as in the female except for sexual characters. *Labium:* with dorsal light patch or incomplete indistinct pale ring on apical 0.15–0.2 in addition to narrow extreme apical light ring.

MALE GENITALIA (fig. **56**).—As figured; apparently indistinguishable from other members of the complex.

PUPA (fig. **56**).—*Abdomen:* 2.62 mm. *Trumpet:* 0.38 mm. *Paddle:* 0.62 mm. Chaetotaxy as figured; diagnostic characters as in the key; general coloration brownish yellow. *Trumpet:* dark brownish yellow, with a darker preapical line. *Abdomen:* hairs 9-II-IV short, of roughly the same order of magnitude but progressively distinctly longer; 9-V of the same order of magnitude as 9-VI,VII, at least twice as long as 9-IV; 9-VI,VII acutely tapered but somewhat thickened, without barbs.

FOURTH INSTAR LARVA (fig. **57**).—*Head:* 0.63 mm. *Anal Saddle:* 0.36 mm. Chaetotaxy as figured; diagnostic characters as in the key; in life body clear and translucent. *Head:* general color light yellowish with variable amount of light brown spotting and banding; hair 2-C very long, strongly but minutely barbed; 3-C long, 0.35–0.5 length of 2-C, usually minutely barbed; 4-C long, usually reaching level of tubercles of 2,3-C, usually 3,4b (2–5); 8,9-C short, usually 3,4b (2–6). *Thorax:* tubercles of 1-P and 2,3-P always separate and never closely approximated; stem of 1-P strongly swollen; 9-P usually 7-8b (5–10); 9-M occasionally 2b; 9-T usually 2,3b; 10-T usually single, occasionally 2b. *Abdomen:* hair 1-II a medium-sized to large palmate tuft with notched, broad, strongly pigmented leaflets; 1-III-VII large, with leaflets often broader than on 1-II; 2-IV,V usually 2,3b; 6-IV,V usually 2-4b; no accessory tergal plates. *Pecten:* with about 4 very large teeth sharply differentiated from the very small teeth, none of intermediate size. *Anal Segment:* saddle very lightly pigmented except on middorsal apical angle.

FIRST INSTAR LARVA (fig. **58**).—Hair 1-T distinct, simple; 1-M lanceolate, large; 1-II lanceolate, at least 0.75 length of 1-III; 1-VII lanceolate.

EGG.—The edges of the frill separated on middle of dorsal surface by a space about half the distance between lower surface of frill and upper edge of float on each side.

MATERIAL EXAMINED.—1,376 specimens; 149 ♀; 181 ♂; 350 pupae; 696 larvae; 115 individual rearings (98 larval, 17 pupal).

SYSTEMATICS.—The labium of female *solomonis* has less pale scaling than other species in the complex; some specimens have only a few pale scales dorsally basad of the extreme apical pale ring. In this respect, as well as in the development of hair 9-V of the pupa, *solomonis* shows the extreme conditions in the complex. In the larva, however, it may be considered to be intermediate between *lungae* and *nataliae* but closer to the former. I have seen a single female and its pupal skin from Bougainville. The labium of this female is more extensively light-scaled than in the majority of specimens from Guadalcanal, but the pupa is typical. In the progeny rearings on Guadalcanal, no specimens were obtained which could be mistaken for *nataliae* or *lungae*. Therefore it appears that *solomonis* is a distinct species.

BIONOMICS.—*A. solomonis* is predominantly a breeder in deeply shaded undisturbed jungle streams in the coral foothills. It has been collected in potholes in stream beds, in coral depressions above stream beds, and in blocked mouths of tributary streams of larger rivers. It was found once in a taro garden in a foothill village and also in a deeply shaded spring-fed tributary of the Metapona River in the coastal plain of Guadalcanal. In all probability *solomonis* also breeds in temporary pools in the jungle, since adults have been collected in such areas. The largest concentrations of larvae are usually found in the blocked mouths of small streams following a rain, and it seems likely that these concentrations are the result of flushing of larvae from breeding sites located upstream.

Small numbers of unfed, blooded and gravid females, as well as males, have been collected on buttresses of trees in the jungle. Nothing is known about the blood-feeding habits of *solomonis.*

DISEASE RELATIONS AND ECONOMIC IMPORTANCE.—*A. solomonis* is a wild species which seldom if ever comes in contact with man and therefore is not likely to be a vector of human pathogens.

DISTRIBUTION (fig. **39**).—*Solomon Islands:* Bougainville; Guadalcanal. Not known elsewhere.

TRIBE URANOTAENIINI

Genus URANOTAENIA Lynch Arribalzaga

1891. *Uranotaenia* Lynch Arribalzaga, La Plata U. Nac. Mus., Rev. 1:375; 2:163–164. TYPE SPECIES: *U. pulcherrima* Lynch Arribalzaga, 1891, Argentina; selection of Neveu-Lemaire (1902:227).

1905. *Anisocheleomyia* Theobald, Entomologist 38:52–53. *TYPE SPECIES: *A. nivipes* Theobald, 1905, Queensland; selection of Brunetti (1914:55).

1905. *Pseudouranotaenia* Theobald, J. Econ. Biol. 1:33: *TYPE SPECIES: *P. rowlandi* Theobald, 1905, British Guiana; monobasic.

1911. *Pseudoficalbia* Theobald, So. Africa Dept. Agr., Rpt. Dir. Vet. Res. 1:272, *F. inornata* only included species; 1912, Theobald, Linn. Soc. London, Trans. (2) Zool. 15:89–90, 4 species including *F. inornata.* *TYPE SPECIES: *Ficalbia inornata* Theobald, 1908, Transvaal; monobasic; not *P. pandani* as stated by Dyar and Knab (1917:899), Edwards (1932:96; 1941:41), and Belkin (1953*a*:315).

FEMALES.—Size generally very small but some medium-sized species in *"Pseudoficalbia." Head:* frontal tuft present or absent; vertex mainly with broad flat decumbent scales; erect scales variable, sometimes extending far forward; orbital bristles well developed, row interrupted above; clypeus triangular, short; labium long, slender, flexible, frequently somewhat swollen apically, with a single pair of subbasal ventral bristles; palpus with a single segment beyond palpifer, rarely over 0.1 of proboscis, always dark; antenna usually distinctly longer than proboscis, usually about 1.2–1.33 of proboscis; first flagellar segment not markedly longer than second. *Thorax:* mesonotum usually very strongly arched; scutellum distinctly trilobed; postnotum bare; paratergite long and narrow, bare; metameron bare; *apn* lobes small and widely separated; *pra* usually separated by a distinct suture from upper edge of *stp;* meron large, its upper edge above insertion of hindcoxa; disc of mesonotum predominantly with narrow curved scales, iridescent broad scales often present in restricted lines laterally or on midline, rarely mesonotal scales all broad; scutellum usually with broad flat scales; acrostichal bristles weak to moderatae but always (?) developed, dorsocentrals and supraalars very strong; pleural scales always broad, usually restricted to *apn* and *stp,* rarely a few on *ppl,* occasionally a few narrow scales on *ppn; apn* bristles reduced, usually 2(3) dorsal and 1(2) ventral; usually 1 *ppn* bristle, rarely 2; 1 to several *ppl* bristles; 1(0–2) *sp* bristles; *psp* bristles always absent; 1(2) *pra* bristle; *stp* usually with continuous line of dorsal and caudal bristles; upper *mep* bristles present or absent; 1 strong lower *mep* bristle; other pleural bristles absent. *Legs:* very long and slender, general bristles short; hindcoxa with a long curved strong bristle at mesal anterior apical angle; forefemur slightly swollen, midfemur strongly swollen, hindfemur slender; foretarsal segment 4 markedly longer than segment 5; claws of all legs short, simple and subequal; pulvilli not developed. *Wing:* frequently with some iridescent scales, sometimes with color pattern; wing membrane with extremely minute and numerous microtrichia not visible under ordinary magnification; vein scales usually all broad and small; cell R_2 always shorter than vein R_{2+3}, frequently less than 0.5; vein Rs without basal spur; vein R_{4+5} right-angled at base, without spur; vein 1A always sharply curved apically and always ending proximad of level of fork of Cu; vein R without dorsal remigial bristles; vein Sc always without bristles at base below; plical area always without scales at base below; alula bare or with a few broad scales dorsally; upper calypter without bristles or scales. *Abdomen:* tergites and sternites largely scaled; tergite I almost completely scaled; laterotergite with scales; bristles short and not numerous except on tergite I and distal segments; tip of abdomen truncate. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; cercus and postgenital plate short and broad; spermatheca single, large.

MALES.—Essentially similar to the females but sometimes with strong sexual modifications on the legs. *Labium:* usually more distinctly swollen apically. *Palpus:* entirely similar to that of females. *Antenna:* about the same length as in the females; flagellum more or less plumose; flagellar segments 12 and 13 moderately elongated, usually each about 2.0–3.0 length of segment 11. *Legs:* tibiae and tarsi sometimes greatly modified; claws of midleg modified, anterior always enlarged and rarely toothed, posterior reduced or rarely apparently absent; claws of foreleg and hindleg short, simple and subequal.

MALE GENITALIA.—Very short and inconspicuous. *Segment VIII:* very long and wide and containing retracted genitalia. *Segment IX:* well developed; tergite variously developed, with or without (all South Pacific species) bristles; sternite apparently always without bristles. *Sidepiece:* very short; with more or less strongly developed small basal mesal lobe bearing specialized bristles, this lobe probably represents the claspette. *Claspette:* not developed as such. *Clasper:* varied in length and thickness and with a small usually slender subapical spiniform. *Phallosome:* relatively simple; aedeagus short, with a single pair of complex lateral sclerotizations connected at base dorsally, teeth usually developed; ventral paramere very strongly developed, broad at base; basal piece poorly differentiated from base of sidepiece. *Proctiger:* almost completely membranous, without sclerotized paraprocts or cercal setae.

PUPAE.—*Cephalothorax:* palpal case very short; middorsal ridge moderate; all hairs present, varied in development; hair 6-C single, strongly developed; 8-C close to but caudad of trumpet level. *Trumpet:* varied in development and position, close together and far cephalad or widely separated and near wing case; tracheoid always present, short or long; meatus with or without slit. *Abdomen:* hair 1-I usually moderately developed and with secondary branching; all normal hairs present; hair 9 small, removed from caudolateral angle on II-VII, 9-VII often displaced ventrad; 9-VIII at caudolateral angle, single or branched; 6-I,II often 1 or both strongly developed; hairs 1,5-II-VII often strongly developed. *Terminal Segments:* hair 1-IX strongly developed, at least 0.5 length of median tergal lobe; hair 1-X absent; female cercal lobe poorly developed, indistinct, unsclerotized, and never projecting; male genital lobe short. *Paddle:* part mesad of midrib wider than outer part; hair 1-P usually present, 2-P present in some forms.

LARVAE.—*Head:* often distinctly longer than wide, rarely distinctly wider than long; dorsal portion cephalad of antennae short; labrum rather distinctly separated from frontoclypeus; collar varied, never broader than interantennal width; side often bulging caudad of antenna; ventral surface of head capsule usually very long; posterior tentorial pit far cephalad of caudal border; maxillary suture never developed; cephalic border of labial plate only slightly produced; aulaeum fringed; mental plate large, usually with small blunt teeth; mouthbrushes never reduced to 10 flattened filaments on each side; chaetotaxy complete except apparently for 16,17-C; hair 1-C arising on process; 0-C distinct; 2-C not developed; 3-C small; 5-C removed from 4 and 6; 5,6-C often spikelike; 13-C closer to 12 than to 11; 14-C small, near cephalic border at base of maxilla, often flattened; 15-C variable in position but never close to cephalic or caudal borders. *Antenna:* less than 0.5 of head capsule; simple, with or without spicules on shaft; hair 1-A varied in position, usually simple and short, rarely branched; 2,3,4-A varied in development, 2,4-A in position also. *Thorax:* spiracular sensilla present; notched organ not developed; hairs 9-12-P,M,T on common tubercles; 1-3-P on common tubercle; 13-P not developed but all others present; none of the hairs plumose or palmate but larger branched hairs barbed. *Abdomen:* spiracular and dorsal sensilla usually distinct; tergites without sclerotizations; hair 1 never palmate; 6-I,II and 7-I always long but never plumose; segment I with full complement of hairs except for 14. *Segment VIII:* comb scales always present, generally arising from a sclerotized plate. *Siphon:* well developed; usually with acus; pecten teeth nearly always developed, often in form of fringed scale; hair 1-S a single pair, varied in development and position but never at base, no accessory hairs (1a-S); hair 2-S a single pair, small, simple, no accessory hairs (2a-S); valves small to large; hair 13-S often long and twisted at base; tracheae usually well developed. *Anal Segment:* saddle usually complete; without acus; median dorsal caudal process developed or absent; hair 1-X on saddle; dorsal brush (2,3-X) varied, hairs never hooked apically; ventral brush (4-X) varied, usually with 5 pairs of hairs on a simple grid, usually surrounded by sclerotization which is prolonged basad as a midventral sclerotized bar joined to saddle; 1 accessory saddle hair rarely present; gills varied, often fingerlike.

EGGS.—Not resistant; without floats; usually laid in boat-shaped rafts on surface of water; in some species the eggs are laid singly.

SYSTEMATICS.—The tribe Uranotaeniini as here understood consists only of the genus *Uranotaenia.* Edwards (1932:64) associated *Hodgesia* and *Zeugnomyia* with *Uranotaenia* in his *Uranotaenia* group of the Culicini. I consider *Hodgesia* as constituting a separate tribe and *Zeugnomyia* as a member of the tribe Aedini.

Uranotaenia, being of no economic importance and containing very small mosquitoes, has attracted very little attention and is therefore very poorly known at present. Its affinities with the other tribes are not understood at all, and its internal classification is in a chaotic state. Striking superficial characters of adult ornamentation have been used more than anything else to separate groups of species within the genus, although Edwards (1941:43–44) added male genitalic characters to the diagnosis of his groups. Despite the fact that the larvae and pupae of *Uranotaenia* are very poorly known, it is evident that the immature stages may be of paramount importance in delineating a natural classification in the genus. However, the immature stages show a great deal of convergent development; therefore, erection of groups based exclusively on larval and pupal types now known should not be attempted, even when striking differences are apparent.

The only unique character possessed by adults of *Uranotaenia* is the extreme minuteness of the wing membrane microtrichia. The venational characters, although distinctive, are quite variable and are occasionally similarly developed in several other groups. The practically unsclerotized proctiger of the male is an interesting feature which is found elsewhere only in the Anophelini, Aedeomyiini, and a few Aedini. The great elongation of the ventral portion of the head capsule of the larva is unusual but is found in the Anophelini, Toxorhynchitini, and some predacerous forms in other tribes. In the pupa, the development of hair 1-IX is greater than in any other genus and is very distinctive of *Uranotaenia.*

The size and complexity of the genus have not been generally recognized. It is very likely that only a small percentage of existing species is known at present and that many of the wide-ranging forms are complexes of closely related species (Belkin, 1953*a*; Galindo, Blanton, and Peyton, 1954). As indicated below, the bulk of species, many different types, and numerous annectent forms are found in the Old World tropics. Therefore it appears probable that this was the site of origin of the genus. The poor present knowledge of these annectent forms in the Indomalayan area in particular prevents us from reconstructing the phylogeny of *Uranotaenia* and attempting a natural classification of the genus, but it appears that *Uranotaenia* may be almost as complex as *Aedes* and that several subgenera will have to be recognized, contrary to the current practice of lumping everything into one supposedly homogeneous genus.

I am following the current practice and am not even recognizing *Pseudoficalbia,* which Mattingly (1957*a*:7) suggests should be treated as a distinct subgenus and which might be broadened to include *colocasiae* and *quadrimaculata* from the South Pacific. I believe it would be better to wait until the immature stages of more species are adequately studied before any subgeneric division is made. For the present I am grouping the 9 known South Pacific species of *Uranotaenia* into the following sections, whose characteristics and systematics are discussed in connection with the treatment of the included species: (1) the monotypic *colocasiae* section from Fiji, (2) the *atra* section represented by *quadrimaculata* in the Solomons, (3) the monotypic *painei* section from Fiji, (4) the monotypic *wysockii* section from the Solomons, and (5) the *Anisocheleomyia* section represented by *barnesi* from the Solomons and the New Hebrides and by *sexaueri, civinskii, lateralis,* and *solomonis,* all from the Solomons. All the species except *lateralis* appear to be endemic to the area, but several of the Solomons forms are quite similar to Australasian and Indomalayan species and may prove to be only subspecies of wide-ranging species.

BIONOMICS AND DISEASE RELATIONS.— The very meager information on the bionomics of *Uranotaenia* is briefly summarized by Belkin (1953*a*:319–320) and Horsfall (1955:338–346).

The range of habitats utilized by the immature stages of *Uranotaenia* is practically as great as in *Culex* and *Aedes.* The largest number of species utilize ground pools in swamps and marshes, stream margins, and temporary ground pools. Rockholes, treeholes, bamboo, plant parts on the ground, leaf axils and inflorescences of plants, and *Nepenthes* pitchers are used by a large number of species. A few may utilize artificial containers. The individual species vary greatly in specific requirements and tolerance of environmental conditions, particularly light, cover, and organic and salt content. No strictly carnivorous forms are known.

Ground pool-breeders lay their eggs in rafts. Their larvae rest parallel to the surface film and immediately below it because of the small size of the siphon and the angle it forms with the abdomen. They spend most of the time near the surface, apparently feeding just below the surface film. Certain species are easily mistaken for the younger instars of anophelines, particularly since they are often present in the same type of habitat. The jerky movements of these larvae are also suggestive of anophelines. The larvae develop rather slowly and in the laboratory usually take 10 days or longer to mature; the pupal stage usually lasts 2 to 3 days but may be considerably longer.

Breeders in small collections of water in living plants or in dead plant material apparently lay their eggs singly, although only a few specific records are available (Belkin, 1953*a*:320). The appearance and behavior of the larvae of such species are often very different from the ground pool-breeders.

Adults of *Uranotaenia* are delicate, shy mosquitoes which apparently do not feed on man. *U. geometrica* Theobald, 1901 was reported on the authority of Lutz (Theobald, 1901*b*:248) as a severe biter, but this has not been confirmed (Shannon, 1931:24; Lane, 1943*a*:138). In the Solomons and elsewhere, very few blooded females have ever been found in natural resting sites where many gravid ones are present. The only definite records on blood-feeding are those of Davis and Philip (1931:137, 138) on bird blood and Remington (1945) on amphibian blood. In the Solomons several species were observed to be active during the day in shaded situations; an occasional specimen landed on a human but, in my experience, would never bite. Adults of both sexes rest on moist protected surfaces near the breeding sites and may be found at times in large concentrations in suitable man-made shelters. Many species come readily to light traps.

Uranotaenia species are entirely inocuous mosquitoes since, as far as is known, they do not feed on man. Because of the superficial resemblance of the larvae of some common species to the younger instars of anopheline larvae, care should be taken to differentiate them.

DISTRIBUTION (fig. 59).—The genus has nearly a worldwide distribution but is not known from New Zealand, New Caledonia, and numerous small oceanic islands and is confined chiefly to the tropical regions, with only a few species extending beyond the tropics of Cancer or Capricorn. The Old World has the bulk of the species and different types, only some 25 species being known from the New World. In the South Pacific *Uranotaenia* has been found in the Solomons, New Hebrides, and Fiji.

KEYS TO SPECIES

(Keys to tribes, pp. 118–122)

ADULTS

1. Vertex of head with numerous conspicuous erect scales; no iridescent light blue or white scales on thorax, wing, or legs; alula with a few scales 2

Vertex of head with at most a few inconspicuous erect scales; thorax, wing, or legs with some iridescent light blue or white scales; alula without scales (WYSOCKII and ANISOCHELEOMYIA SECTIONS) 4

2(1). Sternopleuron without scales; mesonotum with a large velvety integumentary dark spot in front of wing root (ATRA SECTION) .... 2. *quadrimaculata*

Sternopleuron with a large patch of broad translucent scales; mesonotum without dark spot in front of wing root 3

3(2). Propleuron with several small scales and usually 6 or more bristles; vein R_2 at most 0.6 length of vein M_{1+2} (COLOCASIAE SECTION) .... 1. *colocasiae*

Propleuron without scales and usually with at most 4 bristles; vein R_2 about equal in length to M_{1+2} (PAINEI SECTION) .... 3. *painei*

4(1). Thorax with broad whitish integumentary area embracing lower margin of mesonotum in front of wing root and upper half of pleuron; vertex with broad scales all whitish; *ppn* with some broad scales (ANISOCHELEOMYIA SECTION, in part) .... 5. *sexaueri*

Thorax with mesonotal integument all dark but a narrow patch or line of whitish or bluish scales present on lower margin, pleuron with a median longitudinal line or patch of light scales; vertex with some of the broad scales dark; *ppn* without scales 5

5(4). Mesonotum with a more or less continuous lateral line of white scales around front margin from wing root to wing root; conspicuous white knee spots on all femora (WYSOCKII SECTION) .... 4. *wysockii*

Mesonotum with lateral longitudinal line or patch of white or bluish scales restricted to area between scutal angle and wing root on each side; femora without knee spots (ANISOCHELEOMYIA SECTION, in part) 6

6(5). Abdomen without conspicuous dorsal white scaling, lateral light patches may be present but not visible from above; light scaling of head and thorax strongly azure blue, arranged in broad patches on thorax 7

Abdomen with conspicuous dorsal white scaling on at least one segment; light scaling of head and thorax white or bluish, arranged in narrow lines on thorax 8

7(6). Hindtarsus white-scaled from apex of segment 2; wing scales iridescent bluish on base of

R, Cu, and 1A; abdominal tergites completely dark . . . . 8. *barnesi*

Tarsi all dark; wing scales all dark dorsally; abdominal tergites with inconspicuous lateral white patches . . . . 7. *lateralis*

8(6). Hindtarsus white-scaled from apical 0.2 of segment 2; light scaling of head, thorax and wing distinctly bluish; abdominal tergite V completely dark . . . . 6. *civinskii*

Hindtarsus white-scaled from middle of segment 3; light scaling of head, thorax, and wing almost pure white; abdominal tergite V with white apical transverse band . . . . 9. *solomonis*

MALE GENITALIA

1. Ninth tergite with a broad median caudal lobe (sometimes slightly emarginate) and without sclerotized lateral lobes; clasper not swollen subapically, its length at least 6.0 median width 2

Ninth tergite usually strongly emarginate in middle of caudal border and with more or less distinct sclerotized lateral lobes; clasper strongly swollen subapically or if not then length at most 5.0 median width (WYSOCKII and ANISOCHELEOMYIA SECTIONS) 4

2(1). Clasper with a large spatulate spiniform; dorsal surface of sidepiece with short hairs and 1,2 bristles (COLOCASIAE SECTION) . . . . 1. *colocasiae*

Clasper with a small or moderate elongate spiniform; dorsal surface of sidepiece with hairs and bristles of varied sizes 3

3(2). Aedeagus with numerous small teeth not restricted to apex; basal mesal lobe with 1 strongly differentiated apical seta (ATRA SECTION) . . . . 2. *quadrimaculata*

Aedeagus with 5,6 teeth on each side near apex; basal mesal lobe without strongly differentiated apical seta (PAINEI SECTION) . . . . 3. *painei*

4(1). Aedeagal plates with broad dorsal sclerotized bridge; aedeagal spines 2 dorsoapical and several subbasal ventral . . . . 9. *solomonis*

Aedeagal plates with narrow dorsal basal sclerotized bridge; aedeagal spines 1 dorsoapical and 1 subbasal or median ventral 5

5(4). Lateral lobe of tergite IX produced as a strongly sclerotized blunt process longer than wide . . . . 6. *civinskii*

Lateral lobe of tergite IX broadly rounded, not produced as distinct process 6

6(5). Dorsal aedeagal spine long, arising distinctly before apex; ventral spine subbasal, far removed 7

Dorsal aedeagal spine short, arising at extreme apex; ventral spine submedian, close to dorsal 8

7(6). Ninth tergite very narrowly but deeply emarginate apically, lateral lobe broadly rounded . . . . 7. *lateralis*

Ninth tergite broadly and shallowly emarginate apically, lateral lobe slightly but acutely produced . . . . 8. *barnesi*

8(6). Ninth tergite narrowly emarginate apically, median bridge at least as long as width of emargination, lateral lobe broadly rounded . . . . 5. *sexaueri*

Ninth tergite broadly emarginate apically, median bridge distinctly shorter than width of emargination, lateral lobe distinctly produced . . . . 4. *wysockii*

PUPAE

1. Paddle with 2 hairs (ATRA SECTION) . . . . 2. *quadrimaculata*

Paddle with 1 hair or none 2

2(1). Hair 9-VII strong, ventral in position but closer to posterolateral angle than any other hair (COLOCASIAE SECTION) . . . . . 1. *colocasiae*

Hair 9-VII weak, ventral in position and removed cephalad, at least one other hair closer to posterolateral angle 3

3(2). Trumpet without slit in meatus 4

Trumpet with slit in meatus (ANISOCHELEOMYIA SECTION) 5

4(3). Paddle with hair present; trumpet index 3 or less (PAINEI SECTION) . . . . 3. *painei*

Paddle without hair; trumpet index 6 or more (WYSOCKII SECTION) . . . . 4. *wysockii*

5(3). Trumpet index at least 10; hair 8-C with long central stem and short basal branches; hair 2-III laterad or cephalad of hair 1 6

Trumpet index at most 6.5; hair 8-C without long central stem, branches subequal; hair 2-III distinctly mesad of hair 1 7

6(5). Trumpet tracheoid to slightly beyond middle, dark on tracheoid and apex, light in between; hair 5-IV,V double to multiple . . . . 8. *barnesi*

Trumpet tracheoid to pinna, uniformly dark; hair 5-IV,V single . . . . 7. *lateralis*

7(5). Trumpet golden brown on apical half or more; hair 1-II simply branched and less than 8b . . . . 5. *sexaueri*

Trumpet dark throughout; hair 1-II secondarily branched *or* with more than 9 simple branches 8

8(7). Hair 1-II secondarily branched; trumpet index about 5.0 or more . . . . 6. *civinskii*

Hair 1-II primarily branched; trumpet index about 4.0 or less .... 9. *solomonis*

LARVAE

1. Hair 8-M short, multiple, simple; hair 9-M,T single 2
Hair 8-M long, multiple, barbed; hair 9-M,T multiple 3

2(1). Hair 1-A in basal half; accessory hair present on anal saddle; comb plates separate (COLOCASIAE SECTION) .... 1. *colocasiae*
Hair 1-A near apex; accessory hair absent on anal saddle; comb plates connected dorsally (ATRA SECTION) ..... 2. *quadrimaculata*

3(1). Hairs 5,6-C not spikelike, although at least one may be thickened; hair 1-A extending beyond apex of antenna 4
Hairs 5,6-C spikelike; hair 1-A short or minute, never reaching apex of antenna (ANISOCHELEOMYIA SECTION) 5

4(3). Caudal margin of anal saddle with minute spicules; antennal shaft spiculate; pecten not extending beyond 0.6 of siphon (PAINEI SECTION) .... 3. *painei*
Caudal margin of anal saddle with very long fringed spines; antennal shaft without spicules; pecten extending to 0.8 of siphon (WYSOCKII SECTION) .... 4. *wysockii*

5(3). Hairs 2-4-A leaflike; siphon scarcely longer than saddle; hair 9-C short; hair 4-C long and single .... 8. *barnesi*
Hairs 2-4-A simple; siphon at least 1.5 saddle length; hair 9-C long; hair 4-C short and branched 6

6(5). Anal gills short, rounded, hardly longer than wide; head spikes (5,6-C) poorly developed .... 7. *lateralis*
Anal gills long, bluntly tapered, length at least 4.0 width; head spikes (5,6-C) well developed 7

7(6). Hair 14-P single; hair 6-I,II usually 3b .... 9. *solomonis*
Hair 14-P multiple; hair 6-I,II usually 2b .. 8

8(7). Hair 14-P usually 5-8b; middle scale of comb not enlarged .... 6. *civinskii*
Hair 14-P usually 12-16b; middle scale of comb enlarged .... 5. *sexaueri*

COLOCASIAE SECTION

1. Uranotaenia colocasiae Edwards

Figs. **60, 62, 65, 66**

1928. *Uranotaenia colocasiae* Edwards, B. Ent. Res. 18:281–283. *TYPE: lectotype ♂ with attached genitalia mount, marked as type by Edwards, Ovalau, Fiji, from leaf axil of taro, Mar., 1927, R. W. Paine; by present selection (BMNH).

Uranotaenia colocasiae of Edwards (1932:100; 1935:128); Paine (1935; 1943:9, 10, 17–18); Taylor (1934:13); Knight, Bohart, and Bohart (1944:16, 68); Iyengar (1955:25, in part, not questionable Marianas record); Laird (1956); Stone, Knight, and Starcke (1959, not questionable Marianas record).

FEMALE.—*Wing:* 3.43 mm. *Proboscis:* 2.28 mm. *Forefemur:* 2.37 mm. *Abdomen:* about 2.5 mm. Large dark species without light or contrasting ornamentation on thorax, wing, or abdomen. *Head:* decumbent broad scales dark except for a narrow whitish orbital line; no frontal tuft; erect scales dark, long, numerous, and very conspicuous, extending to orbital margin; clypeus dark, bare; labium dark, slightly swollen apically; labella light brown apically; palpus about 0.1 of proboscis, with very long slender hairs; antenna slightly shorter than proboscis; torus with slender apically curved hairs and a few minute dark scales; flagellar segment 1 distinctly longer than 2, with a small patch of broad dark scales near base. *Thorax:* mesonotal integument uniformly dark brown, scales all narrow, curved, dark bronzy except in front of wing root where they are lighter; scutellum dark brown, scales broad, dark, decumbent, more elongate on lateral lobe, midlobe short; postnotum blackish brown; paratergite brown; pleuron brown, darkened on *ppn* and upper portion of *stp* and *mep; apn* without scales; *ppn* rarely with 1,2 scales similar to mesonotal; *ppl* usually with at least 6 bristles (6–12), 1,2 stronger, and several small appressed scales ventrally; *stp* with long narrow posterior patch of small broad decumbent dark bronzy scales; upper *mep* with 4–6 bristles; *pra* not distinctly separated from *stp. Legs:* generally dark-scaled, lighter ventrally, apical 2,3 tarsal segments indistinctly whitish or pale. *Wing:* entirely dark-scaled; cell R_2 very short, vein R_2 about 0.2 of R_{2+3}; cell M_2 much longer than cell R_2, vein R_2 usually about 0.5 of M_{1+2}; alula with a few dorsomarginal scales. *Haltere:* dark brown, lighter at base. *Abdomen:*

dark-scaled, lighter ventrally; laterotergite with scales.

MALE.—Generally as in the female except for sexual differences. *Labium:* apical swelling about the same. *Antenna:* a little longer than proboscis; flagellum strongly long-plumose; flagellar segment 1 distinctly longer than 2; segments 12 and 13 subequal to each other and to segments 10 and 11 combined. *Legs:* enlarged claw of midleg simple.

MALE GENITALIA (fig. **65**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite slightly and broadly produced caudad in the middle, no lateral tergal lobe. *Sidepiece:* with short hairs and moderately long bristles; scales restricted to sides and ventral surface; basal mesal lobe small, more or less distinctly sclerotized, with 1 long heavy apical bristle, several weaker bristles, and numerous hairs of varied size. *Clasper:* about 0.7 of sidepiece length; slender and gradually slightly tapered; distal 0.5 with numerous short hairs; a large somewhat spatulate spiniform arising under a hood. *Phallosome:* aedeagus simple, with a narrow subapical dorsal bridge and a narrow apical ventral bridge, about 5,6 teeth on each side, restricted to apex, the ventral ones more strongly curved. *Proctiger:* strongly swollen and bulbous in basal half, small and short conical in distal half.

PUPA (fig. **65**).—*Abdomen:* 3.75 mm. *Trumpet:* 0.55 mm. *Paddle:* 0.65 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* strongly and rather uniformly pigmented a bright brown; hairs 6,8,9-C blackish brown, others concolorous with integument. *Trumpet:* index about 3.0; inserted closer to wing base than middorsal line; uniformly bright orange brown; indistinctly tracheoid on anterior surface in basal 0.20; apex diagonally truncate and slightly emarginate on outer surface; no slit in meatus. *Metanotum:* hairs 10-12-C blackish brown. *Abdomen:* moderately to strongly pigmented throughout a light brown, darker anteriorly and on intersegmental sclerotizations; hairs single or with few branches except for 1-I; larger hairs blackish brown, others concolorous with integument; hair 1-I dendritic from a heavy, long, sparsely branched stem; 9-III-VII ventral in position, all close to caudolateral angle, progressively longer caudad; 5-IV-VI heavy, single or double; 6-VII dorsal in position. *Paddle:* very short and broad; strongly emarginate apically at midrib; uniformly lightly pigmented a light brown, brighter on external buttress and midrib; external margin with sclerotized closely set sharp serrations in distal half; inner margin with shorter, more widely spaced serrations; hair 1-P strong, hair 2-P not developed.

LARVA (fig. **66**).—*Head:* 1.02 mm. *Siphon:* 0.64 mm. *Anal Saddle:* 0.34 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* slightly longer than wide; ocular bulge not conspicuous; pigmentation uniformly bright light yellowish brown; no visible integumentary sculpturing; aulaeum with short fringes apparently laterad only; mental plate with about 5,6 large teeth on each side of median tooth, latter often compound; hairs concolorous with head capsule; hair 1-C very short; 4-C long, single; 5-6-C not spikelike; 7-C displaced mesad; 9,11-C short. *Antenna:* about 0.25 of head length; shaft smooth; uniformly concolorous with head capsule; hair 1-A in basal 0.5, usually single. *Thorax:* all hairs except the very small strongly pigmented a dark brown; hairs 1-3-P of two sides widely separated; 8-M small, multiple; 9-M,T single, lightly barbed. *Abdomen:* larger hairs strongly pigmented as on thorax; hairs 6 and 7 widely separated on I,II, hair 9 between them on I; 6-III-VI strong, smaller but similar to 6-I,II in development; 1-II-VII spikelike; 13-II-V,VII spikelike, single or 2b, 13-VI dendritic. *Segment VIII:* comb plate lightly pigmented, bearing hairs 0,1,5, not connected by saddle to mate; comb scales with basal teeth; hairs 2-4-VIII small, without basal plates; 3-VIII short and multiple. *Siphon:* a short truncate cone, index about 1.65; acus not developed; uniformly lightly pigmented; pecten teeth reduced, usually 1,2 on each side, sometimes completely absent; hair 1-S usually single; valves short; hair 13-S minute; trachea large. *Anal Segment:* saddle complete, shortened ventrad; lightly pigmented; no caudal marginal spicules; median dorsal caudal process developed; hair 1-X long, heavy; 2,3-X single or 2b; 4 pairs of hairs 4-X on a poorly sclerotized plate which is not connected to saddle, 4a-X usually 2b, others single; accessory hair *x* near caudal border of saddle ventrolaterally; gills 2.0 or more of dorsal saddle length, rounded apically.

EGG.—Larger than in *Culex,* laid in parallel-sided rafts (Paine, 1943:18).

MATERIAL EXAMINED.—263 specimens; 80 ♀; 55 ♂; 17 pupae; 111 larvae; 4 individual larval rearings.

SYSTEMATICS (fig. **60**).—*U. colocasiae* is a very plastic species, which shows a great deal of variation in all stages. In the adults the pleural chaetotaxy and scaling are particularly unstable. In the pupa and the larva the chaetotaxy is extremely variable. A number of anomalies have been noted. Particularly striking is the monstrous basal swelling of the larval antenna in all specimens collected from bamboo near Mt. Thurston on Vanua Levu (Paine, 104, BMNH). One of these specimens is further abnormal in having the labral region extremely wide, as in *Toxorhynchites.* I have not been able to correlate any of these variations of 1 stage with those of another, nor have I found indication of significant differences between populations from different habitats or different islands.

A number of characters of the adults and the pupa relate *colocasiae* to *U. pandani* (Theobald, 1912) from the Seychelles: in the adults, the presence of scales on the alula; in the male genitalia, the apical dorsal bridge and the teeth of the simple aedeagus, the clasper and its spiniform, the basal lobe of the sidepiece, and the shape of tergite IX; in the pupa, the position of the trumpet and its shape, the chaetotaxy of the cephalothorax and abdomen, and particularly the development and position of hairs 9-IV-VII. The larvae of the two species appear to be quite different except for the head chaetotaxy, the antenna, and the comb plate and its scales. However, the larva of the closely related *U. nepenthes* (Theobald, 1912) from the Seychelles shows several additional and probably more important similarities with *colocasiae,* notably hair 8-M short, 9-M,T single, 7-T relatively poorly developed, and 6-III-VI strongly developed. It seems very unlikely that all these similarities between the *pandani* group of species and *colocasiae* are owing to convergence. I regard them as indicative of true genetic relationship. However, this relationship does not appear to be very close, and it is evident that the 2 stocks have been separated for a long time. In this connection it is interesting to note that Mattingly (in Mattingly and Brown, 1955:90) regards *U. moultoni* Edwards, 1914 from Borneo as the closest known relative of the *pandani* group. I suggest that this entire complex of groups originated in the Indomalayan area and that the closest relative of *colocasiae* will also be found there. Both the *pandani* group and *colocasiae* show a number of similarities with the Australasian *atra* group, the Ethiopian *ornata* and *fusca* groups—including *inornata* (Theobald, 1908) as a synonym of *fusca* Theobald, 1907—and several poorly known Indomalayan and Oriental annectent forms. *U. colocasiae* is strikingly similar to the sympatric *painei* in adult characters but differs markedly in the larva. As suggested below under *painei,* it seems probable that this species was produced through hybridization between *colocasiae* and a ground pool-breeding form.

BIONOMICS.—According to Paine (1943:10, 17–18) *colocasiae* is one of the commonest mosquitoes of Fiji, but, because females of this species do not bite or visit man, it is seldom collected. This species utilizes a wide variety of container breeding sites, usually in dead or living plants, and breeds readily in artificial containers. It has been recorded from the leaf axils of *Colocasia* and *Alocasia,* from bamboo stumps, treeholes, coconuts and coconut husks, and from fallen leaves, fronds, spathes, and seed pods of various plants. The record from a rock pool in a stream bed (Paine, 1943:10) undoubtedly pertains to *painei* rather than to *colocasiae.* Domestic breeding sites include canoes, water barrels, tin cans, and a small puddle on the concrete floor of a bathroom.

DISTRIBUTION (fig. **62**).—*Fiji:* Vanua Levu; Taveuni; Lauthala; Viti Levu; Ovalau; Makongai; Kandavu. Not known elsewhere; the records from the Marianas are erroneous.

ATRA SECTION

2. Uranotaenia quadrimaculata Edwards

Figs. 60, 62, 64, 67, 68

1929. *Uranotaenia quadrimaculata* Edwards *in* Paine and Edwards, B. Ent. Res. 20:313–314. *TYPE: lectotype ♂, marked as type by Edwards, Rere, Guadalcanal, Solomon Islands, from coconut husk, Aug. 19, 1928, R. W. Paine; by present selection (BMNH).

Uranotaenia quadrimaculata of Edwards (1932); Taylor (1934:13); Lee (1944*a*:35); Knight, Bohart, and Bohart (1944:15, 69; in part); Belkin (1953*a*:373–381); Iyengar (1955:25); Laird (1955*a*:285–288; 1956); Stone, Knight, and Starcke (1959, not Bismarcks and New Guinea records).

Uranotaenia nigerrima of Edwards (1926:109); Knight, Bohart, and Bohart (1944:15, 68; in part).

FEMALE (figs. **64**, **67**).—*Wing:* 2.67 mm. *Proboscis:* 1.5 mm. *Forefemur:* 1.83 mm. *Abdomen:* about 1.67 mm. Medium-sized brown species with velvety black spot on each side of scutum in front of wing root and another on *ppn,* otherwise without contrasting ornamentation on thorax, wing, or abdomen. *Head:* decumbent broad scales light purplish brown in center, orbital line indistinct in front, whitish laterally; no frontal tuft; erect scales dark, long, numerous, and very conspicuous, extending to orbital margin; clypeus light brown, bare; labium dark-scaled dorsally, lighter ventrally, distinctly swollen apically; labella light brown; palpus about 0.09 of proboscis, hairs about 0.5 of shaft length; antenna about 1.33 of proboscis; torus light brown, with short hairs mesally; flagellar segment 1 slightly longer than 2, without distinct patch of scales. *Thorax* (fig. **64**): mesonotal integument uniformly light brown except for the velvety black spots; mesonotal scales narrow, curved, light purplish brown centrally, a few broader light scales anteriorly among acrostichals and dorsocentrals, elongate patch of very narrow decumbent light to whitish scales over black spot in front of wing root and continuing into supraalars; scutellum brown, scales broad, purplish bronzy brown, midlobe short; postnotum brown; pleuron light-colored, darker along diagonal line from anterior spiracle to lower *mep* and on *apn*, velvety black spot on *ppn; apn* with broad translucent whitish scales; other pleural scales absent; *ppl* usually with 4 bristles, 1 heavier; upper *mep* with several bristles; *pra* not distinctly separated from *stp*. *Legs:* coxae and trochanters light, remainder dark above, light below. *Wing* (fig. **67**): entirely dark-scaled; cell R_2 very short, vein R_2 about 0.3 of R_{2+3}; cell M_2 much longer than cell R_2, vein R_2 usually about 0.7 or less of M_{1+2}; alula with a few dorsal marginal scales. *Haltere:* light at base and lower part of stem, dark-scaled on upper part of stem and knob. *Abdomen:* tergites entirely dark iridescent purplish brown; laterotergite with scales; sternites entirely light-colored.

MALE (fig. **64**).—Generally as in the female except for sexual differences. *Labium:* apical swelling about the same. *Antenna:* a little longer than proboscis; flagellum strongly plumose; flagellar segment 1 about 1.5 of segment 2; segments 12 and 13 subequal, together almost equal to segments 5–11 combined. *Legs* (fig. **64**): enlarged claw of midleg simple.

MALE GENITALIA (fig. **67**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite slightly and broadly produced caudad in the middle, truncate, no lateral tergal lobe. *Sidepiece:* with moderately long hairs and bristles; a few scales restricted to lateral and ventral surfaces; basal mesal lobe moderate, more or less distinctly sclerotized, with 1 very heavy apical bristle, 3 rows of progressively shorter bristles basad, 1 very strong and several short bristles ventrad. *Clasper:* about 0.7 of sidepiece length; slender and gradually tapered; distal 0.3 or less with numerous short hairs; a short blunt simple spiniform. *Phallosome:* aedeagus simple, with a narrow basal dorsal bridge and a narrow submedian ventral bridge, double row of short lateroventral teeth and serrations. *Proctiger:* strongly swollen and bulbous in basal 0.3, distal part broad conical.

PUPA (fig. **67**).—*Abdomen:* 2.7 mm. *Trumpet:* 0.38 mm. *Paddle:* 0.58 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, appendage cases and mesonotum darker; hairs 6-9-C blackish brown, others more or less concolorous with integument. *Trumpet:* index about 2.8; inserted closer to wing base than middorsal line; uniformly brilliant brown; indistinctly tracheoid on anterior surface in basal 0.25; apex diagonally truncate and slightly emarginate on outer surface; no slit in meatus. *Metanotum:* darkened; hairs 10-12-C blackish brown. *Abdomen:* strongly pigmented on proximal segments, with lighter areas around bases of hairs, distal segments moderately pigmented; hairs single or with few branches except for 1-I; anterior dorsal and larger posterior hairs blackish brown, others concolorous with integument; hair 1-I dendritic from heavy long sparsely branched primary divisions; 9-IV-VII lateral, dorsolateral, or ventrolateral in position, close to lateral border but removed from caudolateral angle, progressively longer caudad; 5-IV-VII strong, usually single; 6-VII strong, usually single, dorsocaudal in position. *Paddle:* distinctly emarginate apically at midrib, inner lobe produced caudad of outer; uniformly lightly pigmented a very light brown, brighter on external buttress and midrib; external margin with sclerotized closely set sharp serrations in distal half; inner margin with longer and more widely spaced serrations as well as some smaller; both hairs present and apical, often branched, 1-P strong, 2-P weak.

LARVA (fig. **68**).—*Head:* 0.8 mm. *Siphon:* 0.52 mm. *Anal Saddle:* 0.18 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* slightly longer than wide, index about 1.1; ocular bulge not conspicuous; pigmentation a moderate bright yellowish brown, darker brown caudad and middorsally; integumentary sculpturing indistinct except caudad; aulaeum with short fringes apparently laterad only; mental plate with 7–9 rather small teeth on each side of median tooth which is often compound; hairs concolorous with integument; hair 1-C very short; 4-C long, single; 5,6-C not spikelike; 7-C in normal position; 9-11-C short. *Antenna:* about 0.25 of head length; shaft smooth; uniformly concolorous with head capsule, darker at base; hair 1-A in distal 0.1. *Thorax:* tubercles and all hairs except smallest strongly pigmented a dark brown; hairs 1-3-P of two sides widely separated; 8-M small, branched; 9-M,T single, lightly barbed. *Abdomen:* larger hairs strongly pigmented; hairs 6 and 7 close together on I,II; hair 9-I ventrad of 7-I; 6-III,IV strong, similar to 6-I,II, hairs 6-V,VI smaller; 1-II-VII small, with a few branches; 13-II-VII all small, with a few branches; 9-I-V thickened. *Segment VIII:* comb plates connected dorsally by saddle, uniformly moderately pigmented, bearing hair 0-VIII only; comb scales simple or with a few fine basal spicules but without distinct teeth; hairs 1,2,4,5-VIII short, 3-VIII heavier, all without basal plates. *Siphon:* short, cylindrical, index about 2.0; short attached acus present; uniformly strongly pigmented; pecten teeth 6,7, sharply pointed, heavily sclerotized, with 1–3 short basal denticles; hair 1-S short, branched; valves short, darker than siphon; hair 13 minute; trachea large. *Anal Segment:* saddle complete, very short; lightly pigmented; a few minute caudolateral submarginal spicules; median dorsal caudal process not developed; hair 1-X strong, frequently with 1,2 weak branches; 2-3-X single; 5 pairs of hairs 4-X on poorly sclerotized plate which is not connected to saddle, all hairs usually single; no accessory hair *x;* gills long, sausage-shaped, about 3.0 of dorsal saddle length.

EGG.—Unknown.

MATERIAL EXAMINED.—2,128 specimens; 433 ♀; 411 ♂; 188 pupae; 1,096 larvae; 14 individual larval rearings.

SYSTEMATICS (fig. 60).—*U. quadrimaculata* is a very plastic dominant species, which shows a great deal of variation in all stages. In the adults this is particularly noticeable in the size and, to a lesser extent, in the coloration. The chaetotaxy of the immature stages is more variable than in any other species I have studied, not only in branching but also in the degree of development of the individual hairs and their position. In the larva duplication of hairs is not uncommon, and in the pupa anomalous retention of larval hairs occurs frequently.

On Guadalcanal all individuals bred from taro axils show a conspicuous dark diagonal band running from the dark spot on *ppn* across *ssp, stp,* and *mep* to just above the lower *mep* bristle, but I cannot find any constant correlated structural characters in the adults or the immature stages. A similar but faint band is sometimes found in specimens from other breeding sites. The material from the various islands in the Solomons shows no constant geographical differences.

It is very probable that *quadrimaculata* is only a subspecies of *atra* Theobald, 1905 (= *nigerrima* Taylor, 1914) from New Guinea. Material of this complex is not available from intermediate areas, and therefore I leave *quadrimaculata* for the present as a distinct species. It can be differentiated from *atra* in the adult stage by the lighter color and by the presence of only a few elongate whitish scales above *ppn* instead of a patch of broad white scales. In the larva it has the comb scales usually without distinct basal denticles instead of strong ones, the pecten teeth with very much smaller basal denticles, and the caudolateral border of the anal saddle with very weak instead of very strong spicules. The pupa appears to be distinguishable on the basis of fewer branches in hairs 2,4,5-C, 7-II, 1-II-VII and 3-IV-VI.

The *atra* section includes 3 additional species: *papua* Brug, 1924 and *diagonalis* Brug, 1934 from New Guinea and *obscura* Edwards, 1915 from Borneo and Singapore. This section appears to be quite similar to the *colocasiae* section but is distinguished by the much shorter cell R_2 in the adults, the presence of a dorsal saddle connecting the comb plate of abdominal segment VIII in the larva, and apparently 2 paddle hairs in the pupa (not described for *diagonalis* and *obscura*).

BIONOMICS.—*U. quadrimaculata* utilizes for breeding small water collections in living plants and in dead plant material as well as in various types of artificial containers. It is commonly found in *Colocasia* and *Alocasia* leaf axils and less frequently in treeholes. The largest populations are found in coconut shells, coconut spathes, and large fallen leaves or fronds on the ground. It has also been collected in cut bamboo and in tree stumps. *U. quadrimaculata* appears to prefer fairly fresh water in its breeding sites. Only occasionally is it found in thick fermenting coconut water, such as is preferred by *Armigeres breinli.*

The larvae are very different in appearance from the typical ground pool *Uranotaenia* and most closely resemble *Armigeres breinli,* from which they can be easily separated by the absence of the maxillary sutures. They spend most of the time at the bottom of the breeding site. When at the surface, they rest with their bodies down rather than parallel to the surface. Adults are often seen in great numbers resting among coconuts on the ground and in other breeding sites. They have not been collected at lights.

DISTRIBUTION (fig. 62).—*Solomon Islands:* Bougainville; Treasury; Wanawana; New Georgia; Rendova; Russell; Tulagi; Guadalcanal; Malaita; San Cristobal. Not known elsewhere; the records from the Bismarcks and New Guinea in Stone, Knight, and Starcke (1959) are based on misidentifications of *atra* Theobald, 1905.

PAINEI SECTION

3. Uranotaenia painei Edwards

Figs. **60**, **62**, **69**, **70**

1935. *Uranotaenia painei* Edwards, B. Ent. Res. 26:127–128. *TYPE: lectotype ♂ (Paine, 74), marked as type by Edwards, Salialevu, Taveuni, Fiji, from small rock pool in stream bed, Mar., 1934, R. W. Paine; by present selection (BMNH).

Uranotaenia painei of Paine (1943:9, 11); Knight, Bohart, and Bohart (1944:16, 69); Iyengar (1955:25); Laird (1956); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.47 mm. *Proboscis:* 1.58 mm. *Forefemur:* 1.7 mm. *Abdomen:* about 1.92 mm. Small dark species without light or contrasting ornamentation on thorax, wing, or abdomen; superficially very similar to *colocasiae*. *Head:* decumbent scales dark except on a rather conspicuous whitish orbital line; no frontal tuft; erect scales dark, long, numerous, and very conspicuous, extending to orbital margin; clypeus dark, bare; labium dark, slightly swollen apically; labella light brown apically; palpus about 0.1 of proboscis, with very long slender hairs; antenna about 1.3 of proboscis; torus with slender minute apically curved hairs, and a few minute scales; flagellar segment 1 distinctly longer than segment 2, with a few small broad scales near base. *Thorax:* mesonotal integument uniformly dark brown, scales narrow, curved, very dark bronzy, except on and around prescutellar space where they are distinctly broader; scutellum dark brown, scales broad, dark, decumbent; postnotum dark brown, lighter laterally; paratergite dark brown; pleuron brown; *apn* and *ppn* without scales; *ppl* with 2,3 bristles and no scales; *stp* with long, very narrow posterior patch of small broad appressed dark bronzy scales; upper *mep* with 3,4 bristles; *sp* frequently with 2 bristles; *pra* not distinctly separated from *stp*. *Legs:* generally dark-scaled, lighter ventrally, apical 2 or 3 tarsal segments indistinctly pale. *Wing:* entirely dark-scaled; cell R_2 relatively long, vein R_2 about 0.5–0.6 of R_{2+3}; cell M_2 at most 0.3 longer than cell R_2; vein R_2 usually about 0.8 or more of M_{1+2}; alula with a few dorsomarginal scales. *Haltere:* light at base, dark-scaled on knob. *Abdomen:* dark-scaled, lighter ventrally; laterotergite with scales.

MALE.—Generally as in the female except for sexual difference. *Labium:* apical swelling about the same. *Antenna:* a little longer than proboscis; flagellum strongly plumose; flagellar segment 1 about 1.6 of segment 2; segments 12 and 13 elongate, 12 a little longer than 13 and about equal to 7–10 combined. *Legs:* enlarged claw of midleg simple.

MALE GENITALIA (fig. **69**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite distinctly produced into short broad rounded median lobe, no lateral tergal lobe. *Sidepiece:* bristles and hairs of varied size; scales restricted to sides and ventral surface; basal mesal lobe more or less distinctly sclerotized, with 3 strong subapical bristles and numerous shorter bristles and hairs of varied size. *Clasper:* about 0.7 of sidepiece length; slender and gradually slightly tapered; distal 0.4 with numerous short hairs; a slender blunt spiniform arising under a hood. *Phallosome:* aedeagus simple, with a narrow subapical short dorsal bridge and a narrow longer subapical ventral bridge, each side with about 5,6 teeth restricted to apex. *Proctiger:* strongly swollen and bulbous in basal half, small and short conical in distal half.

PUPA (fig. **69**).—*Abdomen:* 2.5 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.6 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* strongly and rather uniformly pigmented a dark brown, darker on appendage cases and caudally on mesonotum; hairs largely concolorous with integument. *Trumpet:* index about 2.5–3.0; inserted closer to wing base than middorsal line; uniformly bright orange brown; indistinctly tracheoid on anterior surface in basal 0.2; apex diagonally truncate and slightly emarginate on outer surface; no slit in meatus. *Metanotum:* darkened. *Abdomen:* strongly uniformly pigmented on I-III or I-IV, moderately caudad; hairs largely concolorous with integument; some of the larger hairs branched; hair 1-I with many primary branches; 9-VII ventral in position, removed mesad of 6; 6-VII ventral in position; 1,5-IV-VII branced. *Paddle:* shallowly and minutely emarginate apically at midrib; uniformly moderately pigmented; midrib strong and darkly pigmented; external margin with sclerotized sharp serrations in distal half or more; inner margin with smaller, more widely spaced serrations; hair 1-P strong but short, 2-P not developed.

LARVA (fig. **70**).—*Head:* 0.65 mm. *Siphon:* 0.7 mm. *Anal Saddle:* 0.36 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* broad, index about 0.83; ocular bulge distinct; pigmentation uniformly dark brown; integumentary sculpturing strong particularly on ocular bulge; aulaeum with long fringes throughout; mental plate with 12 or more small teeth on each side of median tooth; larger hairs slightly darker than head capsule; hair 1-C very short; 4-C short, multiple, removed caudad; 5,6-C single, thickened but not spikelike, apex strongly attenuate; 7-C in normal position; 8,9-C long; 11-C short; 14-C flattened. *Antenna:* about 0.25 of head length; shaft spiculate basad of hair 1-A; concolorous with head capsule basad, lighter distad; hair 1-A in distal 0.33, long and single. *Thorax:* tubercles and all hairs except smallest strongly pigmented; hairs 1-3-P of 2 sides closely approximated; 8-M long, with multiple barbed branches. *Abdomen:* larger hairs strongly pigmented; hairs 6 and 7 long and close together on I-II, hair 9-I between 6,7-I; 6-III-V very different from 6-I,II, stellate; 1-II-VII, 13-II-V,VI stellate; 9-II-VI weak. *Segment VIII:* comb plates not connected by dorsal saddle but with dorsal extensions, moderately pigmented, bearing hair 0-VIII only; comb scales fringed; hairs strongly developed; 1,2-VIII on a large common basal sclerotized plate which has a caudal extension with a conspicuous circular depression; 3-VIII with a smaller basal plate. *Siphon:* elongate, index about 4.0; acus strongly developed; uniformly moderately pigmented except for darker base, acus, and apex; sculpturing distinct; pecten teeth fringed; hair 1-S long, with multiple barbed branches; valves strongly developed, dark; hair 13 minute; trachea large. *Anal Segment:* saddle complete, emarginate caudoventrad for ventral brush; moderately pigmented, uniform except for darker area at base dorsad; without caudolateral marginal spicules; median dorsal caudal process developed; hair 1-X strong, usually unevenly branched; 2,3-X both usually 2b; 5 pairs of hairs 4-X on grid which is connected to saddle; no accessory hair; gills slender, pointed, shorter than saddle.

EGG.—Unknown.

MATERIAL EXAMINED.—91 specimens; 13 ♀; 8 ♂; 22 pupae; 48 larvae; 4 individual larval rearings.

SYSTEMATICS.—*U. painei* is extremely similar to *colocasiae* in the adult stage in all external characters, as well as in male genitalia. It can be separated from the latter by the reduction in scales and bristles and by the longer cell R_2. On the other hand, the immature stages are entirely different from *colocasiae* or the *atra* section and conform in general to the types found in the ornamented ground poolbreeders. My interpretation is that *painei* was produced through hybridization between *colocasiae* and a ground pool-breeding *Uranotaenia* and that the latter was subsequently eliminated. However, it is possible that the second parental species may have been preserved but has escaped detection. Another interpretation might be that *painei* has been derived from *colocasiae*, or *vice versa*, and that the different types of larvae and pupae are merely a result of adaptive specialization of the immature stages to different environments. It seems most unlikely that this is correct, for the similarities with the corresponding ecological forms are too numerous and extensive to be owing to convergence rather than genetic similarity.

BIONOMICS.—The immature stages of *painei* have been collected in rock pools in stream beds and in shallow ground puddles at the edge of a small flood stream (Paine, 1943:10–11). Algae and cast skins of crabs may be found in such pools. Adults have been collected on the wing along river banks. This species is probably more common and widespread than reported, as it is very easily confused with *colocasiae* in the adult stage.

DISTRIBUTION (figs. **60**, **62**).—*Fiji:* Taveuni Vanua Levu; Viti Levu; Ngau. Not known elsewhere.

WYSOCKII SECTION

4. Uranotaenia wysockii Belkin

Figs. 60, 62, 64, 71, 72

1953. *Uranotaenia wysockii* Belkin, Pacific Sci. 7:366–373. *TYPE: holotype ♀ with associated larval and pupal skins (JNB, 932-103), Tenaru area, Guadalcanal, Solomon Islands, from leaf axil of a pandanaceous plant in nipa palm swamp, Mar. 28, 1945, J. N. Belkin, M. Cohen, and E. Winkler (USNM, 61421).

Uranotaenia wysockii of Iyengar (1955:25); Stone, Knight, and Starcke (1959).

FEMALE (fig. **64**).—*Wing:* 1.7 mm. *Proboscis:* 1.1 mm. *Forefemur:* 1.37 mm. *Abdomen:* about 1.2 mm. Small species with ornamented head, thorax, abdomen, legs, and wing. *Head:* decumbent scales dark except for a conspicuous white orbital line enlarged laterad; conspicuous frontal tuft of very long narrow white scales;

erect scales resricted and small, 1 pair on vertex and 3 on occiput; clypeus dark, bare; labium dark, distinctly lighter ventrally, slightly swollen apically; labella lighter; palpus about 0.05 of proboscis; antenna about 1.2 of proboscis; torus brown, with several broad outstanding light translucent scales; flagellar segment 1 distinctly longer than segment 2, with a few small translucent scales near base. *Thorax* (fig. **64**): mesonotal integument uniformly brown; scales narrow, curved, bronzy, becoming broader and denser in prescutellar space; a narrow line of white scales on lower margin of mesonotum from wing root to wing root around front, scales broad except in front; scutellum brown, scales broad, dark, decumbent, and numerous; paratergite brown; pleuron brown except for light pollinose stripe on *ssp* and *mep* in line with the light scales; *apn* and *stp* each with a narrow line of white scales forming streak in line with white scaling of head; a few broad translucent light scales near lower *stp* bristles; no scales elsewhere; *ppn* bristles very strong; *sp* and upper *mep* bristles absent; 3 strong *ppl* bristles; *pra* distinctly separated from *stp*. *Legs:* dark-scaled above, lighter below; conspicuous white knee spots on all femora; tarsi light-scaled on all legs from basal 0.33 of segment 3, pure white on hindleg, beige on foreleg and midleg. *Wing:* a conspicuous black and white pattern on dorsal and ventral surfaces; anterior border dark, median and posterior part white, an indistinct gray transverse subapical band, apex of wing white beyond base of cell R_2; fringe white, beige on apex; vein R_2 about 0.33 of R_{2+3}; alula without scales. *Haltere:* light at base, dark-scaled on knob. *Abdomen:* tergite I white-scaled; laterotergite dark-scaled; tergites II-IV each with large median patch of white scales extending from base to apex, wider apically; tergite V with white-scaled patch occupying apical 0.67; tergites VI,VII each with median apical transverse band of white scales; remainder of tergites and all sternites dark-scaled.

MALE (fig. **64**).—Generally as in the female except for sexual differences. *Head:* orbital line of white scales narrower. *Labium:* apical swelling stronger. *Antenna:* flagellum strongly plumose; flagellar segment 1 about 1.7 of segment 2; segment 12 about 1.65 of segment 11, segment 13 about 1.1 of segment 12. *Legs:* enlarged claw of midleg simple.

MALE GENITALIA (fig. **71**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite distinctly but shallowly emarginate caudomesally; lateral tergal lobe moderately projecting, with ventrolateral sclerotization. *Sidepiece:* bristles and hairs slender, few; scales few and restricted to lateral and ventral surfaces; basal mesal lobe not defined, represented by a group of about 6 dorsal bristles and 1 ventral bristle. *Clasper:* about 0.7 of sidepiece length; widened beyond middle; distal half with minute setae; spiniform small. *Phallosome:* aedeagus complex, with subbasal dorsal sclerotized bridge and no distinct ventral bridge, each side with 1 large subapical and 1 large submedian lateral tooth, occasionally a small denticle in between. *Proctiger:* broadly conical from base, with a more or less distinct ventrolateral sclerotization on each side.

PUPA (fig. **71**).—*Abdomen:* 1.7 mm. *Trumpet:* 0.25 mm. *Paddle:* 0.32 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly lightly pigmented except for darker mesonotum and base of wing pads; hairs largely concolorous with integument. *Trumpet:* index about 6.5; inserted closer to wing base than middorsal line; uniformly lightly pigmented; tracheoid to about 0.5; apex diagonally truncate; no slit in meatus. *Abdomen:* basal segments unevenly pigmented, with submedian pale areas; posterior segments uniformly more lightly pigmented; all hairs lightly pigmented; some of the larger hairs branched; hair 1-I with many primary branches which are lightly dendritic apically; 9-VII ventral in position, removed mesad of 6; 6-VII ventrolateral in position. *Paddle:* very slightly emarginate apically at midrib; very lightly pigmented; midrib strongly sclerotized and darkly pigmented; external margin with small sclerotized sharp serrations; inner margin with a few minute widely spaced serrations; both hairs absent.

LARVA (fig. **72**).—*Head:* 0.6 mm. *Siphon:* 0.36 mm. *Anal Saddle:* 0.26 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* about as wide as long; ocular bulge near middle, not well defined; pigmentation very light, darker dorsocaudad on midline; integumentary sculpturing distinct caudally only; aulaeum with long fringed spicules throughout; mental plate rather small and rounded, with about 8 small rounded teeth on each side of median tooth; all hairs concolorous with integument, difficult to see; hair 1-C moderately long; 4-C short multiple, nearer hair 6 than 5; 5,6-C slightly thickened but not spikelike, 5-C usually 2,3b, 6-C single; 7-C in normal position; 8,9,11-C moderately long; 14-C dendritic. *Antenna:* about 0.2 of head length; shaft smooth; concolorous with head capsule; hair 1-A near middle, usually 3b and almost as long as antennal shaft. *Thorax:* all hairs and tubercles lightly pigmented, slightly darker than head capsule; hairs 1-3-P of two sides closely approximated; 8-M long, with multiple barbed branches; 9-M,T with multiple barbed branches; hairs 1,5-P, 5,6,10-M, 10-T greatly elongate and with attenuate apex. *Abdomen:* hairs and tubercles on I,II as on thorax, those of following segments more strongly pigmented, particularly the stellate tufts; stellate hairs (1,6,13) with branches of uneven lengths; hairs 6 and 7 very long and close together on tubercle on I,II; hair 9-I between 6,7-I; 6-III-VI very different from 6-I,II, stellate; 9-II-VI weak. *Segment VIII:* comb plates not connected by dorsal saddle but with dorsal extensions, strongly sclerotized and moderately pigmented, bearing hair 0-VIII only; comb scales spinelike but bearing very fine lateral fringes; hairs strongly developed; hairs 1,2-VIII without basal plate; 3-VIII with a small basal plate. *Siphon:* elongate, distinctly narrowed near apex, index about 3.0; uniformly moderately pigmented; sculpturing distinct; pecten teeth fringed apically, extending to about 0.8 of siphon; hair 1-S branched, slightly longer than siphon, inserted beyond middle; valves moderately developed; hair 13-S minute; trachea large. *Anal Segment:* saddle complete, slightly emarginate caudoventrad for ventral brush; uniformly moderately pigmented, with long conspicuous apically fringed caudolateral marginal spicules; median dorsal caudal process developed; hair 1-X strong, usually unevenly branched; 2-X usually 3b; 3-X usually 2b; 5 pairs of hairs 4-X on grid which is connected to saddle; no accessory hair; gills slender, rounded apically, about 1.6 of saddle length.

EGG.—Unknown.

MATERIAL EXAMINED.—136 specimens; 29♀; 15♂; 27 pupae; 65 larvae; 8 individual rearings (7 larval, 1 pupal).

SYSTEMATICS (fig. **60**).—*U. wysockii* is a very distinct species without described relatives in the Australasian area. In the adult stage it shows a number of characters in common with *alboannulata* (Theobald, 1905) from South India, *rutherfordi* Edwards, 1922 from Ceylon, and *trilineata* Leicester, 1908 from Malaya. Among these shared characters are pictured wings, a narrow light-scaled line from wing root to wing root around the front margin of the mesonotum, a narrow light-scaled line across *apn* and *stp,* and conspicuous knee spots. *U. wysockii* differs from the other species named in the following combination of characters: proboscis largely dark-scaled, no conspicuous light markings on the femora other than the knee spots, all tibiae dark-scaled, and the ornamentation of the tarsi.

The immature stages of the Oriental and Indomalayan species are not known, but it is likely that they will be found in water collections in living plants. Until they are described, it is not possible to say whether or not *wysockii* is related to this group of species. It is evident that *wysockii* shares a number of important characters in all stages with species of *Uranotaenia* which utilize ground pools for breeding. However, it appears to have a number of unique characters in all stages; therefore I separate it into a distinct section for the present.

BIONOMICS.—The immature stages of *wysockii* have been collected from the leaf axils of at least 2 species of pandanus on Guadalcanal in association with species of the *Aedes kochi* group and *Culex* (*Lophoceraomyia*). Superficially the larvae of *wysockii* bear little resemblance to those of ground water species of *Uranotaenia.* The broad head is much like that of other mosquitoes inhabiting water collections in plants, and the simple hairs of the thorax and anterior and caudal portions of the abdomen are greatly elongate. The short, characteristically shaped siphon, with its very long ventrolateral hair, is also very different from typical *Uranotaenia.* The larvae spend most of the time feeding at the bottom.

DISTRIBUTION (figs. **60, 62**).—*Solomon Islands:* Bougainville; New Georgia; Guadalcanal. Not known elsewhere.

ANISOCHELEOMYIA SECTION

FEMALES (South Pacific species).—Small species with ornamented head, thorax, and often legs, abdomen, and wings. *Head:* decumbent scales rarely all light, usually dark except for orbital light (blue to white) line of variable extent which is enlarged laterally to meet light scaling of *apn;* frontal tuft present or absent; erect scales reduced or absent; clypeus dark, bare; labium dark-scaled, often lighter ventrally, usually more or less conspicuously swollen apically; labella lighter; palpus 0.05–0.08 of proboscis; antenna about 1.2 of proboscis; torus with short hairs and a few outstanding broad translucent scales; flagellar segment 1 distinctly longer than segment 2, without conspicuous scale patch. *Thorax:* mesonotal integument variable; general mesonotal vestiture of narrow curved bronzy scales; restricted patches or lines of iridescent or light scales laterally, scales sometimes broad; scutellum densely covered with broad dark decumbent scales; pleuron brown except usually for light pollinose stripe on *ssp* and *mep* in line with light scales (*sexauri* with upper half of pleuron and lower part of mesonotum light-colored); *apn* with broad scales; *ppn* without scales except in *sexaueri; stp* with variable lines or patches of broad scales; scales absent elsewhere; chaetotaxy reduced, bristles usually as follows: 2:1 *apn,* 1 *ppn,* 2,3 short *ppl,* 1 *sp,* 1,2 upper *mep; pra* distinctly separated from *stp. Legs:* generally dark-scaled above, lighter below; no distinct knee spots; tarsi all dark-scaled or marked with white. *Wing:* entirely dark-scaled or with restricted areas of light or iridescent scales; vein R_2 usually 0.3–0.45 of R_{2+3};

alula without scales. *Haltere:* light at base, dark-scaled on knob. *Abdomen:* varied in ornamentation; laterotergite scaled.

MALES (South Pacific species).—Essentially as in the females. *Labium:* more conspicuously swollen apically. *Palpus:* entirely similar to females. *Antenna:* flagellar segments strongly plumose; flagellar segments 12 and 13 usually elongate. *Legs:* often modified.

MALE GENITALIA (South Pacific species).—*Segment IX:* tergite bare, emarginate, and with lateral tergal lobe either broad or produced into spine. *Sidepiece:* bristles and hairs slender, few; scales few and restricted to lateral and ventral surfaces; basal mesal lobe not well defined, represented by a tergal group of several heavy bristles and 1 sternal bristle. *Clasper:* about 0.7 of sidepiece length; widened beyond middle; distal half with minute setae; spiniform small. *Phallosome:* aedeagus simple, with subbasal sclerotized dorsal bridge but no distinct ventral bridge, with 1 or more subapical and 1 or more submedian lateral teeth. *Proctiger:* broadly conical from base, without distinct sclerotization.

PUPAE (South Pacific species).—*Trumpet:* index variable; inserted closer to midline than to wing case; tracheoid to at least 0.4; apex diagonally truncate; a distinct slit in meatus. *Abdomen:* hair 1-I with many primary branches moderately dendritic apically; 9-VII ventral in position, removed mesad of hair 6; 6-VII ventral or ventrolateral; 1-III-VII stellate, 5-III-VII stellate or thickened. *Paddle:* midrib strongly developed; only hair 1-P present.

LARVAE (South Pacific species).—*Head:* usually longer than wide and with distinct ocular bulge; aulaeum with long fringed spicules throughout; hair 1-C at least moderately long; 4-C varied, at level of 6-C; 5,6-C single, more or less distinct spikes; 7-C normal in position; 8,9-C usually long; 11-C usually strongly developed; 14-C unbranched, thickened. *Antenna:* about 0.2–0.25 of head length; shaft smooth or spiculate; hair 1-A short, unbranched, usually in basal half. *Thorax:* hairs 1-3-P of 2 sides closely approximated; 8-M long, with multiple barbed branches; 9-M,T with multiple barbed branches; long single hairs not markedly elongate; 1-M, 1,13-T stellate. *Abdomen:* hairs 6,7-I,II long, on common tubercles close together, hair 9-I between 6,7-I; hair 6-III-VI very different from 6-I,II, stellate; 1-II-VII, 13-II-V,VII stellate; 9-II-VI weak. *Segment VIII:* comb plates not connected by dorsal saddle but with dorsal extensions, strongly sclerotized, bearing hair 0-VIII only; comb scales spinelike but with very fine lateral fringes proximad; hairs strongly developed; hairs 1,2-VIII with large basal plate, 3-VIII with small basal plate. *Siphon:* elongate, more or less cylindrical, not distinctly narrowed subapically; pecten teeth fringed apically, not extending beyond 0.5 of siphon; hair 1-S branched, less than 0.5 of siphon, inserted before middle; valves moderately to strongly developed; hair 13 long, twisted near base. *Anal Segment:* saddle complete; slightly to moderately emarginate caudoventrad for ventral brush; with caudolateral marginal spicules; median dorsal caudal process developed; hair 1-X stellate; 5 pairs of hairs 4-X on grid which is connected to saddle, hair 4e-X very short; no accessory saddle hairs; gills variable.

EGGS.—Laid in small boat-shaped masses on water surface; not resistant.

SYSTEMATICS.—I am erecting the *Anisocheleomyia* section for its type species, *nivipes* (Theobald, 1905), and its relatives and all the ground pool-breeding species of *Uranotaenia* from the South Pacific except *painei,* which appears to be a species produced through hybridization between a member of this section and *colocasiae.* All these forms are ornamented in the adult stage, and it seems probable that the majority of the ornamented ground pool-breeding species of *Uranotaenia* from the Australasian, Indomalayan, and Oriental regions will also fall into this section. I have not studied carefully the Ethiopian species of *Uranotaenia;* on superficial examination, however, it appears that some of the species in section A of Edwards (1941:43–44) may also be placed in the *Anisocheleomyia* section. There are a number of similarities between the *Anisocheleomyia* section and the typical *Uranotaenia* section of the New World, but it seems advisable to separate them at least until a thorough revision is made.

Each of the 5 South Pacific species assigned to the *Anisocheleomyia* section falls into a distinct species group. Prior to the revision of the *Uranotaenia* of the Solomon Islands (Belkin, 1953*a*) the species found on these islands were regarded as identical with wide-ranging forms, but it appears that at least 4 of them are probably distinct species. However, when material from intermediate areas is carefully studied they may be shown to be subspecies of wide-ranging polytypic species.

BIONOMICS.—All members of this section are ground water-breeders, utilizing swamps, marshes, stream margins, and temporary pools. Individual species vary greatly in requirements for light, oxygen, and cover. As far as is known, all species lay egg rafts. Adults are commonly found near larval habitats and may be attracted to artificial lights at night.

DISTRIBUTION (figs. **60**, **61**, **63**).—The *Anisocheleomyia* section is restricted to the Old World and is predominantly Australasian, Indomalayan, and Oriental in distribution; it may also be represented in the Ethiopian region by some members of group A of Edwards. In the South Pacific the section is represented by 5 species in the Solomons, 1 of which (*barnesi*) occurs also in the New Hebrides.

5. Uranotaenia sexaueri Belkin

Figs. 60, 63, 64, 73, 74

1953. *Uranotaenia sexaueri* Belkin, Pacific Sci. 7:359–366. *TYPE: holotype ♀ with associated larval and pupal skins (JNB, 713-15), West Poha swamp, Guadalcanal, Solomon Islands, from dense grassy jungle swamp, Nov. 3, 1944, M. Cohen and L. J. Lipovsky (USNM, 61420).

Uranotaenia sexaueri of Iyengar (1955:25); Stone, Knight, and Starcke (1959).
Uranotaenia nivipes in part of Knight, Bohart, and Bohart (1944:15).

FEMALE (fig. **64**).—*Wing:* 1.55 mm. *Proboscis:* 1.15 mm. *Forefemur:* 1.15 mm. *Abdomen:* about 1.1 mm. *Head:* all scales white except for small dark patch laterad; frontal tuft conspicuous; a few erect scales present. *Thorax* (fig. **64**): integument of lower part of mesonotum and upper part of pleuron white including around front; white part of mesonotum with numerous small broad decumbent white scales and with a patch of elongate slender white scales in front of wing root; scutellum with dark integument; *apn, ppn,* and upper *stp* each with large patch of broad white scales; lower half of *stp* with broad dark scales. *Legs:* hindtarsus white-scaled from about 0.5 of segment 3 distad; foretarsus and midtarsus pale on segments 3–5. *Wing:* a conspicuous black and white pattern on dorsal surface; anterior border dark, median and posterior white, a subapical transverse dark band, apex white beyond base of cell R_2; vein R without dark scales in basal 0.3; fringe white. *Abdomen:* tergite I white-scaled; laterotergite white-scaled; tergites with apical transverse white bands, wider on basal segments; remainder of tergites dark-scaled; sternites with dull white scales.

MALE (fig. **64**).—Generally similar to the female except for sexual differences. *Labium:* more strongly swollen apically. *Antenna:* flagellar segments 12 and 13 subequal and each about 2.0 of segment 11. *Legs* (fig. **64**): enlarged claw of midleg simple.

MALE GENITALIA (fig. **73**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite long, proximal and distal emarginations shallow; lateral tergal lobe slightly projecting and with ventrolateral sclerotization. *Sidepiece:* basal mesal lobe with dorsal group of 2 strong and 3 weak bristles and with 1 strong ventral bristle. *Clasper:* as figured. *Phallosome:* aedeagus with 1 heavy slightly curved subapical spine and 1 heavy strongly curved submedian spine with a basal tooth.

PUPA (fig. **73**).—*Abdomen:* 1.62 mm. *Trumpet:* 0.2 mm. *Paddle:* 0.42 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly moderately pigmented, darker on mesonotum and bases of wing and appendage cases; hairs largely concolorous with integument; larger branched hairs with a short slightly flattened stem. *Trumpet:* index about 3.5; dark on basal 0.4 tracheoid part, golden brown beyond; pinna about 0.25. *Metanotum:* darkened. *Abdomen:* uniformly moderately pigmented throughout; hairs largely concolorous with integument; larger branched hairs without strong flattened stem; hair 1-II with 6,7 simple branches; 5-V-VII usually 4-6b, slightly longer than following tergite. *Paddle:* lightly pigmented; external margin with small teeth distinct apically only; internal margin with even shorter and sparser serrations; hair 1-P very weak and short.

LARVA (fig. **74**).—*Head:* 0.65 mm. *Siphon:* 0.7 mm. *Anal Saddle:* 0.36 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* index about 1.3; ocular bulge prominent; uniformly strongly pigmented except for light ocular areas; integumentary sculpturing very prominent and uniform; mental plate usually with 5–7 blunt inconspicuous teeth on each side of median tooth; all hairs conspicuous and strongly pigmented; hair 0-C bristlelike; 1-C long; 5,6-C strong, very dark spikes, apex frayed, shaft minutely spiculate; 4-C moderate, usually 2b(2–3); 7-C usually 4b(3–5); 9,11-C long. *Antenna:* about 0.23 of head length; shaft weakly spiculate; uniformly darkly pigmented; hair 1-A arising near middle, length about 0.75 of shaft width; apical hairs short, unmodified. *Thorax:* all hairs and tubercles strongly pigmented; long hairs with apex blunt or frayed; hair 4-P usually 2b; 7-P usually 2b(2–4); 9-P short, usually 4b(4–6); 10-P single, well developed; 14-P very strong, with at least 12 branches. *Abdomen:* hairs and tubercles of segments I,II strongly pigmented, those of following segments moderately pigmented; hairs 6-I,II usually 2b, branches uneven in length; 6-III,IV usually 7,8b(7–11); 1-II,III usually 7-9b(7–11). *Segment VIII:* comb scales 6,7, one greatly enlarged and sharply pointed, with very inconspicuous basal lateral fringe. *Siphon:* index about 5.5; uniformly darkly pigmented and imbricate; pecten extending to about 0.4; pecten teeth 12–16, each tooth narrow, fringed apically and laterally; ventral valve strongly developed. *Anal Segment:* saddle strongly pigmented, darker dorsad; caudal marginal spicules long, slender, and sharply pointed; hair 1-X usually 6,5b; 2-X usually 3b(2–4); 3-X usually 2b; 4a-X usually 3b; 4b-X usually 2b; gills about 0.5 saddle length.

MATERIAL EXAMINED.—166 specimens; 16♀; 13♂; 19 pupae; 118 larvae; 7 individual rearings (1 larval, 6 pupal).

SYSTEMATICS (fig. **60**).—This is a very strikingly marked species which superficially is very different in the adult stage from the other members of the *Anisocheleomyia* section in the South Pacific. However, in the immature stages it is quite similar to them. There seems to be little individual variation in the small series I have examined, and there is no indication of striking geographical variation.

U. sexaueri appears to be closely related to *nivipes* (Theobald, 1905) from Queensland and *albofasciata* Taylor, 1920 from Northern Territory, Australia, both of which also have pictured wings and the striking broad band of whitish integument on the lower part of the mesonotum and upper part of pleuron (fig. **60**). The adults of *sexaueri* are distinguished from these species by the following combination of characters: absence of dark scales on the basal 0.3 of vein R, dark-scaled knob of haltere, hindtarsus white-scaled from about 0.5 of segment 3, and lateral white integument of mesonotum not triangularly produced mesad above mesothoracic spiracle. The immature stages of *nivipes* and *albofasciata* have not been described.

Several other species appear to belong to the same group as *nivipes, albofasciata,* and *sexaueri: nivea* Leicester, 1908 from Malaya, *triangulata* (Ludlow, 1908) from the Philippines, and *orientalis* Barraud, 1926 from Assam.

BIONOMICS.—The immature stages of *sexaueri* have been collected only in dense jungle swamps in association with *barnesi* and *solomonis.* This species appears to be uncommon, the adults are rarely collected, and the immature stages are difficult to rear in the laboratory.

DISTRIBUTION (fig. **63**).—*Solomon Islands:* Bougainville; Guadalcanal. Not known elsewhere.

6. Uranotaenia civinskii Belkin

Figs. **61, 63, 64, 75, 76**

1953. *Uranotaenia civinskii* Belkin, Pacific Sci. 7:341–350. TYPE: holotype ♀ with associated larval and pupal skins (JBN, 504–44), Bonegi River valley, Guadalcanal, Solomon Islands, from cattle tracks, July 18, 1944, L. J. Lipovsky, S. Civinski, and H. F. Sexauer (USNM, 61418).

Uranotaenia civinskii of Iyengar (1955:25); Laird (1956); Stone, Knight, and Starcke (1959).

Uranotaenia argyrotarsis in part of Edwards (1932:98); Taylor (1934:13); Lee (1944*a*:116); Knight, Bohart, and Bohart (1944:15, 67); Stone, Knight, and Starcke (1959).

Uranotaenia argyrotarsis var. of Edwards (*in* Paine and Edwards, 1929:312–313).

FEMALE (fig. **64**).—*Wing:* 2.3 mm. *Proboscis:* 1.5 mm. *Forefemur:* 1.83 mm. *Abdomen:* about 1.4 mm. *Head:* decumbent scales dark except for broad orbital line of bluish white scales expanded into broad patch laterad; frontal tuft bluish white and conspicuous; erect scales dark, 4 pairs on vertex, 2 pairs on occiput. *Thorax* (fig. **64**): mesonotal integument uniformly dark except for indistinct lighter longitudinal stripes; a narrow supraalar line of bluish white scales angled dorsad anteriorly, not reaching scutal angle; *ppn* without scales; *apn* and *stp* each with a narrow line of bluish white scales forming a streak in line with light scaling of head; scattered small patches of translucent light scales along lower caudal border of *stp. Legs:* hindtarsus white-scaled from at least the apical 0.1 of segment 2 distad; foretarsal and midtarsal segments 2–5 with beige scales; a small subapical light patch on hindtibia. *Wing:* dark-scaled except for bluish white scales as follows; (1) 2,3 on extreme base of C, (2) on caudal margin of R to slightly beyond arculus, (3) on extreme base of anterior margin of R, (4) on basal 0.5 of Cu, (5) a few on base of 1A; fringe light, darker on apex. *Abdomen:* tergites II-IV each with a broad median trapezoidal patch of pure white scales, patches broader apically;

tergite I often with some light scales, remainder of tergites and laterotergite dark-scaled; sternites with dull white scales.

MALE (fig. **64**).—Generally similar to the female. *Head:* vertex more extensively dark-scaled. *Labium:* very strongly swollen apically. *Antenna:* flagellar segment 12 about 2.0 of segment 11, segment 13 about 1.7 of segment 12. *Legs* (fig. **64**): hindtibia straight in basal 0.25 then curved, basad of curve 1 short straight and 2 long curled bristles; enlarged claw of midleg simple. *Abdomen:* tergite IV with large patch of dull white scales, broad apically, narrowed triangularly almost to base; tergite III usually and II less frequently with smaller median apical light patches; remainder of tergites dark-scaled except that tergite I may have a few light scales.

MALE GENITALIA (fig. **75**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with proximal emargination very strong and deep, apical deep and wide; lateral tergal lobe in form of strongly projecting, heavily sclerotized short tooth; median bridge longer than tooth. *Sidepiece:* basal mesal lobe with dorsal group of about 8 bristles in 3 irregular rows and with 2 ventral bristles. *Clasper:* as figured; distal bristles numerous and long. *Phallosome:* aedeagus with narrow subbasal dorsal bridge; 1 long, slender subapical spine and 1 subequal more strongly curved submedian spine.

PUPA (fig. **75**).—*Abdomen:* 1.83 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.5 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately and uniformly pigmented, slightly darker on leg cases; hairs moderately pigmented; larger branched hairs with slender basal stem only slightly expanded distally. *Trumpet:* index about 5.0; uniformly strongly pigmented; tracheoid to about 0.5; pinna about 0.23. *Metanotum:* darkened. *Abdomen:* moderately pigmented, somewhat darker basad, ventral integumental sclerotizations darker; hairs largely concolorous with integument; larger hairs as on cephalothorax; hair 1-II dendritic, with 3,4 primary branches, each with 3–5 secondary branches; 5-V-VII usually 3b, distinctly longer than following tergite. *Paddle:* lightly pigmented; external margin with serrations distad of buttress, becoming strongly sclerotized on apical 0.5; internal margin with poorly sclerotized sparse crenulations; hair 1-P minute.

LARVA (fig. **76**).—*Head:* 0.7 mm. *Siphon:* 0.7 mm. *Anal Saddle:* 0.34 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* index about 1.4; ocular bulge prominent; moderately pigmented anteriorly, darker posteriorly, ocular bulge light; integumentary sculpturing very prominent and uniform; mental plate usually with about 10 poorly defined teeth on each side of median tooth; all hairs conspicuous and strongly pigmented; hair 0-C very well developed, flattened, reaching to middle of 1-C; 1-C long and slender; 5,6-C very dark strong spikes, apex sharply pointed, shaft minutely spiculate, more conspicuously distad; 4-C moderate, usually 3b(2–4); 7-C usually 4,5b(4–6); 9,11-C long. *Antenna:* about 0.23 of head length; shaft weakly spiculate; uniformly darkly pigmented; hair 1-A at about 0.3–0.4, length about 1.4–1.5 of shaft width; apical hairs unmodified. *Thorax:* all hairs and tubercles strongly pigmented; long hairs attenuate and sharp apically; hair 4-P usually 3b; 7-P usually 2b; 9-P long, usually 2b(2–3); 10-P single, strong, barbed; 14-P moderately developed, usually 6,5b(4–8). *Abdomen:* tubercles of I,II and all hairs strongly pigmented; hairs 6-I,II usually double, branches uneven in length; 6-III,IV usually 6,7b(5–9); 1-II,III usually 5-8b. *Segment VIII:* comb scales usually 8,9(6–9), median ones longer but not sharply differentiated, very sharply pointed and with conspicuous lateral fringe in basal 0.5. *Siphon:* index about 5.0; uniformly moderately pigmented, imbrications faint; pecten extending to almost 0.6; pecten teeth usually 16,15(13–18), each tooth narrow and with strong apical and weak lateral fringe; ventral valve moderate to small. *Anal Segment:* saddle moderately pigmented, darker dorsad; caudal marginal spicules in form of sparse spines of varied lengths; hair 1-X usually 5,4b(4–7); 2-X usually 3b; 3-X usually 2b; 4a-X usually 3b; 4b-X usually 2b; gills about 0.6 saddle length.

MATERIAL EXAMINED.—731 specimens; 141 ♀; 133 ♂; 116 pupae; 341 larvae; 9 individual larval rearings.

SYSTEMATICS (fig. **61**).—Adults of *civinskii* show marked individual variation in the ornamentation of the head, thorax, and abdomen. This is particularly noticeable in the male abdomen, which may have the white scaling restricted to tergite IV. The white scaling of the hindtarsus always includes the apex of segment 2 but may be extended to cover as much as the apical 0.25 of this segment. No correlation has been found between adult variation in ornamentation and the considerable variation in the chaetotaxy of the immature stages.

Specimens from Bougainville have the subapical light patch on the hindtibia larger and more conspicuous than those from New Georgia and Guadalcanal, but no other differences are apparent.

U. civinskii is a member of the **argyrotarsis* Leicester, 1908 complex (fig. **61**) which includes, besides the typical form from Malaya, *parangensis* (Ludlow, 1909) from the Philippines. It is very possible that these 3 forms are conspecific, but since *civinskii* appears to be distinguishable from the others by a number of characters in adult ornamentation, I prefer to retain it as a distinct species for the present. The complex is most strikingly characterized by the peculiar development of the base of the hindtibia of the male. *U. civinskii* differs from *argyrotarsis* and *parangensis* in the following combination of characters: hindtarsus white from at least the apical 0.1 of segment 2, female hindtibia with a conspicuous subapical anterior patch of light scales, and abdominal segment I usually dark, at most with a few light scales in both sexes.

BIONOMICS.—*U. civinskii* is predominantly a jungle stream-breeder utilizing side pools and rock pools in stream beds in preference to other habitats. It apparently requires fresh, well-oxygenated, clear water and, when breeding in swamps or small pools, is usually found near springs or seepages. Because of these requirements it is difficult to rear in the laboratory. It is usually found in densely shaded areas but when flushed into open situations, it appears to survive successfully.

Both males and females are found in numbers in the vicinity of breeding sites and fly readily in the daytime. They rest most frequently on shaded, moist rock surfaces and stream banks but have been found also on tree buttresses. A small number of both sexes have been collected in night hand-catches near lighted quarters but never biting.

DISTRIBUTION (fig. **63**).—*Solomon Islands:* Bougainville; New Georgia; Russell; Florida; Guadalcanal. Not known elsewhere.

7. Uranotaenia lateralis Ludlow

Figs. **61**, **63**, **64**, **77**, **78**

1905. *Uranotaenia caeruleocephala* var. *lateralis* Ludlow, Canad. Ent. 37:385–386. *TYPE: lectotype ♀, Cottabato, Mindanao, Philippines, June, E. B. Vedder; selection of Stone and Knight, 1957*b*:200 (USNM, 27786).

1908. *Uranotaenia cancer* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):215–217. *TYPES: syntypes, 3 ♂, 10 ♀, Port Swettenham and Klang, Malaya, Leicester (BMNH).—Synonymy with *lateralis* and *ceylonica* and incorrectly with *atra* by Edwards (1922*b*:460).

1910. *Uranotaenia ceylonica* Theobald, Monog. Culicidae 5:503–505. *TYPE: holotype ♀, Galle, Ceylon, B. Fletcher (BMNH).—Synonomy with *lateralis* and *cancer* by Edwards (1922*b*:460) and incorrectly with *atra* by Edwards (1913:238).

1914. *Uranotaenia propria* Taylor, Roy. Ent. Soc. London, Trans. 1913(61):704–705. TYPE: holotype ♂, Townsville, Queensland, H. Priestley (location unknown).—Synonymy with *cancer* and *cairnsensis* and incorrectly with *atra* by Edwards (1924:357–358).

1919. *Uranotaenia cairnsensis* Taylor, Linn. Soc. N. S. Wales, Proc. 43:839. TYPES: syntypes, 2 ♀, Cairns, Queensland, July, 1917, F. H. Taylor (location unknown). —Synonymy with *cancer* and *propria* and incorrectly with *atra* by Edwards (1924:357–358).

1925. *Uranotaenia innotata* Dyar and Shannon, Insecutor Inscitiae Menstruus 13:69–70. *TYPE: holotype ♀, Camp Nichols, Rizal, Luzon, Philippines, December 14, 1924, Carraway (USNM, 28098).—Synonymy of Bohart (1945:34).

Uranotaenia lateralis of Stone (1957*a*:173); Stone, Knight, and Starcke (1959).

Uranotaenia atra of Edwards (1913:238; 1922*b*:460; 1924:357–358; 1932:98); Brug (1924:441); Barraud (1926:340; 1934:72–74); Bonne-Wepster and Brug (1939:1231); Lee (1944*a*:30); Knight, Bohart, and Bohart (1944:16, 67); Belkin (1953*a*:324–332); Bonne-Wepster (1954:22–25); Iyengar (1955:25); Laird (1956).

FEMALE (fig. **64**).—*Wing:* 1.7 mm. *Proboscis:* 1.17 mm. *Forefemur:* 1.33 mm. *Abdomen:* about 1.2 mm. *Head:* decumbent scales dark except for broad orbital line of deep azure blue scales expanded laterad; frontal tuft not developed; erect scales dark, 2 pairs on vertex, 3 pairs on occiput. *Thorax* (fig. **64**): integument uniformly dark; a short broad line of deep azure blue scales in front of wing root; *ppn* without scales; *apn* and *stp* each with a broad patch of azure blue scales, not markedly in line, a small patch of translucent scales on lower caudal part of *stp*. *Legs:* tarsi dark, without definite white markings on hindleg. *Wing:* scales all dark. *Abdomen:* inconspicuous apicolateral white patches on tergites II-VII, invisible from above; sternites with light beige to almost white scales.

MALE (fig. **64**).—Generally similar to the female except for sexual differences. *Head:* orbital light-scaled line narrower. *Labium:* very strongly swollen apically, conspicuous ventral light patch on swollen part. *Antenna:* flagellar segment 12 about 1.25 of segment 11, segment 13 about 1.5 of segment 12. *Legs* (fig. **64**): hindtibia with specialized apical and subapical bristles; foretarsal segment 1 shortened, excavated, and with specialized bristles, segment 2 with specialized bristles; enlarged claw of midleg toothed.

MALE GENITALIA (fig. **77**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with proximal emargination wide and deep, apical narrow and deep; lateral tergal lobe short, broadly rounded, apically sclerotized; median bridge about as long as lobe. *Sidepiece:* basal mesal lobe with a dorsal group of 6 strong and several weaker bristles and with 1 large and 1 small ventral bristle. *Clasper:* as figured; postmedian expansion strong; distal bristles short. *Phallosome:* aedeagus with narrow subbasal dorsal bridge, 1 long weakly curved subapical spine and 1 strongly curved heavy submedian spine with a weak serration near its base.

PUPA (fig. **77**).—*Abdomen:* 1.8 mm. *Trumpet:* 0.63 mm. *Paddle:* 0.47 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* dark pigmentation of basal and distal portions of wing cases, midventral and middorsal lines contrasting sharply with lighter pigmentation of remainder; hairs moderately pigmented; larger branched hairs except 8-C with long slender basal stem which is moderately expanded distally where branches arise, outer branches often shorter, longer branches with small but distinct barbs; hair 8-C with central stem greatly elongate, branches short. *Trumpet:* index about 12.0; uniformly strongly pigmented; tracheoid to about 0.75–0.8; pinna about 0.04. *Metanotum:* sharply darkened laterally. *Abdomen:* moderately pigmented and with darker areas midlaterally and intersegmentally, segments VIII and IX almost completely dark; hairs largely concolorous with integument; larger branched hairs as on cephalothorax; hair 1-II usually 7-9b(6–10), primarily branched only; 5-IV,V single, longer than following 2 tergites; 5-VI,VII usually double, only slightly shorter than 5-IV,V. *Paddle:* lightly pigmented; external margin with distinct serrations on distal 0.3; internal margin with a few scattered serrations apically; hair 1-P small but distinct.

LARVA (fig. **78**).—*Head:* 0.6 mm. *Siphon:* 0.57 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* width about equal to length; ocular bulge not distinctly defined; pigmentation light, darkened in antennal and postocular areas; integumentary sculpturing distinct caudad only; mental plate usually with about 6 teeth on each side of median apical portion which has 3 indistinct teeth; all hairs moderately pigmented and conspicuous; hair 0-C short, leaflike; 1-C short, stout; 5,6-C thin spikes, lighter in color than usual, apex sharply pointed, shaft spiculate basad and barbed distad; 4-C short, 2,3b; 7-C usually 3b; 9,11-C long. *Antenna:* about 0.2 of head length; shaft without spicules; uniformly moderately pigmented, darker basad; hair 1-A at about 0.18–0.27, length about 1.1 of antennal width; apical hairs unmodified. *Thorax:* long hairs and tubercles strongly pigmented, stellate hairs and short hairs lightly pigmented; long hairs attenuate; hair 4-P usually 2b; 7-P usually single; 9-P long, single; 10-P long, single; 14-P short, single. *Abdomen:* tubercles and hairs 6,7-I,II strongly pigmented, other hairs moderately pigmented; hairs 6-I,II usually 2b, branches uneven in length; 6-III,IV usually 5-7b; 1-II,III usually 4-6b. *Segment VIII:* comb scales usually 7,8(5–8), median ones not sharply differentiated, sharply pointed, and with short lateral fringe in basal 0.75. *Siphon:* index about 4.0; uniformly moderately pigmented, imbrications distinct; pecten extending to about 0.5; pecten teeth usually 12,13(10–15), each tooth rather narrow and with strong apical and weak lateral fringe; ventral valve small. *Anal Segment:* saddle lightly pigmented, darker dorsad apically; caudal marginal spicules very short; hair 1-X usually 6-10b; 2,3-X usually 2b; 4a,b-X usually 2,3b; gills about 0.3 saddle length, rounded apically.

MATERIAL EXAMINED.—239 specimens; 8 ♀; 23 ♂; 74 pupae; 134 larvae; 14 individual rearings (13 larval, 1 pupal).

SYSTEMATICS (fig. **61**).—The complex to which the Solomons form described here belongs was known under the name *atra* until Stone (1957*a*:173) showed that *atra* Theobald, 1905 should be applied to the species formerly known as *nigerrima* Taylor, 1914 and that *lateralis* Ludlow, 1905 should replace *atra* of authors.

The *lateralis* complex is readily recognized by the peculiar modification of the foretarsus, the toothed enlarged claw of the midleg, and the specialized bristles of the hindtibia of the male. It has a wide geographical distribution in the Oriental, Indomalayan, and Australasian areas, having been reported from India, Ceylon, Malaya, Indonesia, Philippines, New Guinea, Australia, and the Bismarcks, in addition to the Solomons (fig. **61**). Although specimens from all these areas agree well in general features, I find small constant differences in the modifications of the legs of the males from the

Solomons and New Guinea as compared with those from India (Barraud, 1934:73) and the Philippines (Baisas, 1935:65). It seems very likely that 2 or more closely related forms are involved in the complex. The typical *lateralis* of the Philippines differs in utilizing forest streams for breeding, in sharp contrast to the brackish water pool habitats reported elsewhere. Since the types of *propria* and *cairnsensis* have not been studied in detail and no thorough comparison has been made of material from the entire range of the complex, I leave the Solomons form under *lateralis* for the present.

BIONOMICS.—In the Solomons the immature stages of *lateralis* have been collected only in slightly brackish water pools immediately back of the beach in open sunlit areas. This form appears to be restricted to the same ecological niche as *Culex* (*Culex*) *sitiens*, another species with short hair 1-C and stubby anal gills, characters apparently associated with a brackish water habitat. The only other species associated with *lateralis* on Guadalcanal was *Anopheles farauti*. Living larvae are paler than those of other ground pool *Uranotaenia* and can be recognized in the field by the extremely short anal gills. The pupae are also easily recognized in the field by the entirely dark and very elongate slender trumpets.

Species of this complex have been reported breeding in crabholes and stagnant pools or swamps with Nipa palms (Leicester, 1908:217), in brackish water on a coral islet in Java (Brug, 1924:442), and in forest streams in the Philippines (Baisas, 1935:65).

Adults of *lateralis* have not been collected in nature in the Solomons, and there is no published account of their habits elsewhere.

DISTRIBUTION (fig. 61, 63).—*Solomon Islands:* New Georgia; Guadalcanal. Reported also from *New Guinea* (BMNH, USNM, UCLA); *Australia* (Taylor, 1914:705; 1919:839); *Bismarcks; Indonesia* (Bonne-Wepster, 1954:25), *Philippines* (Baisas, 1935:65), *Thailand, Malaya, Andaman Islands, Ceylon,* and *India* (Barraud, 1934:74).

8. Uranotaenia barnesi Belkin

Figs. **61, 63, 64, 79, 80**

1953. *Uranotaenia barnesi* Belkin, Pacific Sci. 7:332–341. *TYPE: holotype ♀ with associated larval and pupal skins (JNB, 624-24), Togirie swamp, Guadalcanal, Solomon Islands, from clear jungle swamp in partial shade, Aug. 23, 1944, V. R. Roa and F. B. Wysocki (USNM, 61417).

Uranotaenia barnesi of Iyengar (1955:25); Stone, Knight, and Starcke (1959).
Uranotaenia sp. of King and Hoogstraal (1947*c*:593); Belkin (1953*a*:321).
Uranotaenia tibialis of Knight, Bohart, and Bohart (1944:15, in part); Perry (1946:14); Laird (1956:82); Rageau (1958*a*:878); Rageau and Vervent (1958:27–28); Stone, Knight, and Starcke (1959, in part).

FEMALE (fig. **64**).—*Wing:* 1.67 mm. *Proboscis:* 1.17 mm. *Forefemur:* 1.2 mm. *Abdomen:* about 1.0 mm. *Head:* decumbent scales dark in center, a very broad orbital line of light azure blue scales expanded into broad patch laterad; frontal tuft not developed; 1 pair of dark erect occipital scales. *Thorax* (fig. **64**): mesonotal integument dark with lighter indistinct longitudinal areas; a moderately long broad supraalar line of light azure blue scales not reaching scutal angle; *ppn* without scales; *apn* and *stp* each with moderately broad patch of light azure blue scales not markedly in line; a few translucent scales along lower caudal border of *stp*. *Legs:* hindtarsus white-scaled from extreme apex of segment 2 distad; foretarsus and midtarsus entirely dark. *Wing:* dark-scaled except for white scales dorsally on (1) caudal margin of R to slightly beyond arculus, (2) on basal 0.3 of Cu, and (3) on base of 1A. *Abdomen:* tergites and laterotergite with dark scales only; sternites light-scaled, contrasting sharply with tergites, especially basad.

MALE (fig. **64**).—Generally similar to the female. *Head:* vertex more extensively dark-scaled; orbital line narrower dorsally, more conspicuously enlarged laterad. *Labium:* more strongly swollen apically. *Antenna:* flagellar segment 12 about 1.3 of segment 11, segment 13 about 1.7 of segment 12, with slender apical process. *Legs* (fig. **64**):—foreleg with apex of tibia and tarsal segments 1,2,3 with specialized bristles and scales as figured; midleg with enlarged simple subequal claws, smaller about 0.9 of larger.

MALE GENITALIA (fig. **79**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with proximal emargination deep and wide, apical shallow and wide; lateral tergal lobe poorly defined.

Sidepiece: basal mesal lobe with a dorsal group of 3 large bristles and 1 short bristle and with 1 short ventral bristle. *Clasper:* as figured; strongly expanded in distal half; bristles short and sparse. *Phallosome:* aedeagus with narrow subbasal dorsal bridge, with 1 long slender curved subapical spine and 1 subequal but more strongly curved submedian spine.

PUPA (fig. 79).—*Abdomen:* 1.65 mm. *Trumpet:* 0.6 mm. *Paddle:* 0.4 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* darker pigmentation of distal portion of wing case and midventral area, including leg cases, contrasting very sharply with light pigmentation of remainder; all hairs lightly pigmented; larger branched hairs except 8-C with long slender basal stem which is moderately expanded distally where branches arise; hair 8-C with long central stem, lateral branches short. *Trumpet:* index about 13.0; dark on tracheoid and apex of pinna, light in between; tracheoid to about 0.55; pinna about 0.05. *Abdomen:* lightly pigmented on tergite I,II, progressively darker distad except for caudolateral areas on V-VIII; hairs lightly pigmented on basal segments, darker caudad; larger branched hairs with elongate basal stem which is not strongly expanded distad; hair 1-II usually 10-12b(8–13), primarily branched only; 5-IV,V usually 3,4b(2–5), reaching beyond middle of second tergite following; 5-VI,VII usually 4,5b(3–6), only slightly longer than following tergite. *Paddle:* lightly pigmented; external margin with very short blunt indistinct serrations; internal margin with a few faint apical serrations; hair 1-P short and indistinct.

LARVA (fig. 80).—*Head:* 0.55 mm. *Siphon:* 0.42 mm. *Anal Saddle:* 0.36 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* index about 1.1; ocular bulge very prominent, preocular area strongly narrowed; pigmentation very light except for transverse dark band in antennal region and another on posterior part of ocular bulge; integumentary sculpturing distinct and uniform; mental plate small, with about 4–6 small indistinct teeth on each side of median tooth; dorsal hairs of head capsule strongly pigmented except for 8-10-C, ventral hairs lightly pigmented; hair 0-C very large, leaflike, strongly flattened, and translucent; 1-C long and straight; 5,6-C very dark strong spikes, apex sharply pointed, shaft strongly spiculate; 4,7-C darkly pigmented and thickened, shaft minutely spiculate, 4-C long and single, 7-C usually 2b(1–3); 9,11-C short. *Antenna:* about 0.23 of head length; spicules very strong and dark; uniformly very darkly pigmented; hair 1-A at about 0.4, very thin, length about 2.5 of shaft width and 0.4 of shaft length; hairs 2-4-A leaflike, strongly flattened, and broadened; 2,3,5-A inserted before apex. *Thorax:* all hairs and tubercles strongly pigmented; apices of long hairs sharply pointed not attenuate, except 1,2-P,5-M which are frayed and brushlike; hair 4-P usually 2b; 7-P usually single; 9-P very short, multiple; 10-P very short, single; 14-P small and single. *Abdomen:* tubercles of I,II and all hairs strongly pigmented; hair 6-I,II usually 3b, branches even in length; 6-III,IV usually 6-9b; 1-II,III usually 4-6b. *Segment VIII:* comb scales usually 10,9(8–11), median ones longer but not sharply differentiated, sharply pointed, lateral fringe long but inconspicuous in basal 0.7 or more. *Siphon:* index about 3.5; uniformly lightly pigmented; imbrications distinct at base only; pecten extending to about 0.5; pecten teeth usually 12,13(11–14), each tooth narrow but expanded apically, fringe distinct apically and indistinct laterally; ventral valve strongly developed. *Anal Segment:* saddle lightly pigmented, darker dorsad; caudal marginal spicules a few short heavy spines; hair 1-X usually 5b(3–6); 2-X usually 4,5b; 3-X usually 2b; 4a,b-X usually 2b; gills about 0.5–0.7 saddle length.

MATERIAL EXAMINED.—855 specimens; 128 ♀; 109 ♂; 103 pupae; 515 larvae; 19 individual larval rearings.

SYSTEMATICS (fig. 61).—The adults of *barnesi* show a great deal of variation in the amount of the iridescent azure blue scaling, particularly on the head capsule. The modified foreleg of the male is extremely variable in the degree of development of the specialized scales and hairs. It is probable that some of the variations noted are the result of the teneral condition of the reared specimens. In 1 female the apical 2 segments of the foretarsus are distinctly white-scaled. The range of variation in the chaetotaxy of the immature stages is moderate.

The material from the New Hebrides is quite similar to that from the Solomons, but there appear to be some differences in the number of branches of some of the larger hairs of the pupa. For the present I am not separating these populations nomenclaturally, since a thorough analysis and comparison has not been made. The specimen from Efate, New Hebrides, reported by Belkin (1953*a*:321) appears to be merely a greasy specimen of *barnesi* and probably does not represent a distinct form.

U. barnesi is closely related to 3 New Guinea species of the *tibialis* group described by King and Hoogstraal (1947*c*): *setosa, neotibialis,* and *fimbriata.* It is unfortunate that the earliest described nominal species in the *tibialis* group are still unrecognized. *U. tibialis* Taylor, 1919 and *antennalis* Taylor, 1919 were both based on specimens from Cairns, Queensland; it seems unlikely that they would occur in the Solomons and New Hebrides, since King and Hoogstraal have shown that the *tibialis* group (fig. 61) is represented by several closely related species in New Guinea, none of which can be definitely associated with either of

Taylor's species and all of which are distinct from *barnesi*. Adults of *U. barnesi* are readily separated from *setosa, neotibialis,* and *fimbriata* by the extent of the light scaling of the hindtarsus in both sexes and by details of the modified foreleg of the male. The larvae and pupae of New Guinea species of the *tibialis* group are poorly known but appear to be amply distinct from those of *barnesi* (Belkin, 1953*a*:339–340).

Three Philippine species—*clarae* Dyar & Shannon, 1925 (= *delae* Baisas, 1935), *ludlowae* Dyar & Shannon, 1925, and *reyi* Baisas, 1935—are undoubtedly members of the *tibialis* group, judging by the modifications of the male foreleg, the ornamentation of the head, thorax, and hindtarsus of the adults, and the leaflike hairs of the antenna and hair 4-C of the larva. *U. annandalei* Barraud, 1926 from Assam, Burma, Hongkong, and the Philippines has a similar development of the larval antennal hairs and may also be a member of this group. In several respects *barnesi* is more similar to *clarae* than to any other species.

BIONOMICS.—*U. barnesi* breeds largely in dense, fresh water jungle swamps but has also been found to utilize small pools and, less frequently, rock pools and side pools of small densely shaded jungle streams. It prefers shade but is found in open situations on occasion. On Guadalcanal it was found associated most frequently with *Bironella hollandi*, the *Anopheles lungae* complex, *U. civinskii, U. sexaueri,* and *U. solomonis, Hodgesia solomonis,* and various species of *Culex* (*Culex*) and *C.* (*Lophoceraomyia*). Living larvae of *barnesi* are easily recognized from other *Uranotaenia* in the Solomons by the wide thorax and the narrow lobed abdomen, both of which are usually a dark translucent brown color. The pupae are easily recognized in the field by the very long dark trumpets which have a broad submedian light ring. Adults have been collected in nature resting on tree buttresses. Both males and females come to man in shaded situations in the daytime as well as to artificial lights but have never been found biting.

DISTRIBUTION (fig. **63**).—*Solomon Islands:* Bougainville; New Georgia; Russell; Guadalcanal; Rennell. *New Hebrides:* Espiritu Santo; Efate. Not known elsewhere.

9. Uranotaenia solomonis Belkin

Figs. **61, 63, 64, 81, 82**

1953. *Uranotaenia solomonis* Belkin, Pacific Sci. 7:350–359. *TYPE: holotype ♀ with associated larval and pupal skins (JNB, 300–12), Lunga area, Guadalcanal, Solomon Islands, from temporary ground pool, Apr. 4, 1944, Brackins (USNM, 61419).

Uranotaenia solomonis of Iyengar (1955:25); Laird (1956); Stone, Knight, and Starcke (1959).

Uranotaenia albescens of Paine and Edwards (1929:304); Edwards (1932:97); Taylor (1934:13); Lee (1944*a*:32, in part); Knight, Bohart, and Bohart (1944:15, 68, in part); Stone, Knight, and Starcke (1959, in part).

FEMALE (fig. **64**).—*Wing:* 1.7 mm. *Proboscis:* 1.1 mm. *Forefemur:* 1.25 mm. *Abdomen:* about 1.1 mm. *Head:* decumbent scales dark except for very narrow white orbital line, not expanded laterad; frontal tuft white and conspicuous; no erect scales. *Thorax* (fig. **64**): mesonotal integument uniformly dark; a narrow supraalar line of white scales from wing root almost to scutal angle; *ppn* without scales; *apn* and *stp* each with a narrow line of white scales forming a streak in line with white scaling of head; a few white scales in patch in lower caudal part of *stp. Legs:* hindtarsus beige from 0.5 of segment 3 distad; foretarsus and midtarsus dark basally, lighter apically, particularly ventrally. *Wing:* dark-scaled except for flat white scales as follows, (1) 2,3 scales on extreme base of C, (2) on caudal margin of R to slightly beyond arculus, (3) on extreme base of anterior margin of R, (4) on basal 0.5–0.6 of Cu, and (5) a few scales on base of 1A; fringe light, darker on apex. *Abdomen:* tergite I white-scaled; laterotergite largely dark-scaled; tergites II,III with broad median white patch extending from base to apex; tergite IV with median apical white patch; tergite V with narrow apical transverse band of white scales extending to sternite; remainder of tergites dark-scaled; sternites with light brown to beige scales.

MALE (fig. **64**).—Generally similar to the female except for sexual differences. *Labium:* moderately swollen apically. *Antenna:* flagellar segment 12 about 3.0 of segment 11, segment 13 about 0.9 of segment 12. *Legs* (fig. 64): enlarged claw of midleg simple, other apparently not developed.

MALE GENITALIA (fig. 81).—As figured; diagnostic characters as in the key. *Segment IX:* tergite long, proximal emargination deep and narrow, apical deep and wide; lateral tergal lobe in form of long slender heavily sclerotized tooth; median bridge less than length of tooth. *Sidepiece:* basal mesal lobe with a dorsal group of 1 very strong, 3 medium and 2 short bristles and a ventral group of 1 long and 1 short bristle. *Clasper:* as figured; distal bristles not numerous. *Phallosome:* aedeagus with dorsal bridge very broad, extending from base to near apex, 2 sharp subequal subapical spines and 3 or 4 submedian spines on a common lobe.

PUPA (fig. 81).—*Abdomen:* 1.8 mm. *Trumpet:* 0.28 mm. *Paddle:* 0.52 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately and uniformly pigmented, appendage cases and mesonotum darker; hairs lightly to moderately pigmented; larger branched hairs with slender basal stem only slightly expanded distally. *Trumpet:* index about 4.0; uniformly strongly pigmented; tracheoid to about 0.5; pinna about 0.27. *Metanotum:* darkened. *Abdomen:* uniformly moderately pigmented; hairs largely concolorous with integument; larger hairs as on cephalothorax; hair 1-II usually with 10,11 simple branches (8–13); 5-V-VII usually 4-6b, shorter than following tergite. *Paddle:* distinctly produced apically; lightly pigmented; external margin with distinct serrations in distal half; internal margin with apical serrations gradually changing to larger poorly sclerotized crenulations at about 0.12 from apex; hair 1-P slender, elongate.

LARVA (fig. 82).—*Head:* 0.7 mm. *Siphon:* 0.6 mm. *Anal Saddle:* 0.33 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* index about 1.2–1.3; ocular bulge moderately prominent; pigmentation extremely strong except in ocular areas; integumentary sculpturing very strong and uniform; mental plate small, usually with 7 teeth on each side of median tooth; all hairs conspicuous and strongly pigmented; hair 0-C flattened but with attenuate apex; 1-C long; 5,6-C very dark strong spikes, apex frayed, shaft strongly spiculate, becoming barbed distally; 4-C short, usually 3,4b; 7-C usually 4b(3–5); 9,11-C long. *Antenna:* about 0.22 of head length; shaft weakly spiculate, uniformly and extremely darkly pigmented; hair 1-A at about 0.3–0.4 from base, length subequal to shaft width; apical hairs unmodified. *Thorax:* all hairs and tubercles very strongly pigmented; long hairs attenuate apically; hair 4-P usually 2b; 7-P usually 2b(2–3); 9-P strong, usually 2b(2–3); 10-P single, well developed; 14-P single. *Abdomen:* tubercles and hairs of all segments strongly pigmented; hair 6-I,II usually 3b, branches uneven in length; 6-III,IV with 7–11 branches; 1-I,II usually 6-10b (4–14). *Segment VIII:* comb scales 7,8, median ones longer but not sharply differentiated, with conspicuous lateral fringe in basal 0.6. *Siphon:* index about 4.0; strongly pigmented, darker dorsally at base, imbricate; pecten extending to about 0.45; pecten teeth 11–13, each tooth broad and with basal lateral lobes, fringed apically and laterally; ventral valve strongly developed. *Anal Segment:* saddle strongly pigmented, darker dorsoapically; caudal marginal spicules sparse, short and of varied lengths; hair 1-X usually 5b(5–7); 2-X usually 3b; 3-X usually 2b; 4a-X usually 3b; 4b-X usually 2b; gills about 0.6 saddle length.

MATERIAL EXAMINED.—1,249 specimens; 285 ♀; 252 ♂; 117 pupae; 595 larva; 36 individual larval rearings.

SYSTEMATICS (fig. 61).—*U. solomonis* adults show less variation in the light-scaling of the head and thorax than any other ornamented species in the South Pacific. The light scales are in narrow lines and are nearly always pure white, only rarely showing a faint bluish tinge. The abdominal white scaling shows moderate variation; it is always extensive on tergites I-III but is frequently reduced and almost completely lacking on tergite IV. The transverse apical white band on tergite V is generally very prominent and reaches the sternite in all but a few specimens, which may be teneral. There is more variation in the branching of the stellate hairs of the larva than in any other South Pacific ground-breeding *Uranotaenia.* The pupal chaetotaxy is moderately variable (Belkin, 1953*a*:357).

The majority of specimens from New Georgia show a reduction in abdominal light-scaling with an almost complete absence of white scales on tergite IV and a weakening of the apical band on tergite V. There is also in these specimens a more extensive white-scaling of segment 3 of the hindtarsus. I have not been able to find any constant differences in the immature stages in this material and therefore regard the New Georgia populations as constituting at most a weakly marked local race. The Bougainville specimens agree very well with the material from Guadalcanal.

U. solomonis is conspicuously differentiated from the other ornamented *Uranotaenia* of the South Pacific by the development of the aedeagus, which has a complete heavily sclerotized dorsal bridge extending from base to near apex and bearing 2 or more teeth each in the subapical and submedian fields; in the other species, there is only a very narrow subbasal bridge and only 1 strong tooth in each field.

The nearest known relative of *solomonis* is undoubtedly *albescens* Taylor, 1914, described from Queensland. The 2 forms are extremely similar, and it is possible that *solomonis* is only a subspecies of *albescens*. However, I find apparent constant differences and consider *solomonis* a distinct species for the present. It is most conspicuously differentiated from *albescens* by the much greater extent of white-scaling on segment 3 of the hindtarsus of the adults and by the longer siphon and anal saddle in the larva.

The *albescens* complex appears to be restricted to the Papuan region (fig. **61**) but may be related to *campestris* Leicester, 1908 from Malaya, *arguellesi* Baisas, 1935 from the Philippines, *zelena* Barraud, 1934 from India, and possibly *macfarlanei* Edwards, 1914, which has been reported from Assam, Malaya, Sumatra, Java, Hongkong, China, and Okinawa.

BIONOMICS.—*U. solomonis* is the commonest ground pool-breeding *Uranotaenia* in the Solomons. Usually it is found in rather open situations but will tolerate considerable shade. It frequently breeds in temporary pools, ruts, and springs and is common in somewhat open parts of jungle swamps. Stagnant foul water is no deterrent to its breeding; it has even been collected in tin cans. On Guadalcanal it has been found associated with practically every species of mosquito utilizing ground water. Living larvae can be distinguished in the field fairly easily by the long siphon, black head and antenna, and usually light-colored bodies.

Adults of *solomonis* are commonly seen on jungle vegetation near the breeding sites, usually resting close to the ground but also on tree buttresses. They do not appear to fly readily until darkness sets in. In routine night hand-catches at lighted quarters on Guadalcanal, *solomonis* was more frequently collected than any other *Uranotaenia*. However, this may have been owing to the relatively greater abundance of this species in populated areas.

DISTRIBUTION (fig. 63).—*Solomon Islands:* Bougainville; New Georgia; Guadalcanal. Not known elsewhere.

TRIBE CULICINI

Genus CULEX Linnaeus

1758. *Culex* Linnaeus, Systema Naturae, ed. 10, 1:602. TYPE SPECIES: *C. pipiens* Linnaeus, 1758, Europe; selection of Latreille (1810:442).

See also under subgenera and, for complete synonymy, Stone, Knight, and Starcke (1959).

FEMALES.—Small to rather large species. *Head:* eyes contiguous to narrowly separated above antennae; frontal area without scales or at most with small upper tuft; decumbent scales varied, in South Pacific species narrow in the center, broad laterally; orbital line with narrow or broad scales or without scales, sometimes with short hairs in addition to scales; erect scales always numerous on the vertex in South Pacific species; orbital bristles well developed; palpus usually less than 0.25 of proboscis, usually with 4 segments, rarely with 5; antenna usually distinctly longer than proboscis, flagellar segment 1 usually not more than 1.5 of segment 2. *Thorax:* mesonotum moderately to strongly arched; scutellum distinctly lobed; postnotum always without hairs or scales; paratergite narrow, always bare; *apn* lobes always widely separated and with bristles on anterior face; *pra* not separated by a suture from *stp;* upper edge of meron never in line with base of hindcoxa; mesonotal scales usually all or predominantly narrow; scutellar scales usually narrow, rarely broad; pleural scaling varied, often reduced; acrostichal bristles present or absent, dorsocentrals always present and usually well developed; pleural bristles varied, always present on *apn, ppn, ppl, stp, pra,* and upper *mep,* on *stp* in more or less continuous line along upper and caudal margins; *sp* bristles always absent; *psp* bristles usually absent but rarely present (*postspiraculosus* Lee, 1944 from Australia, *Culex* (*Culex*) sp. 8, and possibly occasionally present in species which have *psp* scales); lower *mep* bristles present or absent, rarely some short hairs in middle and lower part of *mep. Legs:* usually slender; tarsal segment 4 on all legs distinctly longer than segment 5; tarsal segment 1 of hindleg rarely shorter than tibia; claws all simple and very small, particularly on hindlegs; pulvilli usually more or less distinctly developed as densely long-spiculose lobes under each claw. *Wing:* membrane with distinct microtrichia; vein scales varied; cell R_2 always longer than vein R_{2+3}; vein Rs without basal spur; vein R_{4+5} right-angled at base and without spur; vein 1A ending distad of branching of Cu; vein R usually with more or less distinct dorsal remigial bristles; vein Sc without distinct bristles at base on lower surface; plical area without scales at base ventrally; alula with marginal scales at least in distal portion; upper calypter usually with complete marginal fringe of long hairs. *Abdomen:* laterotergite small, narrow, always without scales; tergite I usually with only small scale patch in the middle caudally; tergites and sternites II-VII largely scaled; tip of abdomen truncate. *Buccopharyngeal Armature:* always developed, varied.

FEMALE GENITALIA.—Not studied in detail; segment VIII not retracted, broad; cercus short, broad; apparently always 3 subequal spermathecae, usually oboval in shape.

MALES.—*Labium:* with or without submedian false joint and long hairs. *Palpus:* varied in length from distinctly longer than proboscis to less than 0.25; 5-segmented when long. *Antenna:* usually about as long as proboscis, sometimes a little longer or shorter; flagellar whorls usually strongly developed; flagellar segments 12 and 13 usually elongate. *Legs:* claws of foreleg and midleg usually enlarged, unequal, some or all with 1 tooth; claws of hindleg as in the female, very small.

MALE GENITALIA.—Usually small and inconspicuous. *Segment VIII:* well developed, never very strongly narrowed at base; tergite sometimes with indistinct caudal margin and appearing deeply emarginate in the middle. *Segment IX:* tergite usually poorly developed; tergal lobe usually short and broad, sometimes prominent but relatively short; tergite with distinct articulation with lateral projection of sternite; sternite well developed but without bristles or hairs. *Sidepiece:* varied in development; with or without scales; always with a more or less strongly developed subapical lobe which is probably homologous with the basal mesal lobe and claspette of other tribes; without any other conspicuous lobes but with apical sternal area sometimes somewhat differentiated; mesal surface proximad of subapical lobe more or less membranous, distad strongly sclerotized so that lobe is firmly joined to sidepiece. *Subapical Lobe* (fig. **99**): varied in position and development, frequently divided into proximal and distal divisions; proximal division typically with 3 specialized setae (*a-c*), *a* being most mesal or sternal; distal divisions typically with several setae in a sternal group (*d-f*); between these 2 groups of setae tergally typically a seta (*g*) which may be a leaf or simple and an accessory seta (*h*) which is usually simple. *Clasper:* articulating in a vertical plane; varied in development, often more or less sickle-shaped but irregular, distal part frequently flattened and widened; hairs not numerous, scales absent; 1 spiniform always present, usually apical or nearly so, and more or less flattened and widened distally, rarely long, broad, or heavy; rarely 1 or more additional spiniform hairs present. *Phallosome:* homologies not definitely determined; composed of basal piece, ventral paramere, and a more or less complex median structure which includes a pair of lateral sclerotizations called lateral plates; latter in normal resting position are connected by membrane tergally at least at base, articulate sternally with ventral parameres, and are connected sternally to what appears to be the true aedeagus; at least in subgenera *Culex, Culiciomyia,* and *Lophoceraomyia,* these structures are apparently everted in the mating position, as shown in figures **99** and **154,** so that the lateral plates project anteriorly and the aedeagus posteriorly; in normal folded resting position aedeagus is sternal and anterior and hidden on midline between the ventral parameres; each lateral plate composed of a single sclerite or divided into inner division and outer division, in everted position inner division is tergal to outer; lateral plate frequently with 1 or more strong spines. *Proctiger:* strongly developed, prominent, and conspicuous; basolateral sclerotization more or less developed; sometimes a conspicuous basal sternal process; paraproct crown always with several spicules, these often numerous and large; cercal sclerites more or less indistinct, cercal bristles usually present and not numerous, rarely absent.

PUPAE.—*Cephalothorax*: middorsal ridge moderate; hairs all present, variously developed; hair 6-C always much smaller than 7-C; 6,7-C close together; 8,9-C relatively close together and always far behind trumpet. *Trumpet:* not placed on distinct tubercle; widely spaced, usually nearer wing base than middorsal line; variable in length from moderate to very long; tracheoid always distinct, usually at least 0.3; distal portion sometimes flared; slit sometimes present in meatus; pinna small or quite large. *Abdomen:* all normal hairs present; hair 1-I strongly developed, usually strongly dendritic; 9-II-VI small, lateral, dorsolateral, or ventrolateral in position, removed cephalad from caudolateral angle; 9-VII thickened, moderate to quite large, dorsal in position, removed cephalad a considerable distance from caudolateral angle of tergite and cephalad of hair 6; 9-VIII thickened, well developed, moderate to quite large, ventral in insertion, usually removed cephalad a considerable distance from caudolateral angle of sternite, rarely at or near caudal border. *Terminal Segments:* hair 1-IX usually present, rarely absent, always a simple bristle; 1-X absent; cercal lobe of female projecting only a short distance caudad of genital lobe, always rounded apically; male genital lobe relatively short. *Paddle:* variously developed but never very narrow; external buttress more or less distinct; midrib usually strongly developed and dividing paddle into more or less subequal outer and inner parts, sometimes inner part narrower; outer margin usually without distinct spicules, rarely with fringe of long hairlike spicules; inner margin always simple; usually hairs 1,2-P both present, sometimes only hair 1 present or even both hairs absent.

LARVAE.—*Head:* usually distinctly wider than long; labrum usually short and poorly differentiated dorsally, very strongly developed in subgenus *Lutzia;* mouthbrushes varied, usually numerous and filamentous, sometimes inner thickened and pectinate apically, thickened and reduced in number in *Lutzia;* collar usually well developed and narrow; ventral part of head capsule long; posterior tentorial pit a considerable distance from caudal border; maxillary suture always complete, nearly straight to moderately sinuate and moderately divergent, usually extending only a short distance caudolateral of tentorial pit; cephalic border of labial plate more or less truncate or slightly produced; aulaeum usually with filamentous spicules; mental plate usually well developed, teeth sometimes indistinct; chaetotaxy varied, complete except that hair 2-C is usually absent; 3-C sometimes quite long; both 2,3-C sometimes represented at least by spicules; 16,17-C sometimes represented by distinct elongate hairlike spicules (*Lophoceraomyia, Mochthogenes,* and some *Neoculex*). *Antenna:* varied in length but usually quite long; usually with spicules, rarely without; chaetotaxy rather uniform, hair 1-A usually large and multiple, rarely single. *Thorax:* integument varied, sometimes spiculose; spiracular sensilla usually distinct; notched organ not developed; hairs all present except 13-P; hairs 9-12-P,M,T on common tubercles; 1-3-P usually on strong common tubercle which is usually but not always close to midline, at least 1,2-P strongly developed; 4-7-P usually strongly developed; 8-P varied; 9,10-P usually single and rather weak; 12-P usually very strong, always strongest hair in group; 14-P single; 1-4-M usually all weak; 5-7-M all single; 8,9-M large, multiple; 13-M short, usually dendritic; 14-M short, dendritic; 1-5-T usually all short; 6-T varied, usually single and moderate; 7-T large, multiple; 8-T short, multiple; 9-T large, multiple; 13-T small to rather large. *Abdomen:* integument varied; spiracular sensilla usually distinct; dorsal sensilla present; tergites without sclerotizations other than those at base of large hairs; hair 1 never palmate; 6-I,II and 7-I usually strongly developed and large; 6-III-VI varied in development, usually moderate to rather strong; 13-II,VI usually dendritic; segment I with hairs 9-13 all present, 14 absent. *Segment VIII:* comb always present, varied from a few large spines to usually numerous small scales in large patch, never with common sclerotized plate at base of scales; hair 3-VIII about halfway between siphon and anal segment; 5-VIII ventrolateral. *Siphon:* varied in length, usually moderately long to long, sometimes extremely long, rarely short; acus usually present and attached; pecten usually well developed, sometimes reduced; always at least 2(3?) subventral hairs (1,1a-S), sometimes extremely small in very long-siphoned forms and difficult to see; hair 2-S always (?) beyond sclerotized portion of siphon, apparently never any accessory hairs 2a-S; valves short; trachea usually well developed; spiracular apparatus sometimes with a filamentous median caudal process. *Anal Segment:* saddle varied, usually complete, sometimes incomplete and greatly reduced, chiefly in brackish water and plant-breeding forms; acus apparently not developed; caudal margin usually without strong spicules; chaetoxay varied, accessory hairs (*x,y,z*) not developed; ventral brush usually with at least 4 pairs of hairs, rarely with only 1 pair (*Acallyntrum*) or even completely absent (*moucheti* Evans, 1923).

EGGS.—Not resistant; usually laid on water surface in boat-shaped mass; probably laid singly at least by breeders in leaf axils of plants; usually hatch within a few days.

SYSTEMATICS.—Only 2 genera are recognized at present in the tribe Culicini: *Culex,* with a nearly worldwide distribution, and *Deinocerites,* which is confined to the Neotropical region. For a recent review of the latter, see Belkin and Hogue (1959). The tribe is undoubtedly a natural and ancient group. The immature stages are remarkably similar to some groups of *Culiseta.* The phallosome of the male genitalia is suggestive of the subfamily Dixinae, and the buccopharyngeal armature of the females is developed elsewhere only in the Anophelini, as far as is known. The tribe is unique in the development of more or less distinct long-spiculose pulvilli at the base of the claws, but this character is rather difficult to see and is apparently not always present. The numerous spicules on the paraproct crown of the male genitalia are also a unique feature of the Culicini but show considerable reduction in some subgenera of *Culex;* these are not setae, as implied by Edwards. The absence of spiracular (*sp*) and postspiracular (*psp*) bristles is rather distinctive of the Culicini, but at least 2 species—*C.* (*Neoculex*) *postspiraculosus* Lee, 1944 and *C.* (*Culex*) sp. 8 from New Caledonia—show distinct *psp* bristles; it is probable that other species of *Culex* which possess *psp* scales may also have bristles on this sclerite at least occasionally.

The tribe is about equally well represented in Palaeogea and Neogea. Although the primitive annectent groups are perhaps better represented in the New World, this does not necessarily imply that the tribe originated there.

The genus *Culex,* with about 565 described species and subspecies, is the largest of the mosquito genera next to *Aedes* and may actually be as large (or even larger) than the latter; at the present time, however, it is relatively much more poorly known, particularly in Palaeogea. The adults do not show many conspicuous characters of ornamentation, and the females are often extremely similar in species that are characterized by striking differences in the larva or the male genitalia. The genus as a whole is a very difficult one and requires careful and painstaking work in the association of all stages.

Culex has been examined on a worldwide basis only by Edwards (1932, 1941), whose classification, although a great improvement on previous regional treatments of the group, is in need of thorough reëxamination, particularly with respect to the characters of the immature stages, the male phallosome complex, and the female genitalia. At the present time, the following 15 subgenera appear to be more or less natural groups: the widespread subgenera *Culex, Lutzia,* and *Neoculex;* the Old World subgenera *Acalleomyia, Acallyntrum, Barraudius, Culiciomyia, Lasiosiphon, Lophoceraomyia,* and *Mochthogenes;* and the New World subgenera *Aedinus, Carrollia, Eubonnea, Melanoconion* (including *Mochlostyrax*), and *Microculex.* The affinities of the subgenera are not at all clear, but there appear to be 2 main phyletic lines, represented by *Culex s. str.* and *Neoculex* respectively, and several secondary or annectent lines. Several of the subgenera are quite complex, particularly *Culex, Neoculex,* and *Culiciomyia,* and may require subdivision into 2 or more subgenera each.

In the South Pacific 7 subgenera are represented, all 3 of the widespread subgenera and all the Old World subgenera except the monotypic *Acalleomyia* and *Lasiosiphon* and the subgenus *Barraudius* with 2 species. It is doubtful, however, that *femineus* is really a member of the subgenus *Mochthogenes.* Altogether I have recognized 56 species of *Culex* in the South Pacific, but 14 of these are insufficiently known to be named at this time. It is very probable that many more species of *Culex* exist in the area.

As one would expect from the nonresistant type of of egg and the principal type of breeding sites utililized, the genus is poorly represented on the smaller island groups to the east. It is most remarkable that relict endemic forms of *Culex* have been preserved in the Marquesas (*marquesensis*), the Society Islands (*atriceps, kesseli,* and *roseni*), Samoa (*samoaensis*), and Fiji (*albinervis*). On the other hand, the larger land masses to the west offer more suitable habitats and, except for New Zealand, have a richer fauna of *Culex*. In the Solomons the subgenus *Lophoceraomyia* is particularly well represented and appears to be in the process of speciation at the present time.

BIONOMICS AND DISEASE RELATIONS.—The known species of *Culex* are primarily general breeders in more or less permanent waters on the ground, but quite a large number of species are adapted for breeding in the leaf axils of plants, treeholes, rockholes, and crabholes. A few species that are normally ground water- or treehole-breeders utilize large artificial containers as well. The eggs of *Culex* are nonresistant and apparently are always laid on the water surface; to survive, the larva must hatch within a few days after egg deposition. The eggs of most species of *Culex* are laid in boat-shaped masses or rafts, but it is very probable that they are laid singly, possibly in individual gelatinous coverings (as in *Microculex*), in species which breed in the leaf axils of plants.

The females of quite a large number of species attack human and other mammalian hosts; several of these are also known to feed on birds. Other species appear to be primarily restricted to birds for their blood source, and some are known to feed on frogs and lizards. Several species, primarily of the subgenus *Culex*, are more or less closely associated with man. Members of the *pipiens* complex, at least *quinquefasciatus,* have been spread through commerce to many parts of the world.

Several species of the subgenus *Culex* are involved in the transmission of human diseases, particularly filariases and encephalitides and possibly various other viruses (Horsfall, 1955). Although none of the South Pacific species have been incriminated as efficient vectors of human diseases, several are potentially important species because of their blood-feeding habits and abundance, notably the ubiquitous introduced *quinquefasciatus* (= *fatigans*), as well as *pervigilans, annulirostris,* and *sitiens.*

DISTRIBUTION (fig. 83).—The genus *Deinocerites* is restricted to the Neotropical region, but *Culex* is nearly worldwide in distribution. In the South Pacific *Culex* has been reported from every island group. Although some of this distribution is owing to human agency, the genus is represented by endemic species in the Marquesas, Society Islands, Samoa, Fiji, New Zealand, New Caledonia, New Hebrides, and the Solomons. It is very probable that endemic species will be found elsewhere, at least in the Santa Cruz Islands.

KEYS TO SUBGENERA

(Keys to tribes, pp. 118–122)

ADULTS

1. Acrostichal bristles not developed except at extreme anterior end and rarely weakly near prescutellar space 2

Acrostichal bristles well developed on disc of mesonotum 3

2(1). *Male:* antenna without tufts of scales or specialized bristles, palpus with distal ventral row of scales on segment 3, labium with false joint and with long ventral hairs; *female:* mesonotal scaling very dense, smooth in appearance, labium relatively thick . . . . CULICIOMYIA, p. 228

Male: antenna with tufts of scales or specialized bristles on flagellar segments 5–10, palpus with simple distal ventral hairs or none on segment 3, labium without false joint and with long dorsal hairs; *female:* mesonotal scaling sparse, rough in appearance, labium relatively thin . . . . LOPHOCERAOMYIA, p. 248

3(1). No differentiated lower *mep* bristles, at most a few to numerous short hairs in middle *mep* 4

From 1 to several differentiated lower *mep* bristles 5

4(3). Labium with distinct median pale ring; tarsi with distinct pale rings (SITIENS GROUP) . . . . in part, CULEX, p. 183

Labium and tarsi entirely dark-scaled . . . . NEOCULEX, p. 238

5(3). Usually 6 or more lower *mep* bristles; all femora strongly speckled with light scales (1. *halifaxii*) . . . . LUTZIA, p. 219

Usually 1 or 2 lower *mep* bristles, rarely 3; femora not conspicuously speckled 6

6(5). Pleuron with distinct scale patches at least on upper and lower *stp* and middle *mep* (ATRICEPS and PIPIENS GROUPS) .... in part, CULEX, p. 183

Pleuron without distinct scale patches 7

7(6). Hindfemur almost completely white-scaled, at most with dark apical ring and a posterodorsal subapical dark-scaled patch or line; male palpus long ...... ACALLYNTRUM, p. 223

Hindfemur predominantly dark-scaled, entirely dark on dorsal surface; male palpus short (1. *femineus*) ...... MOCHTHOGENES, p. 235

MALE GENITALIA

1. Phallosome complex, lateral plate with distinct inner and outer divisions .. CULEX, p. 183

Phallosome simple, lateral plate not separated into inner and outer divisions 2

2(1). Spiniform of clasper heavy and strongly pigmented; setae *a-c* of subapical lobe short, heavy, darkly pigmented, and spiniform (1. *femineus*) ...... MOCHTHOGENES, p. 235

Spiniform of clasper weak, flattened and unpigmented; setae *a-c* of subapical lobe varied but never short, heavy, and spiniform .. 3

3(2). Subapical lobe with only 2 setae in group *a-c;* proctiger crown with a uniform row of large subequal spicules; cercal setae dorsoapical .... NEOCULEX, p. 238

Subapical lobe with all 3 setae of group *a-c* differentiated; proctiger crown with spicules varied but never large, subequal and in single row; cercal setae dorsolateral or absent 4

4(3). Clasper with a conspicuous crest of spicules .... CULICIOMYIA, p. 228

Clasper without crest of spicules 5

5(4). Subapical lobe poorly developed; setae in group *d-f* all simple hairs; basal sternal process of proctiger long and conspicuous (1. *halifaxii*) .... LUTZIA, p. 219

Subapical lobe strongly developed; some setae in group *d-f* specialized; basal sternal process of proctiger not developed 6

6(5). Lateral plate of phallosome with a simple recurved sternal spine; apex of paraproct with 2 sternal processes and very inconspicuous spicules; cercal setae developed .... LOPHOCERAOMYIA, p. 248

Lateral plate of phallosome with denticles on dorsal surface; apex of paraproct without sternal processes and with stronger spicules; cercal setae not developed .... ACALLYNTRUM, p. 223

PUPAE

1. Paddle with distinct fringe of long spicules on outer margin ..... ACALLYNTRUM, p. 223

Paddle without distinct fringe of spicules on outer margin 2

2(1). Paddle strongly emarginate on apex; hairs 2,3-C very close together (1. *halifaxii*) .... LUTZIA, p. 219

Paddle usually slightly produced or evenly rounded on apex, at most only slightly emarginate; hairs 2,3-C usually widely separated 3

3(2). Metanotal hair 10-C usually multiple, rarely 3,4b (*atriceps*) .... CULEX, p. 183; CULICIOMYIA, p. 228

Metanotal hair 10-C usually double or single 4

4(3). Trumpet short, index usually less than 6.0 (1. *femineus*) ...... MOCHTHOGENES, p. 235

Trumpet long, index usually over 9.0 5

5(4). Hair 9-VIII at or immediately adjacent to caudolateral angle ... NEOCULEX, p. 238

Hair 9-VIII well removed cephalad from caudolateral angle .... LOPHOCERAOMYIA, p. 248

LARVAE

1. Labrum produced in front; mouthbrushes thickened, inserted in compact group laterally; anal saddle longer than siphon (1. *halifaxii*) .... LUTZIA, p. 219

Labrum not produced in front; mouthbrushes normal; anal saddle shorter than siphon 2

2(1). Ventral brush composed of 1 pair of hairs; gills with constriction near middle .... ACALLYNTRUM, p. 223

Ventral brush composed of at least 4 pairs of hairs; gills without constriction near middle 3

3(2). Ventral brush with 4 pairs of hairs .... CULICIOMYIA, p. 228

Ventral brush with 5 to 7 pairs of hairs and sometimes additional unpaired hairs proximad 4

4(3). Ventral brush with 1 or more hairs proximad of grid, on saddle or between saddle and grid .... NEOCULEX, p. 238

Ventral brush without detached hairs proximad of grid 5

5(4). Hairs 1 of siphon in 2 subventral apical pairs and a median ventral row of 12 or more (1. *femineus*) . . . MOCHTHOGENES, p. 235

Hairs 1 of siphon usually all more or less distinctly paired; *if* more or less midventral *then* less than 12 and without the 2 apical differentiated pairs 6

6(5). Prothoracic hair 3-P of the same order of magnitude and thickness as 1-P, usually at least 0.67 as long; when rarely weaker and shorter (ATRICEPS GROUP) then head hairs 5,6-C placed far forward; hairs 16,17-C not developed at all . . . . CULEX, p. 183

Prothoracic hair 3-P much thinner than 1-P and usually less than 0.5 of its length *and* head hairs 5,6-C near middle of dorsal surface; hairs 16,17-C usually both distinctly developed as spicules . . . . LOPHOCERAOMYIA, p. 248

Subgenus CULEX Linnaeus

1758. *Culex* Linnaeus, Systema Naturae, ed. 10, 1:602. TYPE SPECIES: *C. pipiens* Linnaeus, 1758, Europe; the first of 6 included species; selection of Latreille (1810:442).

1903. *Lasioconops* Theobald, Monog. Culicidae 3:235–236. *TYPE SPECIES: *L. poicilipes* Theobald, 1903, West Africa; monobasic.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Medium-sized to rather large species. *Head:* decumbent scales of vertex predominantly narrow except for patch of broad ones laterally, rarely some broad decumbent scales on orbital line; eyes narrowly separated or contiguous above antennae; frontal tuft more or less developed, short in South Pacific species; labium with or without median pale ring or pale scaling on basal ventral surface; palpus 0.25 or less of proboscis, entirely dark-scaled or with a few to many pale scales, usually 4-segmented and with segments 1,2 ankylosed; antennal torus usually with some small broad scales in addition to hairs; flagellar segment 1 usually with a few scales. *Thorax:* mesonotal scaling varied; acrostichals always developed, sometimes short, dorsocentrals well developed; scutellum with narrow scales; pleuron usually with extensive scaling, usually present at least on *apn*, *ppn*, *ppl*, 2 patches on *stp* and 2 on *mep*, present or absent on *pst*, *acx*, *psp*, and *pra;* pleural bristles varied, *psp* rarely present, lower *mep* 1–5 or absent. *Legs:* varied; hindfemur never completely pale-scaled; tarsi with or without pale bands. *Wing:* scaling usually dense; dorsal scales all dark or sometimes scattered pale scales or even distinct pale spots present. *Abdomen:* tergites with or without basal or apical pale transverse bands. *Buccopharyngeal Armature:* strongly developed, not studied.

MALES.—*Labium:* more or less distinct submedian false joint usually present; no conspicuous dorsal hairs. *Palpus:* 5-segmented; usually distinctly longer than proboscis, rarely about as long or slightly shorter; segments 4 and 5 subequal, upturned, and usually with numerous bristles; segment 3 with a more or less continuous row of simple short hairs on ventral surface from base to near apex and a variable number of ventrolateral external longer hairs. *Antenna:* about as long as proboscis or slightly longer or slightly shorter; flagellum with long dense whorls of bristles, without tufts of specialized hairs or scales; segments 12 and 13 strongly elongate. *Legs:* claws not studied.

MALE GENITALIA.—*Segment VIII:* tergite usually with distinct caudal margin, never deeply emarginate in center. *Segment IX:* tergite lobes poorly differentiated, usually short and broad. *Sidepiece:* with or without scales. *Subapical Lobe:* usually simple or indistinctly divided; setae *a-c* usually long, *b* and *c* hooked apically; seta g a leaf or simple; other setae varied. *Clasper:* usually relatively simple, without distinct crown of spicules; spiniform weak, usually flattened and widened distally. *Phallosome:* complex; lateral plate usually with distinct inner and outer divisions. *Proctiger:* paraproct crown usually with large patch of conspicuous well-developed numerous spicules of varying size and character; basal sternal process varied; cercal setae present or rarely absent, dorsolateral in position.

PUPAE (South Pacific species).—Varied; not definitely separable from *Culiciomyia*. *Cephalothorax:* hairs varied in development; hair 1-C usually rather close to caudal border of sclerite; 2,3-C well separated from each other. *Trumpet:* varied in length, usually relatively short and broad and with large pinna; usually no slit in meatus; tracheoid variable, usually at least to 0.3. *Metanotum:* hair 10-C usually at least 4b, rarely triple. *Abdomen:* chaetotaxy varied. *Paddle:* apex rounded, slightly produced or very slightly emarginate; external margin without distinct spicules; paddle hairs relatively weak, sometimes only 1 pair present.

LARVAE (South Pacific species).—Varied. *Head:* varied in size; labrum and mouthbrushes normal; hairs 5,6-C varied in position; 16,17-C not developed. *Antenna:* varied in length and shape, sometimes less than 0.35 head length, usually longer; basal portion usually wider than distal but not markedly swollen; spicules usually present, rarely completely absent; hair 1-A varied in position, always multiple; 2,3-A varied in position, never far removed from apex. *Thorax:* spiracular sensilla distinct; hairs 1-3-P on common tubercle close to midline; 3-P usually subequal to 1,2-P in thickness and length, usually single, rarely branched; 4-7-P usually strongly developed; 5,6-P always single; 8-P varied in length and development; 9,10-P relatively weak and short, 12-P very strongly developed, always single. *Abdomen:* spiracular and dorsal sensilla distinct; hair 1-III-VII weak or strongly developed; 6-III-VI strongly to moderately developed; 7-II rarely strongly developed. *Segment VIII:* comb varied from numerous fringed scales to a few strong spines; hairs 1,2-VIII sometimes with basal tubercles which may be fused; 2,4-VIII always single. *Siphon:* varied in length; acus always attached; pecten varied from a few to numerous teeth; subventral tufts (1,1a-S) from 3 to 7 pairs, subapical 1,2 sometimes out of line; hair 2-S usually short and simple, sometimes hooklike and large; valve hairs usually all single, 6-S sometimes branched, 9-S more or less hooklike; median caudal filament of spiracular apparatus sometimes strongly developed. *Anal Segment:* saddle complete or incomplete and much reduced; hair 1-X varied, never very strong; 2-X usually branched; ventral brush (4-X) with 6,7 pairs of hairs all on grid, no detached proximal hairs.

SYSTEMATICS.—The nominate subgenus is the best known of the subgenera of *Culex,* probably chiefly because it consists of species which are most frequently encountered, are rather large, and show at least some ornamentation in the adults, which makes it possible to differentiate them superficially. The male genitalia show good specific differences in the complex phallosome, as well as in the setae of the subapical lobe. There are also some striking differences in the larvae of a rather large number of species which at present cannot be differentiated in the females. The pupal stage has not been sufficiently studied to date, but it is apparent, at least in the South Pacific fauna, that it offers both group and specific characters.

The subgenus *Culex* has been examined on a worldwide basis only by Edwards (1932:201–202; 1941:281–283), who divided it into 2 groups: (1) group A, the *sitiens* group or *Lasioconops,* confined to the Old World, and (2) group B, the *pipiens* group or *Culex s. str.,* represented in both the Old World and the New World. Although these 2 groups are more or less natural assemblages, both are highly complex, at least group B contains species which are intermediate, and some species do not readily fit into either group. A major reclassification of the subgenus cannot be made without a thorough study of all the species complexes, but it is evident that additional groups will have to be recognized.

In the South Pacific the nominate subgenus is better represented than any other subgenus of *Culex* except possibly *Lophoceraomyia.* At the present I am recognizing 21 forms, 3 of which are not named. These species fall into 3 groups. The *pipiens* group, which I am restricting to the *pipiens* series of Edwards, includes the introduced widespread *quinquefasciatus* and the indigenous and largely endemic *pervigilans, pacificus, iyengari, australicus,* and sp. 2, 3, and 8, which occur in the New Hebrides, New Caledonia, New Zealand, and adjacent islands. The *atriceps* group is a most interesting complex of 3 forms (*atriceps, kesseli,* and *marquensensis*), which is confined to the Society Islands and the Marquesas and shows some similarities with the *decens* series of the *pipiens* group of Edwards, as well as with the *sitiens* group and apparently even with the New World species of the subgenus. The *sitiens* group is represented by 10 species which occur throughout the South Pacific except in New Zealand and possibly the Marquesas and some outlying islands; all these species appear to be indigenous. Four are apparently endemic: *roseni* in the Society Islands, *samoaensis* in Samoa, *albinervis* in Fiji, and *omani* in the Solomons (possibly present in New Guinea). Of the remaining 6, *annulirostris, bitaeniorhynchus,* and *sitiens* are more or less widespread outside the area; *starckeae* is also known from Australia; *squamosus* is known from Australia and New Guinea; and *whittingtoni* may occur in New Guinea, although it is considered here endemic to the Solomons.

BIONOMICS AND DISEASE RELATIONS.—Members of the subgenus *Culex* are largely general breeders in ground waters, but several species frequently breed in large artificial containers and rarely in large treeholes. A few species are restricted to breeding habitats in rockholes, crabholes, treeholes, bamboo, and even leaf axils of living plants. Some of the ground pool- and artificial container-breeders have a high tolerance for salts or organic matter in the water. At least the *bitaeniorhynchus* complex is associated with dense algal mats.

The subgenus *Culex* contains the majority of the species of *Culex* that are notorious pests of man. These include several species closely associated with man. At least some members of the ubiquitous *pipiens* complex, particularly *quinquefasciatus* in the warmer regions of the world, have been spread through human agency. Females of these species are primarily crepuscular or nocturnal biters. The natural hosts of zoöphilic species are not definitely known but undoubtedly include birds and mammals and possibly cold-blooded vertebrates. In the South Pacific only *quinquefasciatus, pervigilans, annulirostris,* and some populations of *sitiens* have been reported to attack man.

Species of the subgenus *Culex* are apparently not important in the transmission of human diseases in the South Pacific except in a few localities. However, they are potentially dangerous forms, at least those that normally feed on man. Elsewhere members of this subgenus are known to transmit periodic Bancroftian filariasis and encephalitides and may be involved in the transmission of Malayan filariasis and various viruses (Horsfall, 1955).

DISTRIBUTION (fig. 83).—The subgenus *Culex* occupies the entire range of the genus and is known from every zoögeographic region. In the South Pacific it has a natural range at least as extensive as the genus *Aedes* and occurs in every major island group. The present distribution of some of the species in the area is the result of dispersal through human agency, undoubtedly in *quinquefasciatus* and probably also in *annulirostris* and *sitiens*.

KEYS TO SPECIES

(Keys to subgenera, pp. 180–182)

ADULTS

(10. *kesseli*, 13. *whittingtoni*, and sp. 2 and 3 not included)

1\. One or more lower mesepimeral bristles present; labium without a distinct complete median light ring; tarsi without distinct light rings 2

Lower mesepimeral bristles not developed; labium with a distinct complete median light ring; tarsi with distinct basal or basal and apical light rings 13

2(1). *Females:* lower surface of labium uniformly dark *and* hindtibia without outer apical pale spot; *males:* palpus without white scales on lower surface of segments 4 and 5 3

Females: lower surface of labium more or less extensively pale-scaled *or* hindtibia with distinct apical spot on outer (anterior) surface; *males:* palpus with white scales on lower surface of segments 4 and 5 4

ATRICEPS GROUP

3(2). Abdominal tergites with transverse basal pale bands connecting basolateral pale spots on some segments . . . . . . 11. *marquesensis*

Abdominal tergites with basolateral pale spots not connected by transverse basal pale bands on any segment . . . . . . 9. *atriceps*

PIPIENS GROUP

4(2). Postspiracular area with numerous small broad scales and 1 or 2 small bristles . . . . 8. New Caledonia form

Postspiracular area usually without scales or bristles, at most with 1 to 4 small broad scales 5

5(4). Females (separation of species very tenuous) 6

Males (separation not reliable, use genitalia) 9

6(5). Upper part of *apn* without scales or with 6 or less scales; *mep* with only a few or no scales at base of upper bristles 7

Upper part of *apn* with numerous scales; *mep* usually with numerous scales at base of upper bristles 8

7(6). Tergal abdominal pale bands narrow and whitish . . . . 4. *pacificus*

Tergal abdominal pale bands broad and beige . . . . 5. *iyengari*

8(6). Thoracic integument very dark, mesonotal scaling pale and strongly contrasting; size large . . . . 1. *pervigilans*

Thoracic integument lighter, mesonotal scaling darker, not sharply contrasting, size smaller . . . . . . 6. *australicus;* 7. *quinquefasciatus*

9(5). Light scales on ventral surface of palpal segment 4 restricted to a patch in basal half . . . . 4. *pacificus*

Light scales on ventral surface of palpal segment 4 in a streak from base to near apex 10

10(9). Palpal segment 3 with very numerous long ventrolateral external hairs in 2 or more rows on at least distal 0.5, usually more than 25 11

Palpal segment 3 with fewer and shorter ventrolateral external hairs usually in a single row and restricted to distal 0.35, usually less than 15 12

11(10). Mesonotal scaling usually very pale and strongly contrasting with very dark integument . . . . 1. *pervigilans*

Mesonotal scaling moderately pale and not strongly contrasting with integument . . . . 6. *australicus*

12(10). Palpus long, exceeding proboscis by full length of segment 5; upper part of *apn* with numerous scales; scales of *mep* including those at base of upper bristles numerous and whitish . . . . 7. *quinquefasciatus*

Palpus shorter, usually exceeding proboscis by less than full length of segment 5; upper part of *apn* with no scales or only a few; scales of *mep* few and beige in color, only a few at base of upper bristles . . . . 5. *iyengari*

SITIENS GROUP

13(1). Abdominal tergites II-VI without any indication of transverse pale bands 14

One or more of abdominal tergites II-VI with more or less complete transverse pale bands 15

14(13). Scales of *ppn* dark bronzy . . 17. *samoaensis*

Scales of *ppn* pale . . . . 16. *omani*

15(13). Transverse pale bands of abdominal tergites II-VII largely apical . . . . 20. *bitaeniorhynchus*

Transverse pale bands of abdominal tergites II-IV largely or entirely basal 16

16(15). A more or less conspicuous patch of broad erect scales in front of supraalar bristles 17

No broad erect scales in front of supraalar bristles 19

17(16). Crossveins *r-m* and *m-cu* and base of vein R_{4+5} whitish . . . . 18. *albinervis*

Crossveins *r-m* and *m-cu* and base of vein R_{4+5} normal, dark 18

18(17). Transverse pale bands of abdominal tergites poorly developed, yellowish in color . . . . 19. *squamosus*

Transverse pale bands of abdominal tergites well developed, whitish in color . . . . 21. *starckeae*

19(16). Foretibia usually with a line of small pale spots on anterior surface along dorsal row of bristles . . . . 15. *annulirostris*

Foretibia usually without any pale spots on anterior surface along dorsal row of bristles 20

20(19). Midfemur usually with some pale speckling on anterior surface . . . . 14. *sitiens*

Midfemur usually without pale speckling on anterior surface . . . . 12. *roseni*

MALE GENITALIA

(10. *kesseli*, 13. *whittingtoni*, 17. *samoaensis*, and sp. 2, 3, and 8 not included)

1. Subapical lobe divided, setae *d-f* on small separate distant sternal lobe; inner division of phallosome entirely sternal, simple and straight 2

Subapical lobe undivided, setae *d-f* if present not on a separate distant sternal lobe; inner division of phallosome projecting tergally or if entirely sternal then sharply bent laterad 3

ATRICEPS GROUP

2(1). Subapical lobe with seta *g* simple, not a leaf; inner division of phallosome very small, the 2 sclerites parallel . . . . 9. *atriceps*

Subapical lobe with seta *g* a broad leaf; inner division of phallosome much larger, the 2 sclerites divergent distally . . . . 11. *marquesensis*

3(1). Inner division of phallosome simple, entirely sternal and sharply bent laterad to form a large acute spine 4

Inner division of phallosome complex, with at least some denticles, always projecting tergally at least on apex 8

PIPIENS GROUP

4(3). Proctiger with basal sternal process not developed or very short, weak, and poorly pigmented 5

Proctiger with basal sternal process long, strong, curved, and heavily pigmented 6

5(4). Tergal arms of outer division of phallosome nearly parallel in dorsal aspect, DV/D usually more than 0.7 . . 7. *quinquefasciatus*

Tergal arms of outer division of phallosome widely divergent in dorsal aspect, DV/D usually less than 0.5 . . . . . . 6. *australicus*

6(4). Subapical lobe without any setae in group *d-f* . . . . 4. *pacificus*

Subapical lobe with at least 1 seta in group *d-f* 7

7(6). Subapical lobe with 1 seta in group *d-f;* tergal arm of outer division of phallosome very long, extending to or beyond apex of proctiger in dorsal aspect . . . . . 1. *pervigilans*

Subapical lobe with 3 setae in group *d-f;* tergal arm of outer division of phallosome short, not reaching apex of proctiger in dorsal aspect . . . . 5. *iyengari*

SITIENS GROUP

8(3). Basal sternal process of proctiger not developed or inconspicuous, very short or moderately long but weak and poorly pigmented 9

Basal sternal process of proctiger very conspicuous, long, curved, and darkly pigmented 12

9(8). Subapical lobe with only 2 differentiated setae in group *a-c;* inner division of phallosome simple, in dorsal aspect with 3 short denticles near base and a long apical process . . . . 21. *starckeae*

Subapical lobe with all 3 setae differentiated in group *a-c;* inner division of phallosome in dorsal aspect with conspicuous apical or subapical denticles and no long apical process 10

10(9). Subapical lobe without any setae in group *d-f* .... 12. *roseni*

Subapical lobe with 2 to 4 setae in group *d-f* 11

11(10). Subapical lobe with 2 approximated setae in group *d-f*, leaf usually broad .... 15. *annulirostris*

Subapical lobe with 4 widely spaced setae in group *d-f*, leaf usually very narrow .... 20. *bitaeniorhynchus*

12(8). Outer division of phallosome with several denticles between the spine and thumblike process; subapical lobe with only 2 setae in group *d-f* and 2 poorly differentiated accessory setae (*h*) .... 18. *albinervis*

Outer division of phallosome without denticles between the spine and thumblike process; subapical lobe usually with at least 3 setae in group *d-f* and only 1 more or less differentiated accessory seta (*h*) 13

13(12). Leaf of subapical lobe poorly developed, usually short and relatively narrow .... 19. *squamosus*

Leaf of subapical lobe well developed, long and broad 14

14(13). Subapical lobe with 3 of the setae in group *d-f* strongly flattened and widened apically, the most distal leaflike .... 16. *omani*

Subapical lobe with none of the setae flattened or widened apically, sometimes 3 with hooked apex .... 14. *sitiens*

PUPAE (including CULICIOMYIA)

(5. *iyengari*, 6. *australicus*, 10. *kesseli*, 13. *whittingtoni*, 17. *samoaensis*, and sp. 2, 3, and 8 not included)

1. Hairs 3-II,III both single 2

Hairs 3-II,III usually double or triple, rarely one single 3

ATRICEPS GROUP

2(1). Hair 1-IV very short, usually less than 0.3 of tergite following; 1-V usually about 10b .... 11. *marquesensis*

Hair 1-IV long, usually about 0.7 of tergite following; 1-V about 3,4b .... 9. *atriceps*

3(1). Hairs 6-III-VI usually all single, rarely 1 double 4

Hairs 6-III-VI usually all at least double, rarely 1 single 7

SITIENS GROUP

4(3). Hair 1-II usually single or forked, thickened .... 20. *bitaeniorhynchus*

Hair 1-II multiple and weak 5

5(4). Hair 1-VI weak; paddle without infuscated area .... 18. *albinervis*

Hair 1-VI strong, thickened; paddle with infuscated area 6

6(5). Hair 1-VII weak; infuscated area of paddle including most of the inner division .... 19. *squamosus*

Hair 1-VII strong, thickened; infuscated area of paddle confined to small spot at apex of midrib .... 21. *starckeae*

7(3). Hair 5-IV usually at least 5b; 6-V,VI usually at least 4b 8

Hair 5-IV usually double or triple; 6-V,VI usually double or triple 9

8(7). Hair 6-V,VI usually at least 6b; 5-VI usually reaching middle of tergite VIII; paddle with only 1 hair .... 16. *omani*

Hair 6-V,VI usually 4,5b; 5-VI shorter, not reaching middle of tergite VIII; paddle with both hairs present .... 15. *annulirostris*

9(7). Hairs 6-V,VI markedly stronger than 6-IV, usually double 10

Hairs 6-V,VI not markedly stronger than 6-IV, double or triple 11

10(9). Hair 1-VI longer than 3-VI; 6-V,VI less than twice as long as 6-IV .... 14. *sitiens*

Hair 1-VI shorter than 3-VI; 6-V,VI more than twice as long as 6-IV .... 12. *roseni*

CULICIOMYIA

11(9). Hair 1-V usually double or triple; 5-III usually triple and markedly caudad of 4-III (*fragilis, papuensis*) .... CULICIOMYIA, p. 229

Hair 1-V usually at least 4b; 5-III usually at least 4b and at about level or cephalad of 4-III 12

12(11). Hair 1-III usually at least 7b, hair 1-VI as strong as or stronger than 5-VI (*pullus*) .... CULICIOMYIA, p. 229

Hair 1-III usually 5,6b; hair 1-VI weaker than 5-VI 13

PIPIENS GROUP

13(12). Hairs 3-II,III strongly developed, thickened; 5-IV very strong, at least 1.5 length of tergite V; 1-VII usually double or triple .... 4. *pacificus*

Hairs 3-II,III weak; 5-IV moderate, less than 1.5 length of tergite V; 1-VII usually at least 4b .... 1. *pervigilans;* 7. *quinquefasciatus*

LARVAE

(17. *samoaensis* and sp. 3 and 8 not included)

1. Hair 3-P distinctly thinner and usually markedly shorter than 1-P and always sin-

gle; hairs 4-6-C placed far forward on head capsule, latter somewhat elongate; antenna usually less than 0.35 head length 2

Hair 3-P of the same order of thickness and usually about the same length as 1-P *or* branched and long; hairs 4-6-C placed farther back on head capsule, latter not elongate; antenna usually more than 0.4 head length 4

ATRICEPS GROUP

2(1). Head hairs 5,6-C single or double; 1-C spiniform .... 11. *marquesensis*

Head hairs 5,6-C usually at least 4b; 1-C very thin 3

3(2). Hair 8-P longer than 9-P; 2-X usually 4b .... 10. *kesseli*

Hair 8-P shorter than 9-P; 2-X usually about 12b .... 9. *atriceps*

SITIENS GROUP

4(1). Head hair 1-C markedly flattened, its apex rounded or irregular 5

Head hair 1-C very slender or moderately thickened, its apex acuminate or filamentous 7

5(4). Saddle complete; head hair 5-C usually at least 6b .... 14. *sitiens*

Saddle incomplete; head hair 5-C usually 3,4b 6

6(5). Head hair 1-C very pale, very large and irregular; 5,6-C subequal; 8-P about as long as 9-P; 1-IV-VI long and single .... 13. *whittingtoni*

Head hair 1-C dark, usually much smaller and more regular; 5-C shorter than 6-C; 8-P about twice as long as 9-P; 1-IV-VI short and at least double .... 12. *roseni*

7(4). Hair 1-III-VI poorly developed, usually shorter than hair 3; head capsule very small 8

Hair 1-III-VI well developed, usually longer than hair 3; head capsule normal 11

8(7). Mental plate with distinct teeth, large distally, small proximally; siphon with 5 pairs of subventral tufts .... 21. *starckeae*

Mental plate seemingly without teeth; siphon with 3, rarely 4, pairs of subventral tufts 9

9(8). Comb with less than 10 large spinelike scales .... 20. *bitaeniorhynchus*

Comb with not less than 20 small scales 10

10(9). Hair 3-P single; head hair 6-C usually double; 2-S small, not hooked .... 19. *squamosus*

Hair 3-P usually triple or double; head hair 6-C usually single; 2-S long, hooked .... 18. *albinervis*

11(7). Hair 1-C thickened, not filamentous distally, usually very strongly pigmented 12

Hair 1-C very slender, distal part filamentous, sometimes basal somewhat broader, usually very lightly pigmented 13

12(11). Comb scales all small and fringed, without differentiated apical spine .... 15. *annulirostris*

At least lateral and posterior comb scales enlarged and with large apical spine .... 16. *omani*

PIPIENS GROUP

13(11). Comb scales of posterior row enlarged, those in middle with a well-differentiated central apical denticle .... 4. *pacificus*

Comb scale of posterior row not markedly enlarged, uniformly fringed, and without differentiated central apical denticle 14

14(13). Mental plate with at least 10 teeth on each side of median tooth 15

Mental plate with 6 to 9 teeth on each side of median tooth 16

15(14). Siphon index usually at least 5.5 .... 5. *iyengari*

Siphon index usually not more than 5.0 .... 7. *quinquefasciatus*

16(14). Ventral brush with 7 pairs of hairs; gills shorter than saddle .... 2. Rotorua form

Ventral brush with 6 pairs of hairs; gills distinctly longer than saddle 17

17(16). Hair 1-III,IV usually 3,4b; mental plate usually with 6 or 7 teeth on each side; only 1 subventral tuft of siphon slightly out of line .... 1. *pervigilans*

Hair 1-III,IV usually double; mental plate usually with 8 or 9 teeth on each side; 1 or 2 subventral tufts of siphon distinctly out of line .... 6. *australicus*

PIPIENS GROUP

FEMALES.—*Head:* labium usually without distinct median pale ring, sometimes lower surface pale; palpus usually with a few pale scales. *Thorax:* 1–5 lower *mep* bristles present; *psp* and *pra* scales present or absent. *Legs:* tarsi usually without distinct pale rings. *Abdomen:* tergites usually with distinct basal transverse pale bands.

MALES.—Palpal segments 4 and 5 with white scales on lower surface.

MALE GENITALIA.—*Subapical Lobe:* simple; seta g a leaf. *Phallosome:* inner division simple, without denticles, entirely sternal, strongly bent to form a large lateral spine; outer division complex, with tergal and lateral arms. *Proctiger:* normal; basal sternal process always narrow, either strong and long or short and weak; cercal setae present.

PUPAE (South Pacific species).—Very similar to some species of *Culiciomyia;* hairs 3-II,III usually both double; 6-V,VI usually triple; external margin of paddle without distinct spicules.

LARVAE (South Pacific species).—*Head:* hair 1-C very slender, apex attenuate, filiform; 5,6-C near middle of head capsule. *Antenna:* at least 0.5 of head length; distinctly narrowed distad of hair 1-A; always with spicules. *Thorax:* hairs 1-3,5,6-P all single, 1-3-P subequal, 3-P at least 0.7 of 1-P and about the same thickness; 4-P usually double; 7-P usually double or triple; 8-P long, usually double or triple. *Abdomen:* hair 1-III-VII moderately to strongly developed. *Segment VIII:* comb scales numerous, fringed apically or with 1 differentiated apical denticle. *Siphon:* pecten well developed; usually 4 to 6 pairs of subventral tufts (1,1a-S), subapical pair often out of line. *Anal Segment:* saddle always complete; ventral brush with 6 or 7 pairs of hairs.

SYSTEMATICS.—The *pipiens* group as considered here corresponds to the *pipiens* series of Edwards (1932:201; 1941:283) and includes several subgroups and complexes chiefly restricted to the Ethiopian and Malagasy regions but represented by a few indigenous forms in the Palaearctic and Australasian regions and possibly by 1 or more in the Nearctic. The South Pacific members of the group are poorly known and their affinities are not clear. Mattingly and Rageau (1958:241) place *pervigilans, iyengari,* and *pacificus* in the *trifilatus* subgroup, which also includes the Ethiopian *trifilatus* Edwards, 1914, *tamsi* Edwards, 1934 from the island of São Thomé in the gulf of Guinea, *torrentium* Martini, 1925 from the northern Palaearctic, *vagans* Wiedemann, 1828 from the eastern Palaearctic, and *miraculosus* Bonne-Wepster, 1937 from New Guinea. In all probability, the unnamed forms from Rotorua and Auckland Island also belong to this group. *C. pacificus* is an aberrant member of the subgroup both in morphology and breeding sites. Two of the 3 remaining forms in the South Pacific, *quinquefasciatus* and *australicus,* are members of the notorious *pipiens* complex. The affinities of the New Caledonia form (sp. 8) cannot be determined at present, since it is known only from a single female.

The *trifilatus* subgroup is characterized chiefly by the very strongly developed basal sternal process of the proctiger, the well-developed lateral arm of the outer division of the phallosome which projects laterally as a process bent subapically at a right angle, and a tergal arm which is characteristically twisted at the apex. The *pipiens* complex has a short, unpigmented basal sternal process on the proctiger, an inconspicuous short lateral arm on the phallosome, and a tergal arm with a relatively simple apex.

No reliable characters have been found to distinguish the females of the majority of species in the group; identifications have been based largely on minor differences in the male genitalia. The buccopharyngeal armature of females may be of value, but it has not been studied. The pupae of most forms are extremely similar; I have not been able to find reliable characters even for the group as a whole. The characters used to separate the larvae of South Pacific forms are probably not as reliable as they would appear from the key, since I have examined a very limited number of specimens and very few individual rearings have been made.

I am treating all the South Pacific forms as distinct species for the present, even in the *pipiens* complex. In the latter, the evidence from experimental crosses and from natural populations is conflicting; no clear-cut decision can be made as to the specific, subspecific, or infraspecific status of the various forms.

BIONOMICS AND DISEASE RELATIONS.—The natural breeding sites are ground pools and occasionally treeholes; *pacificus* is predominantly a treehole-breeder. The majority of species utilize artificial containers and will tolerate or even prefer water with high organic content. Several species, particularly *quinquefasciatus,* are now semi- or quasi-domestic.

Females of several forms, especially *quinquefasciatus,* are very serious pests of man and feed chiefly at night. Members of the *pipiens* complex have been incriminated as vectors of periodic filariasis and encephalitides in some areas. In the South Pacific none of the forms appear to be important in disease transmission at present, but since the majority are closely associated with and feed readily on man, they are potentially important forms.

DISTRIBUTION (figs. 84, 85).—The group is dominantly Ethiopian with indigenous representatives in the Malagasy, Palaearctic, Australasian, and possibly Nearctic regions. In the South Pacific, 7 of the 8 known forms appear to be indigenous to the

New Hebrides, New Caledonia and the Loyalties, and New Zealand and Auckland Island, while *quinquefasciatus* is a recent introduction of the Europeans and is present in large settlements, chiefly seaports, throughout the area except apparently South Island of New Zealand.

1. Culex (Culex) pervigilans Bergroth

Figs. 84, 90, 91

1889. *Culex pervigilans* Bergroth, Wiener Ent. Ztg. 8:295. TYPE: holotype ♀, Greymouth, New Zealand (location unknown).

C. (*C.*) *pervigilans* of Edwards (1924:396; 1932:209); Graham (1929:216–227; 1939:211); Taylor (1934:24); Lee (1944*a*:109); Miller (1950:44); Miller and Phillipps (1952:19); Mattingly and Rageau (1958:241); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 4.16 mm. *Proboscis:* 2.08 mm. *Forefemur:* 1.83 mm. *Abdomen:* about 2.66 mm. Extremely similar to *quinquefasciatus* and other members of the *pipiens* complex; somewhat larger in size, with darker integument and apparently differing in the following. *Head:* eyes more widely separated above antennae; labium usually with very conspicuous long pale area below; flagellar segment 1 usually with distinct large patch of small broad whitish scales in middle of inner surface. *Thorax:* mesonotal scales usually very pale and strongly contrasting with dark integument. *Legs:* hindtibia always (?) with large, conspicuous apical whitish spot.

MALE.—Differing from *quinquefasciatus* by the same characters as the female and the following. *Palpus:* distal segments with more numerous and longer hairs; external ventrolateral hairs of segment 3 at least 25, in several rows and occupying at least distal half of segment.

MALE GENITALIA (fig. 90).—As figured; diagnostic characters as in the key. *Sidepiece:* dorsal and lateral bristles essentially as in *quinquefasciatus*. *Subapical Lobe:* setae *a-c* all very slender; leaf normal; accessory seta *h* very strong, near leaf; only one strong seta in group *d-f*. *Clasper:* normal, essentially as in *quinquefasciatus*. *Phallosome:* inner division short, bent as in *pipiens* complex; lateral arm of outer division strongly developed, with conspicuous angled process; tergal arm of outer division very long, projecting beyond proctiger, apex slightly curved mesad. *Proctiger:* basal sternal process very long, sharply curved, and strongly pigmented.

PUPA (fig. 90).—*Abdomen:* 2.75 mm. *Trumpet:* 0.85 mm. *Paddle:* 1.05 mm. Chaetotaxy as figured; diagnostic characters as in the key; extremely similar to *quinquefasciatus,* from which it cannot be distinguished with certainty at present; hairs 1-3-C apparently weaker than in *quinquefasciatus;* 1-VII strong, at least 0.67 of tergite VIII; paddle unusually narrow, index about 1.3.

LARVA (fig. 91).—*Head:* 0.91 mm. *Siphon:* 1.32 mm. *Anal Saddle:* 0.53 mm. Chaetotaxy as figured; diagnostic characters as in the key; generally as in the *pipiens* complex. *Head:* uniformly moderately to strongly pigmented except for usual lighter and darkened areas; median spine of aulaeum strongly developed; mental plate with 6,7 teeth on each side of median tooth; hairs 11-13-C usually double, 11 and 13 long. *Antenna:* long, slender; uniformly darkly pigmented, a little lighter near base; spicules essentially as in *quinquefasciatus. Abdomen:* hair 1-III-V usually 3,4b; 6-III-VI usually double. *Segment VIII:* comb scales of posterior row fringed. *Siphon:* index about 6.5–7.0; uniformly moderately to darkly pigmented; 12–16 pecten teeth, distal teeth usually with 3 slender basal denticles and long shaft spine; usually 4 subventral tufts (1,1a-S), subapical slightly out of line, proximal distad of pecten, all longer than width of siphon. *Anal Segment:* saddle moderately to strongly pigmented, dorsolateral and dorsal spicules short but distinct; hair 1-X usually single; 2-X usually double; ventral brush with 6 pairs of hairs; gills subequal, longer than saddle.

MATERIAL EXAMINED.—295 specimens; 108 ♀; 76 ♂; 7 pupae; 104 larvae; no individual rearings.

SYSTEMATICS.—*C. pervigilans* is superficially very similar to members of the *pipiens* complex, but the male phallosome is of the *trifilatus* subgroup of Mattingly and Rageau (1958:241) and resembles most closely that of *vagans* Wiedemann, 1828 and *torrentium* Martini, 1925. This species is easily differentiated from both the latter by the presence of only 1 seta instead of 3 in the sternal group (*d-f*) of the subapical lobe of the sidepiece.

C. pervigilans appears to be endemic to New Zealand rather than an introduced form, as suspected by Edwards (1932:210), who suggested that it might be conspecific with the European *torrentium.*

There is a great deal of variation in the ornamentation of adults of *pervigilans* and considerable variation in the larval stages. The association of the immature stages is presumptive only, as no individual rearings have been made. There is a possibility that more than 1 species is confused in my interpretation of *pervigilans.* The undescribed Rotorua form (sp. 2) appears to be closely related to *pervigilans* to judge from the larva (the only known stage), and it is probable that the Auckland Island form (sp. 3) is also a member of this complex.

BIONOMICS AND DISEASE RELATIONS.—*C. pervigilans* is the common domestic mosquito of New Zealand (Miller and Phillipps, 1952:19; Graham, 1929:216–227; 1939:211). It is said to breed in a variety of natural ground pools and artificial containers from the seacoast to inland mountains, particularly in association with man. Adults rest in dwellings and other shelters and females are said to bite only at night. *C. pervigilans* is potentially a dangerous species, but it has not been incriminated as a vector of any human or animal disease.

DISTRIBUTION (fig. 84).—*New Zealand:* North Island (Auckland, Hawkes Bay, Wellington); South Island (Nelson, Marlborough, Westland, Canterbury, Otago). *Kermadec Islands* (see discussion in General Considerations). Not known elsewhere.

2. Culex (Culex) sp., Rotorua form

Figs. 84, 92

This form is known from 3 larval collections made in thermal springs (80°–100° F.) at Rotorua, Auckland, North Island, New Zealand (Miller and Phillipps, 1, 503, 504; NELSON). The larvae are quite distinct from *pervigilans,* as noted in the key and in the figure (92). Two females collected at Rotorua on July 24, 1923, by O. H. Swezey (BISH) and on Jan. 14, 1944, by W. J. Phillipps (WELL) may belong to the same form, but their condition is too poor to determine anything except that they belong to the *pipiens* group. Although it is possible that this form is a warm-adapted race of *pervigilans,* I believe that it is a distinct species. Since the larval material is in poor condition and the other stages are not definitely known, I am not describing or naming this form. Material examined: 17 specimens; 2 ♀; 15 larvae.

3. Culex (Culex) sp., Auckland Island form

Fig. 84

Harrison (1956:211) reports a species of *Culex* represented by 1 adult from Port Ross and 5 larvae and 1 pupa from brackish rock pools at Tucker Point, all from Auckland Island. In spite of the poor state of preservation, it is said that the visible characters do not agree with any species found in New Zealand. It is probable, therefore, that an undescribed species occurs on this island, and it would seem likely that, if it is a *Culex,* it would be a member of the same complex as *pervigilans.* Material examined: none.

4. Culex (Culex) pacificus Edwards

Figs. 84, 93, 94

1916. *Culex pacificus* Edwards, B. Ent. Res. 6:360–361. *TYPE: lectotype ♂, marked as type by Edwards, French Hospital, Zagabé, Port Vila, Efate, New Hebrides, Feb., 1914; by present selection (BMNH).

C. (*C.*) *pacificus* of Edwards (1924:392; 1932:209); Buxton and Hopkins (1927:87–90); Taylor (1934:24); Lee (1944*a*:108); Knight, Bohart, and Bohart

(1944:48, 62); Perry (1946:16); Iyengar (1955:33, 43); Laird (1956); Rageau and Vervent (1958:21); Mattingly and Rageau (1958:241); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.86 mm. *Proboscis:* 2.57 mm. *Forefemur:* 2.36 mm. *Abdomen:* about 2.83 mm. Superficially similar to *quinquefasciatus,* from which it differs most conspicuously in generally darker coloration and the following. *Thorax: apn* with scaling reduced, usually only 3,4 scales or none in upper part; *ppn* scales very narrow and sparse; *ppl* scales reduced; *stp* scales narrower, largely semierect, in small patches; *mep* scales narrower, central patch small, only 2,3 scales among upper bristles, often 2 lower bristles. *Legs:* hindtibia with very conspicuous continuous apicodorsal and lateral patch of whitish scales. *Abdomen:* sternites with complete apical transverse dark bands.

MALE.—Superficially similar to *quinquefasciatus* and differing from it in the same characters as the female. *Palpus:* segment 4 with ventral pale scaling restricted to basal patch, not produced as narrow line for nearly entire length; apex of segment 3 and segments 4 and 5 with fewer and shorter hairs.

MALE GENITALIA (fig. 93).—As figured; diagnostic characters as in the key; in general as in *pervigilans* and *iyengari* and other members of the *trifilatus* subgroup. *Segment IX:* tergite lobe strongly developed, bristles in 3 or 4 rows. *Sidepiece:* dorsolateral bristles almost as strong and long as lateral, very different from condition in other South Pacific members of group. *Subapical Lobe:* seta *a* very heavy, *b* and *c* slender; leaf very large, markedly asymmetrical, with acute lateral apex, accessory seta (*h*) strongly developed, removed from leaf; sternal setae (*d-f*) not developed. *Clasper:* very strongly widened near middle; 1 lower and 1 upper subapical seta. *Phallosome:* inner division relatively short, moderately bent; lateral arm of outer division well developed, prominent; tergal arms of outer division divergent distad, short, not reaching apex of proctiger in tergal aspect. *Proctiger:* basal sternal process very long, sharply curved, strongly pigmented, its apex flattened.

PUPA (fig. 93).—*Abdomen:* 3.18 mm. *Trumpet:* 0.8 mm. *Paddle:* 0.92 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *quinquefasciatus,* differing chiefly in the following characters; general pigmentation usually much lighter; larger hairs heavier and longer; hair 1-II at least 20b; 5-IV-VI very long, usually reaching middle of second tergite following; paddle index about 1.25.

LARVA (fig. 94).—*Head:* 0.9 mm. *Siphon:* 0.92 mm. *Anal Saddle:* 0.32 mm. Chaetotaxy as figured; diagnostic characters as in the key; generally as in the *pipiens* complex; differing from *quinquefasciatus* chiefly in the following. *Head:* hairs 5,6-C usually with fewer branches; 12-14-C all single. *Segment VIII:* comb scales of at least posterior row with strong median apical spine. *Siphon:* index variable, about 3.5–8.0; main spine of pecten teeth rather short and blunt. *Anal Segment:* spicules of saddle very short but heavy.

MATERIAL EXAMINED.—768 specimens; 172 ♀; 136 ♂; 72 pupae; 388 larvae; 18 individual larval rearings.

SYSTEMATICS.—*C. pacificus* is superficially very similar to members of the *pipiens* complex, but the phallosome is of the *trifilatus* type and resembles most closely that of *iyengari.* This species is easily differentiated from other members of the *trifilatus* subgroup of Mattingly and Rageau (1958:241) by the total absence of sternal setae on the subapical lobe of the sidepiece, the strongly widened clasper, and the very heavy dorsolateral bristles of the sidepiece. Both sexes are fairly easily differentiated from other South Pacific members of the *pipiens* group by the reduced scaling of the pleuron. The larva is immediately separated by the characteristic comb scales.

C. pacificus seems to be an ancient endemic derivative of the *pipiens* group which has been able to survive by adapting to breeding in treeholes.

BIONOMICS AND DISEASE RELATIONS.—*C. pacificus* is primarily a treehole-breeder but has also been reported from coconut shells and plant axils. It is commonly found in various types of artificial containers but is not known to breed in ground pools. Females of *pacificus* apparently do not attack man; nothing is known of their bionomics.

DISTRIBUTION (fig. 84).—*New Hebrides:* Espiritu Santo; Ulilapa; Tutuba; Malo; Aoba; Vao; Malekula; Ambrym; Epi; Tangoa; Efate. *Banks Islands:* Mera Lava (Salaun *in* Rageau and Vervent, 1958:21). Not known elsewhere.

5. Culex (Culex) iyengari Mattingly & Rageau

Figs. 84, 95, 99

1958. *Culex* (*Culex*) *iyengari* Mattingly and Rageau, Pacific Sci. 12:244–247. TYPE: holotype ♂, We, Lifu, Loyalty Islands, from native canoe, Oct. 7, 1955, J. Rageau (BMNH).

C. (*C.*) *iyengari* of Rageau (1958*a*:877; 1958*b*:4–5); Stone, Knight, and Starcke (1959).

C. (*C.*) *pacificus* of wartime collections on New Caledonia.

FEMALE.—*Wing:* 3.13 mm. *Proboscis:* 2.5 mm. *Forefemur:* 1.8 mm. *Abdomen:* about 2.3 mm. Not definitely associated with male. Very similar to *quinquefasciatus* and other members of the *pipiens* complex, from which it cannot be differentiated with certainty at present; apparently differs from the former in the following. *Head:* erect scales longer, usually predominantly light; labium often with rather distinct submedian ventral pale band. *Thorax:* mesonotal scales sparser, longer, and usually lighter; *apn* and *ppn* scaling sparser; broad scales of *ppl, stp,* and *mep* duller, usually beige and inconspicuous, only a small middle *mep* patch and only a few scales at base of upper *mep* bristles; *psp* sometimes with 1–3 small broad scales; pleural bristles all light, upper *mep* bristles less numerous. *Legs:* anterior surface of hindfemur more extensively pale. *Haltere:* knob predominantly pale-scaled. *Abdomen:* pale scaling of tergites more extensive and usually distinctly pale beige instead of whitish; sternites usually as in *quinquefasciatus* and not with continuous dark apical bands as described by Mattingly and Rageau (1958).

MALE.—Differing from *quinquefasciatus* by same characters as female and the following. *Labium:* submedian pale scaling frequently forming indistinct pale ring dorsally. *Palpus:* shorter, exceeding proboscis by less than full length of segment 5, often only half its length; distal segments with longer and more numerous hairs; segment 3 with longer and usually more numerous ventrolateral external hairs but usually in single row, less than 15 and restricted to distal 0.35; frequently a broad submedian pale band on segment 3.

MALE GENITALIA (fig. 99).—As figured; diagnostic characters as in the key; in general as in *pervigilans* and *pacificus* and other members of *trifilatus* subgroup. *Sidepiece:* dorsal and lateral bristles essentially as in *quinquefasciatus. Subapical Lobe:* essentially as in *quinquefasciatus* except that accessory seta (*h*) of leaf distinctly thickened and the flattened seta of the sternal group (*d-f*) broader, foliform. *Clasper:* essentially as in *quinquefasciatus. Phallosome:* inner division short, bent as in *pipiens* complex; lateral arm of outer division strongly developed, with conspicuous angled lateral process as in *pervigilans;* tergal arms of outer division divergent apically, short, not reaching apex of proctiger in tergal aspect. *Proctiger:* basal sternal process very long, sharply curved, strongly pigmented, distal part compressed.

PUPA.—Material too poor for description.

LARVA (fig. 95).—*Head:* 0.85 mm. *Siphon:* 1.47 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured; diagnostic characters as in the key; generally as in *quinquefasciatus. Head:* uniformly moderately pigmented except for usual lighter and darkened areas; mental plate usually with 11–14 teeth on each side of enlarged median tooth. *Abdomen:* hair 3-I usually with 3 or more branches; 1-III-V usually double, shorter than in *quinquefasciatus. Siphon:* index about 5.5–6.5; usually 10–14 pecten teeth, larger teeth with 3,4 basal denticles; usually 4,3 subventral tufts (1,1a-S), subapical distinctly out of line, proximal distal to pecten, all about as long as width of siphon.

MATERIAL EXAMINED.—91 specimens; 15♀; 20♂; 2 pupae; 54 larvae; no individual rearings.

SYSTEMATICS.—*C. iyengari* is superficially very similar to members of the *pipiens* complex, but the male phallosome is of the *trifilatus* subgroup and is quite distinct from that of the other South Pacific species of this subgroup.

The association of the larva with the male is presumptive only, since no individual rearings have been made. The larva is very suggestive of the long-siphoned members of the *pipiens* complex.

C. iyengari appears to be a form endemic to New Caledonia and adjacent islands, but, since it breeds in artificial containers and is undoubtedly dispersed by man to some extent, it may occur outside its present known range.

BIONOMICS AND DISEASE RELATIONS.—Larvae of *iyengari* have been taken from a rock pool in coral, ground seepage pools, a deep well, barrels and tanks, native canoes, a metal cistern, tin cans, and a hole in a coconut trunk (Mattingly and Rageau, 1958:247). Nothing is known of the bionomics or disease relations of the adults.

DISTRIBUTION (fig. 84).—*New Caledonia:* Poncrihuen; Ba River, near Houailou; unspecified localities; Ile des Pins (Baie de la Corbeille). *Loyalty Islands:* Lifu; Tiga; Mare. Not known elsewhere.

6. Culex (Culex) australicus Dobrotworsky & Drummond

Figs. 85, 96, 99

1953. *Culex pipiens australicus* Dobrotworsky and Drummond, Linn. Soc. N. S. Wales, Proc. 78:143–144. TYPE: holotype ♂, Melbourne (MELB).

C. (*C.*) *pipiens australicus* of Marks and Rageau (1957); Rageau (1958*a*:877; 1958*b*:4); possibly of Rageau and Vervent (1958:20–21); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.65 mm. *Proboscis:* 2.25 mm. *Forefemur:* 1.86 mm. *Abdomen:* about 2.33 mm. Not definitely associated with male. Very similar to *quinquefasciatus,* from which it cannot be differentiated with certainty; general coloration usually darker; *psp* sometimes with 1–3 small broad light scales; abdominal sternites usually with median and lateral patches of dark scales.

MALE.—*Palpus:* hairs numerous and long distally; segment 3 with numerous long hairs, usually at least 25, in 2 or more rows on ventrolateral external surfaces on at least distal half; usually a more or less distinct pale area at about middle of segment 3.

MALE GENITALIA (fig. 99).—Essentially as in *quinquefasciatus;* differing chiefly in the following; tergal arms of phallosome diverging apically, DV/D usually less than 0.5 (0.1–0.7).

PUPA.—Unknown.

LARVA (fig. 96).—*Head:* 0.87 mm. *Siphon:* 1.36 mm. *Anal Saddle:* 0.42 mm. Not definitely associated with male. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *pervigilans* and differing chiefly as follows. *Head:* mental plate with 8,9 teeth on each side of median tooth; hairs 11,13-C usually triple. *Abdomen:* hairs 1-III,IV usually double. *Siphon:* index about 6.0; pecten teeth larger, usually 9–13, with 4,5 basal denticles; subventral tufts in South Pacific populations usually 5 pairs (4–6), in Australian 4 pairs, subapical 1 or 2 distinctly out of line, proximal distad of or within pecten.

MATERIAL EXAMINED.—51 specimens: 20♀; 21♂; no pupae; 10 larvae; no individual rearings.

SYSTEMATICS.—*C. australicus* was first reported from the South Pacific by Marks and Rageau (1957:156) on the basis of 3 females, 1 male, and an unspecified number of larvae from New Caledonia. There is a question as to the identity of the South Pacific populations with typical *australicus* from Australia in spite of the undoubted similarity in the male genitalia. The larvae I have seen from New Caledonia are quite variable and differ from the descriptions of both Dobrotworsky and Drummond and Marks and Rageau. It is possible that more than 1 form is involved and even that typical *australicus* does not occur on New Caledonia, since the larvae of Marks and Rageau also differ from the typical Australian form and no individual rearings have been made. Therefore the records of *australicus* from the South Pacific must be regarded as tentative only. On the basis of larval habitats it would appear that "*australicus*" of New Caledonia is a native rather than an introduced form. If this is true, the discrepancies noted may be owing to differences developed since the separation of the stocks and may be on a racial or even a specific level. Recently, Rageau and Vervent (1958:20–21) reported larvae of *australicus* from Espiritu Santo in the New Hebrides. I have not seen this material and have made no attempt to determine whether the form these investigators report is present in the wartime collections of the *pipiens* complex from the New Hebrides. The larvae of Rageau and Vervent differ from *australicus* from New Caledonia and resemble Australian specimens in a shorter siphon (index 4.0–4.5). It is very probable that they are aberrant *quinquefasciatus.*

BIONOMICS AND DISEASE RELATIONS.—On New Caledonia, larvae of *australicus* have been collected in rock pools in stream beds, in ground seepage pools, and in treeholes; the latter record, however, may be caused by an error in labeling. According to Rageau and Vervent (1958:21), *australicus* may occur in artificial containers together with *quinquefasciatus,* but I have not seen material from such sources. Nothing is known of the bionomics and disease relations of the adults.

DISTRIBUTION (fig. 85).—*New Caledonia:* Ba River and Cascade de Ba, near Houailou; unspecified localities. ?*New Hebrides:* Espiritu Santo, Segond Channel (Rageau and Vervent, 1958:20). Also known from *Australia:* New South Wales; Victoria (Dobrotworsky and Drummond, 1953:144).

7. Culex (Culex) quinquefasciatus Say

Figs. 85, 97, 98

1823. *Culex 5-fasciatus* Say, Acad. Nat. Sci. Philadelphia, J. 3:10. TYPES: syntypes, sex not specified, Mississippi River, U.S.A. (lost).—Synonymy with *fatigans* not universally accepted; see Stone (1957*b*:342–343).

1828. *Culex fatigans* Wiedemann, Aussereurop. Zweifl. Insekten 1:10. TYPES: syntypes, ♂ and ♀, East Indies (VIENNA, lost, according to Stone, 1957*b*:343). —Synonymy with *quinquefasciatus* not universally accepted; see Stone (1957*b*:342–343).

1848. *Culex acer* Walker, List. Dipt. Insects Brit. Mus. 1:18. *TYPE: holotype ♀, New Zealand (BMNH).—Synonymy with *fatigans* by Edwards (1924:366, 395), confirmed by Mattingly (1959, *in lit.*).

For the extensive complete synonymy, see Stone, Knight, and Starcke (1959).

C. (C.) *quinquefasciatus* of Knight, Bohart, and Bohart (1944:48, 63); Perry (1946:16); and some American authors.

C. (C.) *pipiens quinquefasciatus* of Stone, Knight, and Starcke (1959) and some American authors.

C. (C.) *fatigans* of Edwards (1924:395; 1928*b*:47; 1932:208); Buxton and Hopkins (1927:83–86); Taylor (1934:24); Lee (1944*a*:107); and some British authors.

C. (C.) *pipiens fatigans* of Laird (1956) and some British authors.

FEMALE.—*Wing:* 3.91 mm. *Proboscis:* 2.16 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 2.86 mm. This ubiquitous tropical and subtropical mosquito cannot be distinguished with certainty in the female from other members of the *pipiens* complex and from many members of the *pipiens* group. *Head:* eyes very narrowly separated or contiguous above antennae; narrow decumbent scales pale, whitish on orbital line and frons, lateral and ventral broad scales whitish; erect scales largely dark, some pale in center, sometimes pale scales more numerous; labium usually pale ventrally, often to apical third; palpus about 0.2 proboscis, 4-segmented, largely dark-scaled, some pale or even whitish scales on segments 3 and 4; antenna about as long as proboscis, torus with rather long hairs and sometimes a few narrow scales, flagellar segment 1 usually with a few whitish scales near middle on inner surface. *Thorax:* integument uniformly brown, pleuron lighter and without darkened areas; mesonotal scales pale brown, usually lighter in front, sides, and prescutellar area; scutellar scales very light brown; pleuron without scales on *psp* and *pra; apn* with numerous broadened elongate light brown scales above and below; *ppn* with light brown to golden narrow scales in upper half, sometimes with patch of broader scales caudoventrad; *ppl* with small patch of broad flat whitish scales; *stp* with an upper and a lower patch of broad whitish scales, latter more elongate and semierect in lower patch; *mep* with a rather large patch of elongate broad whitish scales near middle and numerous more elongate, semierect whitish scales at base of upper *mep* bristles; 1 strong lower *mep* bristle, sometimes 1 or 2 weaker additional bristles. *Legs:* coxae with dark and light scales, latter predominating at base, forecoxa usually predominantly dark-scaled; anterior and dorsal surfaces of forefemur and midfemur predominantly dark, ventral and posterior surfaces and usually apex pale; hindfemur extensively pale on lower part of anterior surface, remainder as on other legs; tibiae predominantly dark-scaled, hindtibia usually with a more or less distinct anterior apical pale-scaled spot; tarsi dark; rarely some indistinct pale scaling on all segments. *Wing:* dorsal scales all dark, those in distal half linear and dense; remigial bristles well developed; alula with complete fringe of slender scales; upper calypter with complete fringe of very long hairlike scales. *Haltere:* upper part of stem and knob with pale brown scales, some darker below. *Abdomen:* tergites largely with dark brown scales; tergite I with small median apical patch of dark brown scales; tergites II-VII with whitish basolateral patches and distinct transverse basal bands, latter usually narrowed laterally and sometimes not connected to basolateral patches, extent of pale markings variable, transverse pale bands usually broad; sternites largely with whitish scales, dark scales variable but usually restricted to middle and never (?) forming a complete apical transverse band. *Genitalia:* not studied.

MALE.—Essentially as in the female. *Palpus:* exceeding proboscis by about length of segment 5 or a little more; segments 4,5 upturned; segment 4 with white-scaled line ventrally from base to near apex, segment 5 with basal ventral patch of white scales; segment 3 usually with less than 12 moderately long external ventrolateral hairs in a single row, restricted to distal 0.3. *Antenna:* shorter than proboscis. *Abdomen:* tergal pale bands broader than in female.

MALE GENITALIA (fig. 97).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe poorly indicated, bristles in 2,3 rows. *Sidepiece:* scales not developed; dorsolateral bristles much weaker and shorter than lateral. *Subapical Lobe:* setae *a* and *b* rather heavy, *c* more slender, *a* blunt apically, *b* and *c* with bent pointed apex; leaf (*g*) moderately developed, apex not sharply produced, accessory seta (*h*) rather slender, close to leaf; sternal setae (*d-f*) usually 3, sometimes 4, most sternal distinctly flattened, others slender, all hooked. *Clasper:* slender, not widened, tapering. *Phallosome:* lateral spine of inner division broad and long; lateral arm of outer division relatively short, bent outward and sternad; tergal arms of outer division relatively short, subparallel, apex acuminate, DV/V usually more than 0.7. *Proctiger:* basal sternal process short but variable, usually poorly pigmented, rarely moderately pigmented and somewhat elongate.

PUPA (fig. 97).—*Abdomen:* 3.27 mm. *Trumpet:* 0.8 mm. *Paddle:* 0.9 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to other species of the *pipiens* complex and group. *Cephalothorax:* lightly to moderately pigmented, darkened on mesonotum; hairs moderately pigmented. *Trumpet:* moderately pigmented, darkened on tracheoid. *Metanotum:* darkened laterally. *Abdomen:* moderately to lightly pigmented, darkened on all of tergite I and middle of tergites II-IV; hairs moderately pigmented; hair 1-IX conspicuous. *Paddle:* index about 1.38; lightly pigmented; outer margin with indistinct spicules on external buttress and slightly beyond; no spicules distally on outer margin or on inner margin; both paddle hairs distinct, single.

LARVA (fig. 98).—*Head:* 0.79 mm. *Siphon:* 1.02 mm. *Anal Saddle:* 0.4 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to other members of the *pipiens* complex and group. *Head:* uniformly moderately pigmented except for usual light and darkened areas; mental plate with at least 10 teeth on each side of median tooth, outer teeth heavier; hair 1-C very slender, filamentous distally; 11,13-C long, double or triple; 12-C short. *Antenna:* relatively short, about 0.5 of head or a little more; diameter of distal part about 0.5–0.6 of proximal; moderately to strongly pigmented, middle of proximal part lighter, base darkened; spicules well developed dorsally on proximal part, slender except toward hair 1-A, distal part usually without spicules. *Thorax:* hairs 1-3-P all long, single; 4,7,8-P usually double, long. *Abdomen:* hair 1-III-V long, usually double or single; 6-III-VI usually double; 13-III-V usually triple. *Segment VIII:* comb in large patch; scales small, fringed. *Siphon:* index variable, usually less than 5.0; more or less distinctly swollen near or before middle, apex narrowed, moderately to strongly pigmented, often darkened at base and apically; pecten variable, usually with 8–12 teeth, larger teeth usually with 4 long basal denticles and rather short principal spine; subventral tufts (1,1a-S) usually 4 pairs, subapical distinctly out of line, proximal distad of pecten. *Anal Segment:* saddle moderately pigmented; dorsolateral apical spicules short; hair 1-X usually single; 2-X double or triple; ventral brush with 6 pairs of hairs, all on grid; gills usually about as long as or slightly longer than saddle, dorsal markedly longer than ventral.

MATERIAL EXAMINED.—4,028 specimens; 832 ♀; 394 ♂; 270 pupae; 2,532 larvae; 5 individual larval rearings.

SYSTEMATICS.—Both the nomenclature and the taxonomy of the ubiquitous Southern House Mosquito are highly controversial matters at present. I am following Stone (1957*b*:342–343) in applying the name *quinquefasciatus* to this form, and I am treating it as a distinct species in spite of the fact that some recent workers regard it as a subspecies of *pipiens*.

C. quinquefasciatus is a member of the *pipiens* complex, which is predominantly Ethiopian, and is itself, in all probability, originally a form native to Africa, from where it has been spread throughout the tropical and warm temperate regions of the world through the agency of man, much as has *Aedes* (*S.*) *aegypti*. It appears to be a more adaptable and plastic form than *aegypti* and has successfully established itself in several areas, notably the southern Nearctic and southern Palaearctic regions. In several areas it appears to interbreed freely in a broad zone of overlap with *pipiens*, which is a form characteristic of colder climates.

C. quinquefasciatus is extremely variable in all stages, and it is often very difficult to differentiate it from other members of the *pipiens* complex, as well as from other forms in the *pipiens* group. At present the only reliable diagnostic character is in the phallosome of the male genitalia. The larval stage has not been sufficiently studied as yet in the *pipiens* complex; indications are, however, that more detailed comparison may reveal reliable characters. I have labeled as *quinquefasciatus* all specimens of the *pipiens* group that cannot be definitely assigned to any of the other species. Therefore it is very probable that upon reëxamination the material identified by me from the South Pacific will prove to be composed of several forms and may even contain currently unrecognized species.

BIONOMICS AND DISEASE RELATIONS.—The Southern House Mosquito is a domestic species in the South Pacific, as well as in many other tropical areas, and is not found far from European settlements. Its principal breeding places are foul ground pools and ditches and large artificial containers, such as rain barrels, cisterns, and cesspools, but it will also breed in small artificial containers. Females attack man readily, primarily at night, indoors as well as out of doors.

C. quinquefasciatus is an important vector of periodic filariasis in some parts of the world and has been reported to be naturally and experimentally infected with various viruses, including those of encephalitides. In the South Pacific *quinquefasciatus* is not an important vector of human diseases but is an important pest in the larger seaports and is a potentially dangerous species. It is apparently the vector of periodic filariasis on Nauru and may be a minor vector of nonperiodic filariasis in Fiji.

DISTRIBUTION (fig. 85).—*C. quinquefasciatus* occurs nearly everywhere in the world in tropical and warm temperate regions, where it has been dispersed through human agency. In the South Pacific it is widespread but very restricted locally, since it has not been able to establish itself in the wild and appears to depend on its association with man for breeding places. *Solomon Islands:* Bougainville; Treasury; New Georgia; Pavuvu; Banika; Tulagi; Guadalcanal. *Nauru. Santa Cruz Islands:* Vanikoro. *Banks Islands:* Vanua Lava. *New Hebrides:* Espiritu Santo; Tutuba; Aoba; Vao; Efate; Tana; Aneityum. *Loyalty Islands:* Ouvea; Lifu. *New Caledonia:* Art (Belep); widely distributed on main island; Ile des Pins. *Norfolk Island. New Zealand:* North Island (Auckland). *Ellice Islands. Fiji:* Viti Levu; Vanua Levu; Taveuni; Ovalau; Makongai; probably widely distributed on other islands. *Wallis Islands:* Uea. *Tonga Islands:* Tongatabu. *Samoa:* Upolu; Tutuila. ? *Northern Cook Islands:* Rakahanga; Maniki (Manihiki); Tongareva (Penrhyn) (Buxton and Hopkins, 1927:85). *Southern Cook Islands:* Aitutaki; Rarotonga. *Society Islands:* Raiatea; Tubuai Manu (Maiao); Moorea; Tahiti. *Austral Islands* (Tubuai): Rimatara. *Marquesas Islands:* Eiao; Nukuhiva; Uahuka; Uapou; Hivaoa; Tahuata; Fatuhiva. *Tuamotu Archipelago:* Makatea; unspecified island (Iyengar, 1955:47). *Rapa Island. Pitcairn Island. Easter Island.* Widely distributed elsewhere in tropical, subtropical, and warm temperate regions.

8. Culex (Culex) sp., New Caledonia form

This form is represented by a single female reared from a ground seepage pool in association with *australicus,* New Caledonia, Jan. 27, 1945, H. E. Milliron (USNM). It resembles *australicus* but is strikingly different in the development of numerous small broad whitish scales and 1 or 2 short light bristles on the postspiracular area. This form is certainly not *postspiraculosus* Lee, 1944, which is a *Neoculex.* The specimen could be an aberrant *australicus,* but I suspect that it represents a distinct species. This problem cannot be resolved without additional material, and the affinities of this form cannot be determined other than that it is undoubtedly a member of the *pipiens* group.

ATRICEPS GROUP

FEMALES.—*Head:* labium and palpus entirely dark-scaled. *Thorax:* 1-3 lower *mep* bristles present; *psp* without scales; *pra* with or without scales. *Legs:* tarsi without pale rings. *Abdomen:* tergites with or without basal transverse pale bands.

MALES.—Palpal segments 4 and 5 without white scales on lower surface.

MALE GENITALIA.—*Subapical Lobe:* divided into tergal and sternal parts; seta g a leaf or simple. *Phallosome:* inner division simple, entirely sternal, straight, not bent laterad to form spine; outer division complex but without tergal arm, with numerous lateral spines. *Proctiger:* relatively short; basal sternal process very broad and short; cercal setae present or absent.

PUPAE.—Hairs 3-II,III both single.

LARVAE.—*Head:* hair 1-C varied; 5,6-C far cephalad. *Antenna:* about 0.35 of head length; not markedly narrowed beyond hair 1-A; with or without spicules. *Thorax:* hairs 1-3,5,6-P all single; 3-P reduced in length, not of the same character as 1-P; 4-P single or double; 7-P double or triple; 8-P short or long. *Abdomen:* hair 1-III-VII short. *Segment VIII:* comb scales small, numerous, fringed apically. *Siphon:* pecten well developed; 4 to 6 pairs of subventral tufts, all in line. *Anal Segment:* saddle always complete; hair 1-X short, usually branched; ventral brush with 6 pairs of hairs.

SYSTEMATICS (fig. **86**).—The *atriceps* group is hereby recognized for *atriceps, kesseli,* and *marquesensis.* The latter is markedly different from the other 2 species and probably should be segregated into a distinct subgroup, possibly even a group of its own. The *atriceps* group shows many resemblances in the adult stage to the Ethiopian *decens* series of Edwards (1932:201–202; 1941:283), but the larvae are strikingly different and the basal sternal process of the proctiger is very different in shape. Therefore I prefer to put these species in a different group for the present.

There are no close relatives of the *atriceps* group anywhere in the South Pacific or adjacent areas to the west or to the east. Therefore it seems likely that this is a relict group of species, preserved only in the Society and Marquesas Islands. There is some suggestion of a relationship with the *sitiens* complex in the male genitalia and in the larva of *marquesensis;* this species may have arisen through hybridization between an ancient member of this complex similar to *roseni* and a species closely related to *atriceps.* There is also some resemblance to the subgenus *Culiciomyia,* especially in the male palpus and the head scaling of *atriceps.* There is a possibility, therefore, that the *atriceps* group is a relict of an ancient stock which may have given rise also to the *sitiens* group and to the subgenus *Culiciomyia.* It is possible also that the entire *atriceps* group arose through hybridization between members of the *pipiens* and *sitiens* groups.

The presence of the isolated *atriceps* group far out in the South Pacific suggests that the area of the Society and the Marquesas Islands at one time contained extensive land masses which were connected by at least fairly closely spaced island masses to the west. These species are now rockhole-, treehole-, or leaf axil-breeders, with limited powers of dispersal and no resistant stage, and could not have reached the area through chance dispersal in recent times. It is quite possible that originally they were ground pool-breeders that occasionally utilized treeholes, as we see in some existing members of the *pipiens* group. As the land areas and ground pool environments were reduced, they may have secondarily invaded rockholes, treeholes, and leaf axils and thus have been able to survive to this day on these isolated island groups.

BIONOMICS AND DISEASE RELATIONS.—The *atriceps* group is known to utilize for breeding only rockholes, treeholes, coconut husks, leaf axils of plants, and artificial containers. Females of only *atriceps* are known to bite man and these only rarely in considerable numbers. Rosen (*in* Stone and Rosen, 1953:358) considers *atriceps* not to be an important vector of *Wuchereria bancrofti,* as only occasional females are capable of allowing complete development of filarial larvae.

DISTRIBUTION (fig. **86**).—The group is known only from the Society Islands and the Marquesas.

9. Culex (Culex) atriceps Edwards

Figs. **86, 100, 101**

1926. *Culex* (? *Culiciomyia*) *atriceps* Edwards, B. Ent. Res. 17:105–106. *TYPE: holotype ♀, Papeari, Tahiti, Aug. 18, 1924, H. W. Smith (BMNH).

C. (*C.*) *atriceps* of Buxton and Hopkins (1927:91); Edwards (1928*a*:279–281; 1932:212); Taylor (1934:23); Knight, Bohart, and Bohart (1944:45, 60); Stone and Rosen (1953:356–358); Rageau (1958*a*:877); Stone, Knight, and Starcke (1959).

C. (*C.*) *nigriceps* of Buxton (1927:307); *lapsus* for *atriceps.*

FEMALE.—*Wing:* 3.58 mm. *Proboscis:* 2.08 mm. *Forefemur:* 2.33 mm. *Abdomen:* about 2.66 mm. Dark species, without basal transverse pale bands on abdominal tergites or pale rings on tarsi. *Head:* eyes contiguous above antennae; erect scales and decumbent narrow scales of vertex very dark, contrasting sharply with white scales on dense orbital lines and short frontal tuft; broad lateral scales whitish; antenna about as long as proboscis; torus with a few translucent broad scales; flagellar segment 1 usually with a few small translucent broad scales. *Thorax:* mesonotal and scutellar integument uniformly brown to dark brown, scales narrow, small, and dark brown throughout; acrostichals and dorsocentrals strongly developed; pleural integument brown to dark brown, with a light stripe from *apn* across upper *stp* and *mep* scale patches; *apn* with conspicuous narrow and some slightly broadened white scales chiefly in lower anterior part; *ppn* with a few narrow dark scales restricted to extreme upper border along whose entire distance are several short bristles or hairs; *ppl* with rather large patch of broad whitish scales below bristles; *stp* with 2 patches of broad whitish scales, upper patch transverse and in line with *mep* scale patch; *pra* often with several broad translucent dark scales; *mep* with rather large patch of broad whitish scales in upper middle part, no scales among upper *mep* bristles, lower *mep* bristles 1–3. *Legs:* coxal scales largely white except for extensive areas of dark scales in middle of forecoxa; forefemur and midfemur largely dark on dorsal and anterior surfaces, pale on lower and posterior, a few pale scales at base and apex dorsally; hindfemur similar except for pale anterior surface in basal half or more; tibiae largely dark, without distinct apical pale spot even on hindleg; tarsi dark-scaled, ventral surface paler. *Wing:* dorsal scales all dark, plume scales linear, moderately dense; remigial bristles 2–4, unusually long; marginal fringe of alula and upper calypter essentially as in *quinquefasciatus*. *Haltere:* upper part of stem and knob with brown to light brown scales. *Abdomen:* tergites largely dark-scaled, no transverse basal pale bands; tergites IV-VII with conspicuous basolateral whitish patches, tergite III with a few pale scales in same position; sternites largely dark-scaled, IV-VII with basal transverse band of whitish scales.

MALE.—Essentially similar to female. *Labium:* lower surface with a few longish hairs near middle. *Palpus:* about as long to slightly longer than proboscis, all segments slender, 4 and 5 upturned; undersurface of segment 3 with short erect hairs or hairlike scales much as in subgenus *Culiciomyia;* external apex of segment 3 and both ventrolateral surfaces of 4 and 5 with a few long and more numerous short hairs. *Antenna:* only slightly shorter than proboscis.

MALE GENITALIA (fig. **100**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe poorly differentiated, with about 10 short hairs. *Sidepiece:* widened in basal half, truncate conical distally; dorsal surface with patch of close-set long bristles in basal 0.25 laterally, remainder largely bare or with very short thin hairs; lateral bristles normal. *Subapical Lobe:* very strongly developed, divided into tergal and sternal parts; tergal part large and prominent, with 4 specialized setae, no leaf, 2 long accessory setae, one at base, other on sidepiece; sternal part small but projecting, with 2 specialized setae; long spicules sternad and mesad of sternal part. *Clasper:* very irregular in shape, distal part widened and with strong dorsal outer process and a small recurved spine near base of small spiniform; about 10 short hairs in distal half. *Phallosome:* inner division short, subparallel; outer division very complex, with short outer sternal process and 6 or more outwardly directed teeth from more mesal portion. *Proctiger:* short and broad; basolateral sclerotization extending as a short broad triangular basal sternal process; cercal setae usually 4.

PUPA (fig. **100**).—*Abdomen:* 3.04 mm. *Trumpet:* 0.7 mm. *Paddle:* 0.75 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly moderately pigmented, darkened on mesonotum; hairs moderately to strongly pigmented. *Trumpet:* moderately pigmented, strongly darkened on tracheoid. *Metanotum:* darkened laterally; hair 10-C usually 3b; 12-C usually 4,5b. *Abdomen:* uniformly moderately pigmented, slightly darkened on anterior segments, particularly near midline of tergites; hairs moderately to strongly pigmented; hair 5-IV-VI very long, single to triple; 1-IV long, usually about 0.7 of tergite V; 1-V,VI usually less than 4b; 6-V,VI weak; 1-IX distinct. *Paddle:* lightly pigmented; marginal spicules indistinct; hairs 1,2-P both present.

LARVA (fig. **101**).—*Head:* 0.86 mm. *Siphon:* 0.92 mm. *Anal Saddle:* 0.32 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately to strongly pigmented a bright yellowish brown except for usual lighter and darkened areas; hairs moderately pigmented; mental plate as figured, usually 10 or more teeth on each side of enlarged median tooth, more basal teeth moderately differentiated from distal and only moderately more widely spaced; hair 1-C very slender; 4-6-C near level of antennae; 4-C small, branched; 5,6-C moderately long, 5-7b; 11-C short. *Antenna:* very short, usually less than 0.35 head length; uniformly a somewhat darker bright yellowish brown than head capsule, darkened at base; slender spicules conspicuous in proximal part, a few shorter, broader spicules on outer surface in distal part; hair 1-A multiple, inserted near middle. *Thorax:* hair 3-P usually less than 0.5 of 1-P; 8-P always shorter than 9-P, usually about 0.5. *Abdomen:* hair 6-III-VI usually double; 7-II short. *Segment VIII:* comb scales spatulate, fringed apically; hair 3-VIII usually about 8b. *Siphon:* index about 3.0–3.5; moderately to strongly pigmented, darkened at base; usually about 20 pecten teeth extending to about middle of siphon, distal pecten teeth usually with 2 subequal distal spines and a smaller subbasal denticle; 6 pairs of subventral tufts all in line but usually not closely paired on the 2 sides, inserted near midventral line, distal pair markedly shorter than others, usually 3 or 4 pairs within pecten. *Anal Seg-*

ment: saddle complete, moderately to strongly pigmented, darkened at base; a small subdorsal caudal patch of short strong spicules; hair 1-X short, single or double; 2-X very strongly developed, with an asymmetrical basal plate from which about 12 branches arise; gills variable.

MATERIAL EXAMINED.—226 specimens; 87 ♀; 53 ♂; 31 pupae; 55 larvae; 15 individual larval rearings.

SYSTEMATICS.—*C. atriceps* is a very clearly marked species without known close relatives except for the sympatric *kesseli.* It is undoubtedly a member of the subgenus *Culex,* but it shows some resemblances to *Culiciomyia* in general ornamentation of the head, mesonotum, and abdomen.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *atriceps* have been collected in treeholes, coconut husks, and various types of artificial containers, frequently in association with *Aedes* (*Stegomyia*) *polynesiensis.* Females will attack man in small numbers at night. Adults are sometimes found resting in houses but more commonly in natural resting places such as tree buttresses. Rosen (*in* Stone and Rosen, 1953:358) found that larvae of *Wuchereria bancrofti* may occasionally complete development in *atriceps* but considers that this species is not an important vector of nonperiodic filariasis.

DISTRIBUTION (fig. 86).—*Society Islands:* Moorea; Tahiti. Not known elsewhere.

10. Culex (Culex) kesseli Belkin, n. sp.

Figs. **86, 102**

TYPES.—*Holotype:* larva, Teachupee, Tahiti, from pandanus leaf axil, Nov. 11, 1950, L. Rosen, 849 (USNM, 64752). *Paratypes:* 3 larvae, same data as holotype. This species is dedicated to John F. Kessel in recognition of his contributions to the knowledge of the mosquitoes of the Society Islands.

FEMALE, MALE, PUPA.—Unknown.

LARVA (fig. 102).—*Head:* 0.81 mm. *Siphon:* 0.93 mm. *Anal Saddle:* 0.30 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *atriceps,* from which it differs chiefly in the following characters; pigmentation much lighter, a lemon yellow; long hairs of thorax much longer; short hairs of abdomen shorter. *Head:* mental plate as figured, usually 9 or less teeth on each side of enlarged median tooth, more basal teeth markedly larger than distal and widely spaced. *Antenna:* usually a little longer; hair 1-A usually more distal. *Thorax:* hair 3-P more than 0.5 of 1-P; 8-P distinctly longer than 9-P. *Segment VIII:* comb scales shorter, broader; hair 3-VIII usually 6b. *Siphon:* index about 3.8–4.0; lightly pigmented, darkened at base; usually 10–15 pecten teeth, usually not reaching middle of siphon, all usually simple; 5,6 pairs of shorter subventral tufts (1,1a-S), at most 1,2 pairs within pecten. *Anal Segment:* saddle lightly pigmented; spicules weaker, less numerous; hair 2-X usually 4b; gills longer than saddle.

MATERIAL EXAMINED.—4 larvae.

SYSTEMATICS.—*C. kesseli* is closely related to *atriceps* and may even be an ecotype of the latter, but I believe it is a distinct species and am describing it as such, in spite of the fact that only the larva is known. Although the larva of *kesseli* is in general very similar to that of *atriceps,* it is distinguished by several constant characters, as indicated in the diagnosis.

BIONOMICS AND DISEASE RELATIONS.—*C. kesseli* has been collected only in the larval stage in leaf axils of a species of pandanus. To date, attempts to rear larvae in the laboratory have failed, and the other stages have not been found.

DISTRIBUTION (fig. 86).—*Society Islands:* Tahiti. Not known elsewhere.

11. Culex (Culex) marquesensis Stone & Rosen

Figs. **86, 103, 104**

1953. *Culex marquesensis* Stone and Rosen, Wash. Acad. Sci., J. 43:354–356.
*TYPE: holotype ♂, Hivaoa, Marquesas Islands, June 12, 1952, L. Rosen (USNM, 61839).

Culex (*C.*) *marquesensis* of Iyengar (1955:33); Rageau (1958*a*:877); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.41 mm. *Proboscis:* 2.41 mm. *Forefemur:* 1.98 mm. *Abdomen:* 2.33 mm. Light brown to yellowish or greenish brown species with distinct basal transverse pale bands on abdominal tergites. *Head:* eyes contiguous above antennae; erect scales light brown; decumbent narrow scales beige except on orbital lines and frontal tuft, where they are dingy white; scales of orbital line broad laterally; broad lateral scales beige; antenna about as long as proboscis; torus light yellowish brown, with several broad dark scales in addition to numerous hairs; flagellar segment 1 usually with a few translucent broad scales. *Thorax:* integument light brown to light greenish or yellowish brown, sometimes with indistinct darkened areas; mesonotal and scutellar scales brown to pale yellowish brown; acrostichals and dorsocentrals strongly developed; *apn* with narrow whitish scales, chiefly on anterior part; *ppn* with a few narrow pale scales and short hairs along upper border; *ppl* with a few very inconspicuous dingy white or beige broad scales; *stp* with small sparse upper and lower patches of pale beige broad scales; *pra* apparently without scales; *mep* with very small patch of pale beige broad scales in upper middle part, 1 to several elongate pale beige erect scales among upper *mep* bristles; lower *mep* bristles 1–3. *Legs:* predominantly dark-scaled; a few pale scales on midcoxa and hindcoxa; trochanters, base of posterior surfaces of all femora, and base of anterior surface of hindfemur pale; a few pale scales on apex of femora and tibiae but no distinct pale spots. *Wing:* essentially as in *atriceps. Haltere:* essentially as in *atriceps. Abdomen:* essentially as in *atriceps,* except tergal basolateral pale spots larger, extending on dorsal surface on IV-VII and connected by narrow transverse basal pale bands dorsally; tergites II,III usually with some indication of transverse basal pale bands; sternites with more extensive basal pale scaling, widened laterally.

MALE.—Essentially similar to female. *Palpus:* extending beyond proboscis from before middle of segment 4; segments 4 and 5 upturned, 5 recurved; segment 3 with long hairs on outer surface from about middle; segments 4 and 5 with numerous long hairs on both inner and outer surfaces below. *Antenna:* distinctly shorter than proboscis.

MALE GENITALIA (fig. **103**).—As figured; diagnostic characters as in the key, markedly different from *atriceps. Segment IX:* tergite lobe poorly defined, not produced, with about 12 short hairs. *Sidepiece:* rather elongate, not swollen at base; dorsal surface with long hairs in 2 lateral groups, one in basal 0.6, the other near apex, remainder with short hairs or bare; lateral and ventral hairs normal. *Subapical Lobe:* strongly developed, divided into tergal and sternal parts, with large apically rounded leaf (*g*) and an accessory seta (*h*) in between distally; tergal part prominent, bearing 3 long specialized setae (*a-c*) apically; sternal part smaller but prominent, bearing 2 specialized setae, 1 long and strong, other short (*d-f*); mesal and sternal faces of lobe with long spicules. *Clasper:* short, irregular, broad; apex produced; distal part with about 6 short hairs, proximal with 1. *Phallosome:* inner divisions long, divergent apically, simple; outer division complex, with lateral sternal process and many outwardly directed teeth of varied size. *Proctiger:* short and broad; basolateral sclerotization produced as a very broad, moderately long basal sternal process; cercal setae absent.

PUPA (fig. **103**).—*Abdomen:* 3.22 mm. *Trumpet:* 0.8 mm. *Paddle:* 0.9 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly moderately to strongly pigmented, mesonotum strongly darkened; hairs moderately to strongly pigmented. *Trumpet:* strongly pigmented, moderately darkened on tracheoid. *Metanotum:* lateral part very strongly darkened; hair 10-C usually at least 8b; 12-C usually 1,2b. *Abdomen:* moderately to strongly pigmented; hair 5-IV-VI very long, usually double or triple; 1-IV very short, usually less than 0.3 of tergite V; 1-V,VI usually at least 5b; 6-V,VI thickened; 1-IX distinct. *Paddle:* lightly to moderately pigmented, midrib darker; marginal spicules rather distinct at end of external buttress; hairs 1,2-P both present.

LARVA (fig. **104**).—*Head:* 0.89 mm. *Siphon:* 0.9 mm. *Anal Saddle:* 0.3 mm. Chaetotaxy as figured; diagnostic characters as in the key; somewhat similar to *atriceps* and *kesseli* and also showing some resemblance to *roseni. Head:* uniformly moderately pigmented except for usual lighter and darkened areas; hairs moderately pigmented; mental plate as figured, usually 8–10 teeth on each side of moderate median tooth, lateral teeth subequal and rather evenly spaced; hair 1-C short, thickened, curved, darkly pigmented; 4-6-C usually all single, 5-C strongly caudad of 6-C; 7-C usually 2-4b; 11-C long. *Antenna:* usually less than 0.35 head length; uniformly moderately pigmented; spicules not developed; not at all constricted distally; hair 1-A usually 3-7b, inserted in basal 0.5. *Thorax:* hair 3-P usually at least 0.5 of 1-P; 8-P shorter than 9-P. *Abdomen:* hair 6-I-II usually 4-6b; 6-III-V usually 5b; 6-VI usually 3b; 7-I usually double; 7-II long, strong, usually double or triple. *Segment VIII:* comb usually with about 20–26 widely spaced short, fringed scales. *Siphon:* index about 3.25–3.5; slightly swollen in middle; moderately pigmented, darkened on basal ring; usually 10–12 short pecten teeth in basal 0.35, larger teeth with about 5 subequal denticles; 4 pairs of subventral tufts (1,1a-S), all in line and regularly paired, proximal 1,2 within pecten, the 2 members of a pair rather widely separated from each other. *Anal Segment:* saddle lightly pigmented, strongly shortened ventrally; spicules short, poorly developed; hair 1-X short, usually 3,4b; 2-X usually 5b; gills unequal, variable in length.

MATERIAL EXAMINED.—184 specimens; 65♀; 66♂; 18 pupae; 35 larvae; 8 individual larval rearings.

SYSTEMATICS.—The closest relatives of *marquesensis* seem to be *atriceps* and *kesseli,* but the differences between them are very striking in all stages. An unusual feature of *marquesensis* is the development of some broad scales along the orbital border of the head, a condition reminiscent of *Culiciomyia.* In some features of the male genitalia, abdominal ornamentation, and larval and pupal chaetotaxy, *marquesensis* suggests an affinity with *roseni* of the *sitiens* group, and it may have arisen through hybridization between *roseni*-like and *atriceps*-like ancestral forms. This view is supported by the type of breeding places utilized by *marquesensis.*

BIONOMICS AND DISEASE RELATIONS.—Immature stages of *marquesensis* have been found in rockholes, coconut husks, water drums, and barrel tops, sometimes in association with *C. quinquefasciatus* and *Aedes* (*Stegomyia*) *polynesiensis.* Adults of *marquesensis* have not been collected in nature.

DISTRIBUTION (fig. 86).—*Marquesas:* Nukuhiva; Uahuka; Uapou; Hivaoa, Tahuata. Not known elsewhere.

SITIENS GROUP

FEMALES.—*Head:* labium with distinct median pale ring; palpus usually with some pale scales, rarely all dark-scaled. *Thorax:* lower *mep* bristles absent; *psp* and *pra* without scales. *Legs:* tarsi with more or less distinct pale rings. *Abdomen:* tergites with or without transverse basal or apical pale bands.

MALES.—Palpus usually with distinct pale dorsal bands, at least on base of segments 4 and 5.

MALE GENITALIA.—*Subapical Lobe:* simple; seta g a leaf or simple. *Phallosome:* inner division complex, always projecting tergally, at least on apex, with at least some denticles tergally, usually with sternal and tergal lobes; outer division simple or more frequently complex but without distinct tergal arm, often a tergolateral or lateral spine. *Proctiger:* short to normal; basal sternal process varied; cercal setae present.

PUPAE (South Pacific species).—Varied; hairs 3-II,III both double or triple; external margin of paddle without distinct spicules.

LARVAE (South Pacific species).—Varied. *Head:* very small to large; hair 1-C varied in development, always somewhat thickened, distal part not filamentous, sometimes strongly flattened; 5,6-C near middle of head capsule. *Antenna:* varied in length; at least a few spicules in basal part; hair 1-A varied in position. *Thorax:* hairs 1,2,5,6-P all single; 3-P of the same order of magnitude and length as 1,2-P, usually single (branched in *albinervis*); 4-P double or single; 7-P usually 2-4b; 8-P varied. *Abdomen:* hair 1-III-VII varied, small or well developed. *Segment VIII:* comb varied from a few large spines to numerous fringed scales. *Siphon:* length, pecten, and subventral tufts varied; median caudal filament of spiracular apparatus strongly developed except in *sitiens* complex. *Anal Segment:* saddle complete or incomplete; ventral brush with 6 pairs of hairs; gills varied.

SYSTEMATICS (figs. 87-89).—The *sitiens* group of Edwards (1932:201) is the dominant group of the subgenus in the South Pacific. The group as a whole is restricted to the Old World and includes many diverse complexes, which Edwards segregated into 4 series but which I am treating for the present as subgroups. When the group is thoroughly studied, it may be necessary to recognize more subgroups and to redefine those of Edwards. For the present I am recognizing 2 complex interrelated subgroups in the South Pacific: the *sitiens* subgroup and the *bitaeniorhynchus* subgroup.

The *sitiens* subgroup (figs. 87, 88) in the South Pacific consists of 5 species: (1) the *sitiens* complex (fig. 87), composed of *roseni, whittingtoni,* and *sitiens* and (2) the *annulirostris* complex (fig. 88), composed of *annulirostris* and *omani.* In the *sitiens* complex, *roseni* shows some similarities with *marquesensis* of the *atriceps* group, and both *roseni* and *whittingtoni* seem to be related to *litoralis* Bohart, 1946 from the Marianas. In the *annulirostris* complex, *omani* appears to have been derived by hybridization with a member of the *bitaeniorhynchus* subgroup.

The *bitaeniorhynchus* subgroup (fig. 89) in the South Pacific consists of 5 very distinct forms: *samoaensis, albinervis, squamosus, bitaeniorhynchus,* and *starckeae.* The latter differs markedly in the mental plate from the others and may have been derived by hybridization with a member of the *sitiens* subgroup.

BIONOMICS AND DISEASE RELATIONS.—Members of the *sitiens* group are primarily general breeders in ground waters, but at least 2 species (*sitiens* and *annulirostris*) are frequently found in canoes, and *annulirostris* has been occasionally collected in large treeholes. Members of the *sitiens* complex are primarily brackish water-breeders, while members of the *bitaeniorhynchus* complex are almost entirely restricted to breeding in dense mats of green algae.

Several members of the group attack man readily, but in the South Pacific only *annulirostris* and some populations of *sitiens* are serious pests. In the South Pacific none of the species are known to be vectors of human pathogens, but at least *annulirostris* and *sitiens* are potentially important species. Elsewhere *bitaeniorhynchus* has been suspected as a vector of encephalitides, as well as of Malayan and periodic Bancroftian filariases.

DISTRIBUTION (figs. **87-89**).—The *sitiens* group is confined to the Old World, where it is widespread in all warmer areas. It has been reported from the southern Palaearctic, Ethiopian, Malagasy, Oriental, Indomalayan, and Australasian regions. In the South Pacific, this is the most widespread group of the genus and has been definitely reported from all the major island groups except New Zealand and the Marquesas.

12. Culex (Culex) roseni Belkin, n. sp.

Figs. **87, 99, 105, 106**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (Rosen, 894-16), from brackish hole, Hitiaa, Tahiti, May 8, 1952, L. Rosen (USNM, 64753). *Allotype:* ♀ with associated larval and pupal skins (Rosen, 894–12), same data as holotype (USNM). *Paratypes:* 2 ♀, 6 ♂ with associated larval and pupal skins (Rosen, 894-7–11, 13–15), 5 ♂ (Rosen, 894-5), same data as holotype. This species is dedicated to the collector in recognition of his important contributions to the knowledge of the mosquitoes of French Oceania.

Culex (*C.*) *litoralis* in part of Iyengar (1955:33); Stone, Knight, and Starcke (1959).

Culex (*C.*) *sitiens* in part of Rageau (1958*a*:877).

FEMALE.—*Wing:* 3.83 mm. *Proboscis:* 1.93 mm. *Forefemur:* 1.90 mm. *Abdomen:* about 2.58 mm. Superficially very similar to *annulirostris* and *sitiens;* differing from latter chiefly in generally lighter coloration and following features. *Head:* erect scales pale in center; orbital line with larger and more numerous broad whitish scales laterally. *Thorax:* mesonotal scales longer, predominantly pale beige, dark bronzy scales restricted to middle of fossa, supraalar area, and in front of prescutellar space; *apn* and *ppn* scales chiefly pale beige. *Legs:* anterior surface of femora not speckled; tarsal pale rings or bands usually much broader, conspicuous on all legs. *Abdomen:* tergal transverse pale bands usually much broader.

MALE.—Essentially as in the female and differing from *sitiens* in the same characters as the female, except for usual sexual differences.

MALE GENITALIA (figs. **99, 105**).—As figured; diagnostic characters as in the key; essentially as in *sitiens* and differing chiefly in following characters. *Subapical Lobe:* sternal setae (*d-f*) not developed. *Phallosome:* inner division with strongly curved distal sternal rugose process, a small sharp distal tergal rugose process, proximad and mesad of this process 2 or 3 leaflike, acuminate long spines; outer division with long sharp spine. *Proctiger:* with very short, inconspicuous, poorly pigmented basal sternal process.

PUPA (fig. **105**).—*Abdomen:* 2.92 mm. *Trumpet:* 0.65 mm. *Paddle:* 0.79 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *sitiens,* from which it differs chiefly in the following; hair 1-VI poorly developed, shorter than 3-VI; 6-III,IV very short, markedly different from 6-V,VI; paddle distinctly broader, about as wide as long.

LARVA (fig. **106**).—*Head:* 0.79 mm. *Siphon:* 1.0 mm. *Anal Saddle:* 0.3 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *litoralis, whittingtoni,* and *sitiens* and differing from latter chiefly in following. *Head:* pigmentation usually lighter; hair 5-C much smaller, usually 3,4b; 6-C usually double or triple. *Antenna:* usually shorter. *Ab-*

domen: dorsal and ventral hairs weaker, shorter, or with fewer branches. *Siphon:* index about 4.5–5.0; pecten teeth darkly pigmented, distal ones with 2–4 strong denticles at base of heavy apical spine; subventral tufts of the 2 sides very close together on midventral line, not distinctly paired, usually at least 1 within pecten. *Anal Segment:* saddle incomplete, largely restricted to dorsal surface, sometimes indefinite separate ventrolateral weak sclerotizations present; hair 1-X often not on saddle; smaller branches of 2-X weaker; gills usually longer.

MATERIAL EXAMINED.—125 specimens; 35 ♀; 39 ♂; 20 pupae; 31 larvae; 16 individual larval rearings.

SYSTEMATICS.—*C. roseni* is most closely related to *whittingtoni* from the Solomons and probably New Guinea and *litoralis* Bohart, 1946 from the Marianas. These species, and possibly some undescribed forms in intermediate areas, are members of the *sitiens* complex but are readily differentiated from the nominate form by the poorly developed basal sternal process of the proctiger of the male genitalia. It seems to me that *roseni* is the most ancient living derivative of the complex and that it may have contributed through hybridization with a form of the *atriceps* or *pipiens* groups to the production of *marquesensis.*

In the adult stage, *roseni* is differentiated most easily from *litoralis* by the total absence of sternal setae on the subapical lobe of the male genitalia. The larvae of the complex are very similar but appear to be separable by the characters indicated in the diagnosis and the key.

The presence of some broad scales laterally on the orbital line of the head of adults of *roseni* is of interest, since this character has been considered to be characteristic of the subgenus *Culiciomyia;* this character is also evident in the *atriceps* group.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *roseni* are known from brackish pools as well as from freshwater swamps. Females apparently do not attack man readily, but a few specimens have been collected in houses. Nothing is known of the bionomics or disease relations of the adults.

DISTRIBUTION (fig. 87).—*Society Islands:* Tubaimanu (Maiao); Moorea; Tahiti. Not definitely known elsewhere. The report of *litoralis* from Samoa by Iyengar (1955:33) is apparently based on aberrant specimens of *sitiens,* but it is possible that *roseni* or a related form occurs on these islands. In the U.S. National Museum, a pinned male (genitalia removed) from Tonga (Tongatabu, 3·16·51, H. Beye) and a genitalia slide from Tahiti (Paea, 13·III·51) are related by identical genitalia labels (51·X·22*b*). The data on the genitalia slide are those of a collection of *roseni* made on Tahiti (Rosen, 886) and the genitalia are typical *roseni.* The pinned male is evidently a member of the *sitiens* complex and appears to be *roseni;* however, it could be an aberrant *sitiens* or an undescribed species. It is clear that an error occurred in labeling the pinned male, but it is impossible at present to determine if it involved the locality or the genitalia label. Therefore, although I have provisionally identified the pinned male as *roseni,* the presence of this species in Tonga should not be considered definitely established.

13. Culex (Culex) whittingtoni Belkin, n. sp.

Figs. **87, 107**

TYPES.—*Holotype:* larva (JGF, 50) Munda, New Georgia, Nov., 1943–Oct., 1944, J. G. Franclemont (USNM, 64754). *Paratypes:* 6 larvae, same data as holotype. This species is dedicated to Forrest B. Whittington in recognition of his contributions to the knowledge of the mosquitoes of Guadalcanal during wartime years.

FEMALE, MALE, PUPA.—Unknown.

LARVA (fig. **107**).—*Head:* 0.75 mm. *Siphon:* 0.98 mm. *Anal Saddle:* 0.29 mm. Chaetotaxy as figured; diagnostic character as in the key; very similar to *roseni, litoralis,* and *sitiens,* differing from the latter chiefly in the following. *Head:* pigmentation light to moderate; hair 1-C very large, flattened and irregular, very pale in coloration, longer than distance between the 2 hairs at base; 5,6-C subequal, usually both triple. *Abdomen:* hair 1-IV-VI usually single, heavy, and long at least on V. *Segment VIII:* comb in 2 or 3 rows, scales usually less than 30, larger in size. *Siphon:* index about 4.0–4.5; pigmentation light, darkened on basal ring and sometimes slightly on apex; pecten teeth usually fewer in number, larger teeth usually with 1 or 2 subequal apical spines stronger than other denticles; apical subventral tuft usually not markedly out of line. *Anal Segment:* saddle very poorly developed and very lightly pigmented, restricted to dorsal part of segment, usually a weak separate ventral sclerotization; marginal spicules smaller and less numerous; hair 1-X usually on ventrolateral margin of saddle; 2-X with weaker smaller branches.

MATERIAL EXAMINED.—9 larvae.

SYSTEMATICS.—I am describing *whittingtoni* as a distinct species in spite of the fact that it is known only in the larval stage, since it is apparent that the *sitiens* complex is prone to speciation and since it seems unlikely that this form is conspecific with *litoralis* from the Marianas, which it resembles most closely. The larvae of the 2 forms can be easily differentiated by the development of hair 1 on abdominal segments IV-VI, long and single in *whittingtoni* and short and at least triple in *litoralis.*

C. whittingtoni is known definitely only from the Solomons, but I have seen larvae of a similar, if not identical, species from Matura Island, near Finschhafen, New Guinea.

BIONOMICS AND DISEASE RELATIONS.—No information is available as to the type of breeding site in which the 2 collections of larvae were made, but it seems very probable that these larvae were found in brackish water. Adults of *whittingtoni* are not known.

DISTRIBUTION (fig. 87).—*Solomon Islands:* Treasury; New Georgia. Not known elsewhere.

14. Culex (Culex) sitiens Wiedemann

Figs. 87, 108, 109

1828. *Culex sitiens* Wiedemann, Aussereurop. Zweifl. Insekten 1:542. TYPE: ♀, Sumatra (COPEN).

1910. *Culex jepsoni* Theobald, Entomologist 43:158–159. *TYPE: holotype ♀, Suva, Fiji, Feb. 8, 1910, F. P. Jepson (BMNH).—Synonymy by Edwards (1924:394).

For complete synonymy, see Stone, Knight, and Starcke (1959).

C. (*C.*) *sitiens* of Edwards (1924:394; 1932:204); Buxton and Hopkins (1927:79); Paine and Edwards (1929:307); Taylor (1934:24); Paine (1935, 1943:25–27); Lee (1944*a*:103); Bohart and Ingram (1946:18–19); Iyengar (1955:33); Laird (1956); Rageau (1958*a*:877, in part; 1958*b*:5); Rageau and Vervent (1958:22–23); Stone, Knight, and Starcke (1959).

C. (*C.*) *jepsoni* of Knight, Bohart, and Bohart (1944:42, 62); Perry (1946:15).

FEMALE.—*Wing:* 3.33 mm. *Proboscis:* 1.83 mm. *Forefemur:* 1.58 mm. *Abdomen:* about 2.46 mm. Extremely variable; very similar in general appearance to *annulirostris,* from which it can be separated most readily by the absence of any pale markings along the dorsal bristles on anterior surface of the foretibia; also quite similar to *roseni,* from which it can be separated by the presence of pale speckling on the anterior surface of the femora, particularly of midleg, usually narrower tarsal pale rings, and usually darker mesonotal scaling; differing from the former chiefly in the following. *Head:* decumbent scales pale beige, whitish on orbital line and on lateral patch of broad scales; no broad scales on orbital line mesad of lateral patch; erect scales brown to light brown, often paler in center; pale ring of labium variable, sharply marked; palpus with variable amount of apical pale scaling. *Thorax:* mesonotal vestiture variable, predominantly dark bronzy to pale brownish or even dark beige, without distinct pattern; prescutellar and scutellar scales pale beige; *apn* and *ppn* scales narrow, numerous, variable in color from dark bronzy to pale beige, *ppn* always with pale scales at least posteriorly; broad scales of *ppl, stp,* and *mep* pale beige to whitish; a few pale scales usually present among upper *mep* bristles. *Legs:* femora usually speckled with a few pale scales on anterior surface, particularly on midleg; foretibia usually entirely dark on anterior surface, without pale spots in a row ventrad of dorsal bristles; tarsal pale markings usually small, often indistinct or absent on distal segments. *Wing:* essentially as in *annulirostris;* dorsal scales usually all dark except for a variable streak of pale scales on posterior face of base of vein C. *Abdomen:* tergite I with dark scales; tergites II-VII usually with narrow, even, transverse white bands connecting to long even lateral whitish spots; sternites with variable amount of whitish scaling, apex of segments usually with complete dark band.

MALE.—Essentially as in the female and differing from *annulirostris* in the same characters. *Labium:* usually with broad pale band. *Palpus:* with variable amount of pale scaling. *Abdomen:* tergal pale bands broader than in female.

MALE GENITALIA (fig. 108).—As figured; diagnostic characters as in the key; markedly different from *annulirostris. Segment IX:* tergite lobe indistinct, indicated by a row of 4–6 bristles. *Sidepiece:* tergal surface with moderately long bristles laterally, a few very short hairs in middle. *Subapical Lobe:* setae *a-c* moderately heavy and long; leaf (*g*) moderate, rounded apically; accessory seta (*h*) simple, removed from leaf; sternal setae (*d-f*) usually 4, well developed, close to *a-c*, one heavy, others slender and usually shorter. *Clasper:* simple, narrowed distally. *Phallosome:* inner division strongly differentiated, porrect, distal sternal angle rounded, distal tergal angle in form of rugose spined process proximad of which are several acuminate teeth, 1 long and 2 short directed caudad and 1 long directed laterad; outer division strongly differentiated, with 1 long pointed tooth dorsally and 1 heavier pointed recurved tooth sternally. *Proctiger:* large; basal sternal process very long, slender, curved, and heavily pigmented.

PUPA (fig. 108).—*Abdomen:* 2.8 mm. *Trumpet:* 0.62 mm. *Paddle:* 0.76 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, ventral surface lighter, mesonotum darkened; hairs moderately to lightly pigmented; all hairs rather small and with few branches. *Trumpet:* uniformly moderately to strongly pigmented, tracheoid only slightly darkened. *Metanotum:* darkened. *Abdomen:* lightly pigmented, darkened on anterior tergites; hairs moderately pigmented; hair 1-III-VI moderately developed, 1-VI longer than 3-VI; 5-IV-VI usually 2,3b; 6-III,IV moderately long, usually 2,3b, 6-V,VI longer and heavier, usually double; 1-IX distinct. *Paddle:* moderately broad; lightly pigmented, midrib and external buttress darker and brighter; marginal spicules not visible; hairs 1,2-P both developed.

LARVA (fig. 109).—*Head:* 0.87 mm. *Siphon:* 1.35 mm. *Anal Saddle:* 0.4 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately pigmented, darkened caudally; mental plate as figured, usually with 7–9 distinct teeth on each side of median tooth; hair 1-C shorter than distance between the 2 hairs at base, strongly flattened and distinctly darker than head capsule; 5-C usually 6-8b, about as long as 6-C, latter usually 4b. *Antenna:* variable in length; distinctly narrowed in distal part; lightly pigmented in proximal part, strongly darkened in distal; spicules slender, numerous proximally, a few distally. *Thorax:* hairs and tubercles strongly pigmented. *Abdomen:* hairs and tubercles strongly pigmented; dorsal and ventral hairs short; hair 6-I,II usually 3-5b; 6-III usually 2,3b; 6-IV-VI usually 2b; 7-I single or double; 1-III,IV usually 2b; 1-V,VI usually 3b. *Segment VIII:* comb usually with at least 30 small fringed scales in 4 rows. *Siphon:* index variable, usually 4.5–5.5; lightly to moderately pigmented, blackened on basal ring and darkened apically; pecten usually with at least 10 teeth, larger teeth usually with fringe of at least 6 subequal denticles from base to apex and no differentiated main spine; subventral tufts usually 7,8 pairs, 2 pairs out of line, remainder more or less in pairs and a considerable distance from midventral line; median caudal filament of spiracular apparatus not developed. *Anal Segment:* saddle complete at base, deeply indented caudoventrally, moderately to lightly pigmented; a small patch of short heavy spicules dorsolaterally; hair 1-X on saddle, usually single; 2-X usually 3,4b, dorsal branches usually strong; gills rounded, always shorter than saddle.

MATERIAL EXAMINED.—3,572 specimens; 395 ♀; 248 ♂; 127 pupae; 2,802 larvae; 25 individual larval rearings.

SYSTEMATICS.—I am following Edwards (1924:394) in applying the name *sitiens* to the South Pacific form which has also been treated as *jepsoni.* The type of *sitiens* from Sumatra is apparently lost; this nominal species cannot be definitely identified, but the name has been widely used. *C. sitiens,* as currently understood, is an extremely variable and widely distributed form which may actually be a complex of several species since published figures of specimens from different areas do not agree in many details. Nothing can be done to resolve the problem until individual rearings are studied from the entire reported range.

Within the South Pacific the known populations of *sitiens* differ from each other quite strikingly but at the same time are extremely variable. The male genitalia appear to be relatively uniform in all the populations. Some adults from the New Hebrides have much broader tergal abdominal pale bands than I have seen in any other population. Adults from Fiji have the mesonotal scales much shorter and darker than in other populations, while those from the Solomons have them very long and unusually light. The larval stage shows a great deal of variation, particularly in the length and shape of the siphon. My impression is that we are dealing here with a single, plastic species with many different populations which have been separated and then mixed at different times in the past and that this process is still in operation at present.

BIONOMICS AND DISEASE RELATIONS.—*C. sitiens* is primarily a brackish water-breeder and is never found far from the seacoast. In the South Pacific immature stages have been collected in brackish and sometimes fresh water in ground pools and coral holes and in canoes and artificial containers. Lever (1944*b*) reports larvae developing to maturity in undiluted sea water in Fiji. *C. sitiens* is stated to be a vicious biter in Fiji (Paine, 1943:26), but in the New Hebrides and in the Solomons it has not been reported to attack man. Nothing is known of the disease relations of *sitiens*.

DISTRIBUTION (fig. 87).—*Solomon Islands:* Bougainville; Kolombangara; New Georgia; Sasavele; Pavuvu; Banika; Florida; Guadalcanal; Ontong Java. ? *Nauru. New Hebrides:* Espiritu Santo; Aore; Ulilapa; Aurora; Pentecost; Tangoa; Efate; Tana; Futuna. *New Caledonia:* Noumea; Ducas Peninsula; unspecified localities. *Ellice Islands:* Funafuti. *Fiji:* Viti Levu; Naingani; Makongai; Koro; Vanua Mbalavu; Nagu; Totoya. ? *Wallis* (Iyengar, 1955:46). *Samoa:* Savaii; Upolu; Tutuila. *Tonga:* Tongatabu. *Niue Island.* Also reported from the Ethiopian, Malagasy, southern Palaearctic, Oriental, Indomalayan, and Australasian regions and from the Central Pacific (Marianas, Carolines).

15. Culex (Culex) annulirostris Skuse

Figs. 88, 110, 111

1889. *Culex annulirostris* Skuse, Linn. Soc. N. S. Wales, Proc. (2)3:1737–1738. TYPES: syntypes, 2♀, Blue Mountains and Berowra, New South Wales (MACL).

1901. *Culex annulirostris Bancroftii* Theobald, Monog. Culicidae 1:367–368. *TYPE: holotype ♀, Burpengary, Queensland, Bancroft (BMNH).—Synonymy with *annulirostris* by Taylor (1934:23).

1912. *Culex palpalis* Taylor, Austral. North. Ter., B. 1*a*:29. TYPE: ♀, Umbrawara Creek, Northern Territory, Australia (SYDN).—Synonymy with *annulirostris* by Edwards (1924:395).

1912. *Culex somerseti* Taylor, Queensland Comn. Pub. Health, Annu. Rpt. 1912:28. TYPE: ♀, Somerset, Queensland (SYDN).—Synonymy with *annulirostris* by Edwards (1924:395).

1913. *Culicelsa consimilis* Taylor, Austral. Inst. Trop. Med., Rpt. 1911:55. TYPES: syntypes, ♂ and ♀, Ayr, Queensland (SYDN).—Synonymy with *annulirostris* by Edwards (1924:395).

1914. *Culicelsa simplex* Taylor, Roy. Ent. Soc. London, Trans. 1913(61):698–699. TYPE: ♀, Townsville, Queensland, H. Priestley and F. H. Taylor (SYDN).—Synonymy with *annulirostris* by Edwards (1924:395).

Culex (*Culex*) *annulirostris* of Edwards (1924:394–395; 1925:257; 1928*b*:46; 1932:204); Buxton and Hopkins (1927:79–83); Paine and Edwards (1929:307); Taylor (1934:23); Paine (1935; 1943:27–28); ? Graham (1939:211); Lee (1944*a*:102); Knight, Bohart, and Bohart (1944:42, 60); Perry (1946:15–16); Bohart and Ingram (1946:17–18); ? Miller (1950:43); Marks (1951*a*:128); ? Miller and Phillipps (1952:22, 23); Iyengar (1955:33); Laird (1956); Rageau (1958*a*:877; 1958*b*:5); Rageau and Vervent (1958:21–22); Stone, Knight, and Starcke (1959).

Culex jepsoni of Bahr (1912); O'Connor (1923).

FEMALE.—*Wing:* 4.06 mm. *Proboscis:* 2.16 mm. *Forefemur:* 1.91 mm. *Abdomen:* about 3.16 mm. Extremely variable; very similar to species in the *sitiens* complex, *omani*, and some species in the *bitaeniorhynchus* subgroup; usually readily distinguished from all by the following combination of characters; anterior surface of foretibia with a line of pale markings along or ventrad of dorsal bristles, mesonotum without distinct pattern or erect broadened scales, abdominal tergites III,IV with transverse basal pale bands usually produced in middle. *Head:* eyes contiguous above antennae; frontal tuft short; narrow decumbent scales predominantly beige, lighter, sometimes whitish, in center and on orbital line, sometimes a submedian area of darker scales; orbital line without broad scales; lateral broad scales whitish; erect scales predominantly light brown, lighter or beige in central area; labium with a well marked light submedian ring, usually more than 0.25 of its length; palpus usually with a few pale scales on apex of segments 3 and 4; antenna slightly longer than proboscis; torus usually with rather numerous small broad whitish scales; flagellar segment 1 with a few small translucent dark scales near middle. *Thorax:* integument rather uniform brown, light to dark; mesonotum with rather long narrow curved scales, variable in color from dark brown to beige, usually not in distinct pattern but sometimes lighter scales concentrated along usual lateral, longitudinal, and transverse lines; acrostichals and dorsocentrals strongly developed; scutellum with pale scales; *apn* and *ppn* with numerous narrow scales, brown to beige in color; broad flat whitish to beige scales on *ppl*, upper and lower *stp*, and middle *mep;* those on *ppl* usually somewhat darker and extending on anterior surface on upper part of *acx* membrane; *pst* without scales; usually a few pale beige broad scales among upper *mep* bristles. *Legs:* forecoxa and midcoxa with dark and light scales, latter chiefly at base, hindcoxa with light scales; trochanters predominantly pale-scaled; femora with broad pale basal ring and predominantly pale ventral and posterior surfaces, apex with a variable but small number of pale scales; forefemur and midfemur with predominantly dark anterior surface, more or less heavily speckled with pale scales; anterior surface of hindfemur similar except that lower part is predominantly pale; tibiae with some pale scales at base and apex, anterior surface predominantly dark, posterior and ventral usually with extensive pale scaling; anterior surface of foretibia with a line of small light brown or beige spots along or ventrad of line of dorsal bristles; anterior surface of hindtibia sometimes with some pale scales; tarsi with basal and apical whitish or beige markings on segments 1–3, basal broader, usually forming a complete ring, apical narrower, often restricted to dorsal surface, segment 4 usually with narrow basal pale marking, segment 5 usually all dark. *Wing:* dorsal scales all dark except for pale scales on posterior portion of base of vein C; outstanding scales linear, dense; remigial bristles usually 2,3 and strongly developed; alula with complete marginal fringe of short narrow scales; upper calypter with complete marginal fringe of long hairs. *Haltere:* knob with brown to pale brown scales. *Abdomen:* tergite I with small median caudal patch of dark scales; tergites II-VII predominantly dark-scaled, with long lateral whitish patches and transverse dorsal basal connecting whitish bands variable in width, those on II-IV usually conspicuously widened in the middle; sternites with whitish scales basally and with a more or less wide apical transverse dark band.

MALE.—Essentially as in the female. *Labium:* with narrower pale band and a conspicuous ventral line of long hairs proximad of band. *Palpus:* exceeding proboscis usually by a little more than segment 5, which is distinctly longer than 4; thinly scaled, with variable whitish or beige dorsal bands in middle of segment 2, base of 3 and sometimes its apex, base of 4, base and apex of 5; a small patch of whitish scales ventrally on base of segments 4 and 5; numerous long hairs on lower outer margin of distal part of segment 3 and both inner and outer lower margins of 4 and 5; inner margin of lower surface of segment 3 with long line of moderately long outstanding hairs. *Legs:* larger claw of foreleg and midleg with large blunt submedian tooth, smaller claw with sharp subbasal tooth. *Abdomen:* transverse pale bands of tergites broader and more even than in female.

MALE GENITALIA (fig. **110**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe poorly developed, indicated by a line of 4-6 hairs. *Sidepiece:* tergal surface with moderately long bristles laterally at base, somewhat shorter distally, short hairs more mesally, longer in region of subapical lobe, sometimes 1 or more of these enlarged; lateral bristles long. *Subapical Lobe:* setae *a-c* long, *b* usually heavier than others; leaf (*g*) moderate to large, rounded apically, accessory seta (*h*) weak, removed from leaf; sternal setae (*d-f*) usually 3, well developed, 1 heavier than others; sternad of subapical lobe a slight protuberance densely long-spiculose. *Clasper:* simple; narrowed apically. *Phallosome:* inner division strongly differentiated, a conspicuous spinose curved sharp sternal process, tergal angle produced into rugose and sometimes toothed truncate process, proximad of which is a short lobe bearing 1–4 foliform, rounded, or slightly acuminate spines; outer division with a long strong curved acute spine. *Proctiger:* large; basal sternal process completely absent; usually 3 cercal setae.

PUPA (fig. **110**).—*Abdomen:* 3.05 mm. *Trumpet:* 0.75 mm. *Paddle:* 0.85 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, ventral surface lighter, mesonotum darkened; hairs lightly to moderately pigmented; majority of hairs usually multiple. *Trumpet:* uniformly moderately to strongly pigmented, darkened on tracheoid. *Metanotum:* darkened. *Abdomen:* lightly pigmented, darkened on anterior tergites; hairs moderately pigmented except for 5-V,VI which are dark; hairs 1-III-VI multiple, moderately to rather strongly developed; 5-IV multiple, very different in appearance from 5-V,VI which are usually double or triple; 6-III-VI subequal, usually 3,4b; 1-IX distinct. *Paddle:* moderately broad; lightly pigmented, midrib and external buttress darker; marginal spicules not visible; hairs 1,2-P both well developed.

LARVA (fig. **111**).—*Head:* 0.8 mm. *Siphon:* 1.4 mm. *Anal Saddle:* 0.36 mm. Chaetotaxy as figured; diagnostic characters as in the key; variable, particularly in length of siphon. *Head:* lightly to moderately pigmented, with usual light and darkened areas; mental plate as figured, usually with 6–9 coarse, distinct teeth on each side of median tooth; hair 1-C short, thick, usually very dark, rarely somewhat flattened, apex acuminate not filamentous; 5-C usually 4,5b, about as long as 6-C, latter usually 3b. *Antenna:* long; basal part distinctly wider than distal, lightly pigmented and with numerous long slender spicules; distal part narrow, dark, with only a few spicules proximally; hair 1-A inserted well beyond middle. *Thorax:* hairs and tubercles strongly pigmented. *Abdomen:* hairs and tubercles moderately to strongly pigmented; dorsal and ventral hairs long and multiple; 6-I,II usually 3b; 6-III-VI usually double; 7-I usually double; 1-III-VI usually 5-7b; 13-III-V usually 4-6b. *Segment VIII:* comb usually with at least 30 small fringed scales in 4 rows. *Siphon:* index extremely variable, from 5.0 to 14.0 or even greater; lightly to moderately pigmented, blackened on basal ring and sometimes darkened distally; pecten usually with 13 or more slender teeth, larger teeth usually with at least 6 subequal denticles and poorly differentiated main spine; subventral tufts all in line, usually 6 pairs (5–7), inserted a considerable distance from midline, usually all distad of pecten; median caudal filament of spiracular apparatus strongly developed, conspicuous. *Anal Segment:* saddle complete, strongly sclerotized, moderately to rather strongly pigmented; marginal spicules not differentiated, some small fine spicules dorsolaterally; hair 1-X usually 3b; 2-X with short smaller branches; gills always pointed, variable in length, usually longer than saddle.

MATERIAL EXAMINED.—6,723 specimens; 1,850 ♀; 1,421 ♂; 366 pupae; 3,086 larvae; 100 individual rearings (93 larval, 7 pupal).

SYSTEMATICS.—*C. annulirostris* is an extremely variable, highly plastic dominant species with a multiude of ecotypes, some of which are very strikingly different in superficial characters. Even the male genitalia show considerable variation, particularly in the shape of the inner division of the phallosome and in the number and shape of foliform spines on this sclerite. Similar variants are found in the majority of populations, and I believe that considerable interchange between populations has occurred in the past and is still taking place. Some of the exchange may be owing to human agency in recent times. At any rate, it does not appear that any of the populations are stabilized and worthy of recognition as separate taxa. *C. annulirostris* appears to be a dominant form actively extending its range; in the western portion of its South Pacific range, it is the dominant species of *Culex*.

In the larval stage there is a remarkable variation in the length of the siphon. Specimens from dense jungle swamps tend to have a very long siphon, while those from temporary ground pools possess a very short one; intermediate siphons are characteristic of specimens from stream margins and open permanent freshwater ground pools. Associated with differences in siphon length are differences in adult coloration. In almost every collection, a great deal of variation results in a complete overlapping of practically all characters.

I have labeled as *annulirostris* all material of the *sitiens* group that cannot be definitely identified as one of the currently recognized species. It is very probable that included in this material are many misidentifications as well as adults of *whittingtoni* and possibly forms not as yet recognized.

BIONOMICS AND DISEASE RELATIONS.—*C. annulirostris* has an extremely wide range of breeding sites. Apparently it can utilize, at least at times, almost any type of water on the ground, permanent or temporary, standing or flowing, fresh or strongly brackish, clean or with a very high organic content. It has been commonly found breeding in canoes and in various types of artificial containers; rarely it is found in coconut husks and in large, open treeholes. It breeds readily in open sunlit sites, as well as in strongly shaded pools and dense jungle swamps.

Females of *annulirostris* attack man readily from late afternoon through the night both indoors and in the open. In the Solomons and New Hebrides *annulirostris* is the most important nocturnal pest mosquito. In spite of its abundance and attraction to man, this species does not seem to be important in the transmission of any human disease in the South Pacific, although its importance as a vector has not been thoroughly studied. Bahr (1912) found *annulirostris* (as *jepsoni*) to be refractory to experimental infection with *Wuchereria bancrofti* on Fiji, and Byrd, St. Amant, and Bromberg (1945) failed to get complete development of filarial larvae in *annulirostris* on Samoa. Recently *annulirostris* has been shown to be an important vector of periodic filariasis in some areas of New Guinea (de Rook and van Dijk, 1959).

DISTRIBUTION (fig. 88).—*Solomon Islands:* Bougainville; Treasury; Kolombangara; Arundel; New Georgia; Sasavele; Pavuvu; Banika; Florida; Guadalcanal; Malaita; Ontong Java; Sikiana; Rennell. ? *Nauru. Santa Cruz Islands:* Vanikoro; Tikopia. *Banks Islands:* Vanua Lava. *New Hebrides:* Espiritu Santo; Ulilapa; Aore; Tutuba; Malo; Malekula; Emae; Efate; Leleppa; Tana; Aneityum. *Loyalty Islands:* Ouvea. *New Caledonia:* Art (Belep);

widely distributed on main island. *Gilbert Islands:* Tarawa; probably present on southern islands. *Ellice Islands:* Nanumea; Lakena; Nanumanga; Funafuti. *Rotuma Island. Fiji:* Viti Levu; Vanua Levu; Taveuni; Naitamba; Vanua Mbalavu; Koro; Makongai; Naingani; Kandavu; Totoya; Lau group. *Wallis Islands:* Uea. *Samoa:* Savaii; Upolu; Tutuila; Tau. *Tonga:* Tongatabu. *Southern Cook Islands:* Aitutaki; Rarotonga. *Society Islands:* Raiatea; Tubaimanu (Maiao); Moorea; Tahiti. *Austral Islands* (Tubuai): Rimatara. *Rapa Island. Tuamotu Archipelago:* Fakarawa. Also reported from the *Bismarcks, New Guinea, Australia* (Northern Territory, Queensland, New South Wales), *Indonesia,* and *Philippines.*

16. Culex (Culex) omani Belkin, n. sp.

Figs. 88, 112, 113

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 682-16), Chacon swamp, Guadalcanal, Solomon Islands, from dense wooded swamps, Oct. 17, 1944, J. N. Belkin (USNM, 64755). *Allotype:* ♀ with associated larval and pupal skins (JNB, 682-14), same data as holotype (USNM). *Paratypes:* 11 ♀, 14 ♂, 19 pupae, 28 larvae, same locality and date as holotype, as follows: 2 ♀ with associated larval and pupal skins (JNB, 682-12, 15), 1 ♂ with associated larval and pupal skins and genitalia slide (JNB, 682-13), 6 ♀, 10 ♂, 12 pupae, 18 larvae (JNB, 682), J. N. Belkin; 2 ♀ with associated larval and pupal skins (RKL, 142-1, 2), 2 ♂ with associated larval and pupal skins (RKL, 142-3, 9), 1 ♀, 1 ♂, 3 larvae (RKL, 142), J. Laffoon and L. E. Rozeboom. This species is dedicated to Paul W. Oman in recognition of his efforts in behalf of entomologists and his support of entomological investigations on Guadalacanal during wartime years.

FEMALE.—*Wing:* 3.25 mm. *Proboscis:* 1.75 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.33 mm. Superficially similar to *annulirostris* and *samoaensis;* differing from the former chiefly in the following characters. *Head:* decumbent narrow scales lighter; erect scales light in center; labium with much narrower light ring, usually less than 0.2; palpus with only a few pale scales on apex of segment 4. *Thorax:* mesonotal scales predominantly pale, longer and broader; *ppn* scales less numerous, pale, larger and broader; *mep* scale patch very small, restricted to anterior border, scales all narrow; upper *mep* bristles less numerous. *Legs:* femora not speckled on anterior surface; tibiae without pale scales on anterior surface; tarsi with very narrow, inconspicuous pale basal markings on 1-3 or 1-4. *Abdomen:* tergites without basal transverse pale bands, lateral spots very small, visible dorsally on VII; sternites with narrower basal light-scaled bands.

MALE.—Essentially as in the female; differing from *annulirostris* in same characters, except as follows; pale ring of labium very narrow; palpus predominantly dark-scaled, with more or less distinct narrow basal pale bands on segments 4 and 5.

MALE GENITALIA (fig. 112).—As figured; diagnostic characters as in the key; suggestive of *sitiens* and *squamosus* but distinctive. *Segment IX:* tergite lobe as in *annulirostris. Sidepiece:* tergal surface with sparse, slender, rather short bristles laterally, a few short hairs mesad toward subapical lobe. *Subapical Lobe:* with a very prominent and slender part bearing tergal and sternal setae; setae *a-c* long, *b* and *c* slender, hooked, *a* usually flattened, rounded apically; leaf (*g*) long, narrow, slender at base, rounded apically, removed from other setae; accessory seta (*h*) slender, poorly differentiated; sternal setae (*d-f*) long, 2 markedly flattened, third more slender, all long and inserted very close to tergal setae (*a-c*) and on same process. *Clasper:* simple; narrowed distally. *Phallosome:* inner division strongly differentiated, porrect, distal sternal angle rounded, distal tergal angle more or less sharply produced, proximad of tergal angle 5 large foliform spines, 2 pairs projecting caudad and 1 single laterad; outer division strongly differentiated, with 2 moderate hooked spines, 1 more tergal than other. *Proctiger:* large; basal sternal process very long, slender, curved, and heavily pigmented; cercal setae usually 2.

PUPA (fig. 112).—*Abdomen:* 2.8 mm. *Trumpet:* 0.79 mm. *Paddle:* 0.72 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general quite similar to *annulirostris* but differing markedly in shape of trumpet and the following. *Cephalothorax:* uniformly pigmented a rather bright light brownish yellow, darker on mesonotum; hairs longer, lightly pigmented. *Trumpet:* slender, slightly swollen distally but narrowed at apex, pinna very small, only slightly oblique; uniformly moderately pigmented, slightly darker on tracheoid which extends to about 0.5. *Metanotum:* darkened; hairs 11-C dark, others light. *Abdomen:* uniformly pigmented a bright light brownish yellow, slightly darker on anterior segments; hairs lightly to moderately pigmented; hairs 1-III-VI strongly developed, multiple; 5-IV usually 5b; 5-V usually triple; 5-VI usually double and reaching middle of tergite VIII; 6-III,IV strongly developed, about same order of magnitude as 6-V,VI and usually 5,6b; 6-V,VI strongly developed, usually 6-9b; 1-IX distinct. *Paddle:* lightly pigmented, midrib and external buttress brighter and darker; margins without distinct spicules; only hair 1-P developed.

LARVA (fig. 113).—*Head:* 0.79 mm. *Siphon:* 2.4 mm. *Anal Saddle:* 0.42 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *annulirostris* except for comb, siphon, and following details. *Head:* lightly pigmented except for black collar; hair 1-C longer, usually somewhat thinner; 5-C usually 2,3b; 6-C usually double and longer. *Thorax:* long hairs longer. *Abdomen:* large hairs longer. *Segment VIII:* comb scales usually at least 25, outer and posterior enlarged and with long apical spine. *Siphon:* very slender; index about 20.0 or more; moderately pigmented, blackened on basal ring; pecten teeth usually at least 12, more distal with numerous indistinct spicules along the main spine; subventral tufts usually 6 pairs, 2 more or less out of line, members of pair widely separated, more or less lateral in position, all short and inconspicuous. *Anal Segment:* saddle moderately pigmented, darkened on basal ring and on distal margin; spicules indistinct except dorsad of hair 1-X on body of saddle; gills slender.

MATERIAL EXAMINED.—145 specimens; 23♀; 22♂; 27 pupae; 73 larvae; 12 individual larval rearings.

SYSTEMATICS.—*C. omani* is a very interesting, clearly marked species which combines features of the *annulirostris* complex with those of the *bitaeniorhynchus* subgroup and may have arisen through hybridization between members of these 2 lines—possibly *annulirostris* and *squamosus*, respectively. The male genitalia are very distinctive, but there is considerable variation in the degree of flattening of the setae of the subapical lobe. A number of similarities are evident with *vishnui* Theobald, 1901 and *tritaeniorhynchus* Giles, 1901.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *omani* have been found only in dense jungle swamps, sometimes in association with the long-siphoned form of *annulirostris* and rarely with *squamosus* as well. All the adults except 2 females have been reared. One female was collected in a night catch, the other resting on vegetation near a jungle swamp. Nothing is known of the disease relations of *omani*.

DISTRIBUTION (fig. 88).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

17. Culex (Culex) samoaensis (Theobald)

Fig. 89

1914. *Pseudotaeniorhynchus samoaensis* Theobald, Entomologist 47:36–37. *TYPE: holotype ♀, Apia, Samoa, Friederiks (LIVER *in* BMNH).

C. (*C.*) *samoaensis* of Edwards (1924:394; 1928*b*:46; 1932:203); Buxton and Hopkins (1927:78–79); Taylor (1934:24); Knight, Bohart, and Bohart (1944:41, 63, in part); Bohart and Ingram (1946:17); Iyengar (1955:33, in part); Stone, Knight, and Starcke (1959).

FEMALE.—*Length:* about 4.8 mm. (Theobald). Very similar to dark form of *albinervis* and with abdominal tergites and legs as in *omani;* differing from former chiefly in the following features. *Head:* a rather distinct orbital line of pale beige scales; proboscis apparently shorter; palpus entirely dark-scaled. *Thorax:* mesonotal scales very short, narrow, curved, dark bronzy, broader in supraalar area; scutellar scales similar but lighter; *apn* scales bronzy; *ppn* scales dark bronzy, broader and longer than on mesonotum; *ppl* scales fewer, translucent whitish; *stp* scale patches very small, only 3–6 scales in each, upper elongate, lower very long and erect; *mep* apparently without median anterior scale patch, 1,2 very elongate light hairlike scales among upper *mep* bristles. *Legs:* essentially as in *omani;* femora not speckled with pale scales on anterior surface; tibiae without distinct pale markings at base and apex; tarsal pale markings reduced, segment 1 with distinct basal whitish ring only on hindleg, on foreleg and midleg with very indistinct pale basal area, apex dark on all legs; indistinct narrow basal whitish markings on segments 2 and 3 of foreleg, 2–4 of midleg, and 2–5 of hindleg. *Wing:* crossveins rather light, almost as in *albinervis. Abdomen:* tergites without transverse pale markings, lateral pale markings indistinct, progressively longer distad, visible dorsally on VII.

MALE, PUPA, and LARVA.—Unknown.

MATERIAL EXAMINED.—2 ♀ (BMNH).

SYSTEMATICS.—*C. samoaensis* seems to be a distinct species with a suggestion of affinities with *albinervis* and the *annulirostris* complex. It also shows similarities with *omani* and, like this species, may have been formed through hybridization between the above-mentioned lines or possibly between the *sitiens* complex and *albinervis*. It is also possible that *samoaensis* is the Samoan representative of *albinervis*, which it closely resembles. Only 3 females of *samoaensis* have been collected to date, and apparently 1 of these has been lost.

BIONOMICS AND DISEASE RELATIONS.—The 2 females of the type series were collected in a latrine. The third female collected by F. W. O'Connor is labeled Samoa, Mar.–Aug., 1921, without further particulars. It seems likely that the immature stages of *samoaensis* will be found in pools with dense vegetation or in algal mats.

DISTRIBUTION (fig. 89).—*Samoa:* Upolu. Not known elsewhere; the records of *samoaensis* from New Guinea (Knight, Bohart, and Bohart, 1944:63; Iyengar, 1955:33) undoubtedly pertain to a different species.

18. Culex (Culex) albinervis Edwards

Figs. **89, 114, 115**

1929. *Culex albinervis* Edwards, B. Ent. Res. 20:338–340. *TYPE: holotype ♂, Suva, Fiji, Jan. 31, 1928, R. W. Paine (BMNH).

C. (*C.*) *albinervis* of Edwards (1932:202); Taylor (1934:23); Paine (1935, 1943:9, 13); Lee (1944*a*:96); Knight, Bohart, and Bohart (1944:41, 60); Iyengar (1955:32); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 4.33 mm. *Proboscis:* 2.13 mm. *Forefemur:* 2.26 mm. *Abdomen:* about 3.08 mm. Dimorphic, some specimens with anterior part of mesonotum with long whitish scales. *Head:* eyes contiguous above antennae; a very short frontal tuft of pale golden scales; narrow decumbent scales all bronzy to light bronzy; no distinct orbital line of scales; broad lateral decumbent scales mixed beige and brown; erect scales brown; pale ring of labium usually narrow, less than 0.20 of proboscis dorsally, variable in color from white to beige; palpus predominantly dark-scaled, usually with a few pale scales apically; antennal torus with several dark translucent broad scales. *Thorax:* mesonotum dimorphic; in dark form largely with short dark bronzy narrow scales throughout, except for a variable pair of spots of golden narrow scales between acrostichals and dorsocentrals in front of prescutellar space and a variable number of broad long erect scales in supraalar area, some scales whitish, others dark; in pale form anterior two-thirds with longer, narrower whitish scales sharply contrasting with shorter dark bronzy scales in posterior part, erect scales as in dark form; scutellum with pale bronzy to golden narrow scales, chiefly confined to midlobe; *apn* and *ppn* with bronzy to dark bronzy scales, some distinctly broadened, particularly on *ppn;* broad scales of *ppl, stp,* and *mep* rather elongate and sparse, beige to whitish; *pst* usually with a few inconspicuous elongate beige scales; *acx* apparently without scales; upper and lower *stp* scale patches both small, scales in lower erect; scale patch of middle anterior *mep* very small; usually a few small erect broad scales among upper *mep* bristles; *psp* and *pra* without scales. *Legs:* forecoxa with dark scales except for small patch of pale scales at base, midcoxa with dark scales, hindcoxa with pale yellowish scales; trochanters with dark and pale scales; femora predominantly dark-scaled on anterior and dorsal surfaces, pale at base and indistinctly paler on lower and posterior surfaces, without speckling, apex with indistinct pale knee spot; tibiae predominantly dark, indistinctly pale at base and apex; tarsal segments 1 with distinct rather broad whitish band at base and a very narrow whitish band on apex dorsally; segments 2 and 3 of foretarsus with distinct basal whitish ring and sometimes a few pale dorsal scales apically on 2; segments 2–4 of midtarsus with somewhat broader whitish basal rings and sometimes a few pale dorsal scales apically on 2 and 3; segments 2–4 of hindtarsus with broader basal whitish rings and a narrow one on segment 5, apex of 2–4 with rather numerous dorsal pale scales; remainder of tarsal segments dark-scaled. *Wing:* dorsal scales all dark except occasionally a few indistinctly pale scales on posterior face of base of vein C; scales all rather small, plume scales relatively short; crossveins *r-m, m-cu,* and base of R_{4+5} and Rs whitish; remigial bristles strong; alula with complete marginal fringe of short hairlike scales;

upper calypter with complete marginal fringe of long hairs. *Haltere:* lower part of knob with brown scales, upper with lighter scales. *Abdomen:* tergite I with small median caudal patch of dark scales; tergites II-VII predominantly dark-scaled, with basolateral whitish or pale beige scale patches and with rather narrow basal beige to pale beige transverse scale bands connected to the patches; sternites dark in middle and with variable transverse basal and apical pale-scaled bands, apical narrower.

MALE.—Essentially as in the female; similar dimorphism in coloration. *Palpus:* segment 3 usually with a few pale scales in the middle dorsally; segment 4 with a patch of whitish scales at base ventrally and usually a few pale scales dorsally; segment 5 with smaller patch of whitish scales ventrally, dorsal surface predominantly with pale scales except for subbasal patch of dark scales. *Abdomen:* tergites with wider basal transverse pale bands on II-VI.

MALE GENITALIA (fig. **114**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe not produced, indicated by a line of 4–8 bristles. *Sidepiece:* dorsal surface with rather short, moderately heavy lateral bristles and some short thin hairs chiefly in region of subapical lobe. *Subapical Lobe:* moderately prominent; setae *a* and *b* thickened, *c* thinner and longer, all usually with hooked apex; leaf (*g*) moderate, accuminate; 2 accessory setae (*h*) not distinctly differentiated from lateral tergal setae of sidepiece; sternal setae (*d-f*) poorly differentiated, widely removed from *a-c,* usually only 2 slender apically hooked setae. *Clasper:* simple, tapered distally. *Phallosome:* inner division strongly differentiated, sternal apical angle rounded, tergal apical angle usually produced into a slender simple or toothed spine proximad of which are 3,4 foliform spines; outer division with broad irregular median lateral swelling, 1 moderate sharp tergal spine and 1,2 smaller denticles. *Proctiger:* long; paraproct crown with long thin hairlike poorly pigmented spines, usually in a double curved row laterally, more numerous, thinner and denser mesad; basal sternal process long, slender, curved, and heavily pigmented; cercal setae usually 2.

PUPA (fig. **114**).—*Abdomen:* 1.85 mm. *Trumpet:* 0.88 mm. *Paddle:* 0.92 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately and uniformly pigmented a bright, light yellowish brown; hairs lightly to moderately pigmented; hairs 1-5-C all very short and inconspicuous. *Trumpet:* moderately to strongly pigmented a bright brown, darkened on tracheoid; apex strongly asymmetrically widened. *Metanotum:* hair 10-C shorter than 11-C. *Abdomen:* uniformly moderately pigmented a bright yellowish brown, darker on proximal segments; hair 1-VI small, thin, markedly different from 1-V; 6-I,II relatively short and thin, of the same order of magnitude as other hairs on these segments; 6-V,VI thickened, markedly different from 6-III,IV. *Paddle:* lightly pigmented, midrib and external buttress darker and brighter; marginal spicules indistinct; only 1 hair developed.

LARVA (fig. **115**).—*Head:* 0.8 mm. *Siphon:* 2.09 mm. *Anal Saddle:* 0.51 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* unusually small; lightly to moderately uniformly pigmented except for black collar; mentum seemingly without teeth but with extremely minute and numerous teeth on each side; entire plate very darkly pigmented; hair 1-C long and slender; 4-C usually single; 5-C usually double; 6-C usually single, long, and heavy; 11,13-C usually both single. *Antenna:* very long and slender, not swollen in basal part and only gradually narrowed distally; lightly pigmented basally, darkened distad of hair 1-A; a few widely scattered small sharp spicules to just beyond hair 1-A; hair 1-A inserted at about middle. *Thorax:* hairs and tubercles strongly pigmented; hair 3-P usually double or triple; 4-P usually single. *Abdomen:* hairs and tubercles strongly pigmented; dorsal and ventral hairs, particularly 1 and 13, short and inconspicuous; hair 6-I,II usually 3,4b; 6-III-IV usually 2,3b; 6-V,VI single or double; 7-I usually double; 3-I-V usually single. *Segment VIII:* comb usually a patch of at least 25 small fringed scales with distinct sharp apical spine; hairs 1,2-VIII on common basal plate. *Siphon:* index about 10.0–12.0; uniformly moderately to strongly pigmented except for black basal ring; pecten of about 8–12 inconspicuous teeth, usually within basal 0.25, distal teeth widely spaced, all slender and with inconspicuous basal denticles; subventral tufts (1,1a-S) usually 3 pairs, widely spaced, all in distal 0.6 and in line; hair 2-S thickened, long, outstanding, slightly hooked apically; median caudal filament of spiracular apparatus strongly developed, conspicuous. *Anal Segment:* saddle complete, moderately pigmented, darkened on basal ring; spicules extremely small on body of saddle, not differentiated on margin; hair 1-X small, branched; gills usually subequal, tapered, usually longer than saddle.

MATERIAL EXAMINED.—143 specimens; 28 ♀; 29 ♂; 31 pupae; 55 larvae; 10 individual larval rearings.

SYSTEMATICS.—*C. albinervis* shows a remarkable dimorphism in the coloration of the mesonotum in both sexes. The light and dark forms are sharply marked, and there are apparently no intermediates. There are no other striking differences between the 2 forms; the rest of the coloration of the adults does not seem to be affected, and no differences have been noted in the larvae or pupae. Paine (*in* Edwards, 1929*b*:340) noted that there are 2 color forms in the larva, a green and a brown, but he was not able to establish whether these are correlated with the 2 adult forms or with the sexes. The 2 adult forms are usually reared from the same collection. It seems likely that the dimorphism is caused by a single gene difference.

C. albinervis appears to be the most ancient derivative of the *bitaeniorhynchus* subgroup. It is a very clearly marked species but shows strong affinities with *samoaensis* and lesser affinities with *bitaeniorhynchus, squamosus,* and *starckeae.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *albinervis* have been collected in mats and clumps of filamentous green algae in taro swamps and at the edge of streams and ditches. Nothing is known of the bionomics and disease relations of the adults. Females have not been taken biting.

DISTRIBUTION (fig. 89).—*Fiji:* Viti Levu; Vanua Levu; Taveuni; Naingani; Kandavu. Not definitely known elsewhere; records from Tonga group are probably based on misidentifications (Tonga, 1957; Helu and Haunga, 1952).

19. Culex (Culex) squamosus (Taylor)

Figs. **89, 116, 117**

1905. *Trichopronomyia annulata* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:98–99. TYPE: holotype ♂, Friedrich-Wilhelmshafen, New Guinea, Biro (BUDA).—Preoccupied by *Culex annulatus* Schrank, 1776 (= *Culiseta annulata*).

1914. *Culicada squamosa* Taylor, Roy. Ent. Soc. London, Trans. 1913(61):691–692. TYPE: syntypes, 2 ♀, Townsville, Queensland, Apr. 12, 1913, F. H. Taylor (SYDN).—Synonymy with *annulata* by Edwards (1924:393), apparently confirmed by Stone (1957*a*:172).

1914. *Leucomyia annulirostris* Taylor, Roy. Ent. Soc. London, Trans. 1913(61):696–698. TYPE: syntypes, ♂ and ♀, Townsville and Ching Do, Queensland (SYDN).—Preoccupied by *Culex annulirostris* Skuse, 1889; synonymy with *squamosus* by Edwards (1924:393).

1921. *Culex taylori* Edwards, B. Ent. Res. 12:78.—New name for *C. annulirostris* (Taylor, 1914) not *C. annulirostris* Skuse, 1889; synonymy with *squamosus* by Edwards (1924:393).

C. (*C.*) *squamosus* of Edwards (1924:393; 1932:203); Hill (1925:74); Lee (1944*a*:98); Knight, Bohart, and Bohart (1944:41, 63); Laird (1955*a*, 1956); Iyengar (1955:34); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 4.46 mm. *Proboscis:* 2.08 mm. *Forefemur:* 2.25 mm. *Abdomen:* about 3.25 mm. In general similar to pale form of *albinervis,* differing chiefly in following characters. *Head:* frontal tuft longer; decumbent narrow scales predominantly pale beige, a very thin orbital line apparent; decumbent broad scales beige; erect scales pale in the center; labium with wider pale ring, especially ventrally; scales of torus beige to whitish. *Thorax:* pale scaling of anterior two-thirds of mesonotum not as white, usually beige to dingy white and with patches of darker scales, erect scales of supraalar area more numerous, somewhat longer and narrower and predominantly pale; scutellum with bronzy scales at base, pale golden distally; *apn* with narrow bronzy scales in middle, beige above, rather broad small beige scales below; *ppn* with dark bronzy scales restricted to central area, beige to pale beige above and caudally; *pst* with rather conspicuous patch of elongate beige scales, *acx* apparently without scales; *mep* scale patch much larger, more pale scales among upper *mep* bristles. *Legs:* speckled with pale scales on femora, tibiae, and at least tarsal segments 1; usually all tarsal segments of all legs with basal pale scaling. *Wing:* usually numerous pale scales among dorsal squame scales, which are larger than in *albinervis;* a rather distinct area of whitish scales on posterior face of vein C near base; dorsal plume scales longer; crossveins and base of R_{4+5} and Rs dark. *Abdomen:* tergites with larger basolateral pale beige spots produced mesad caudally, transverse basal pale bands poorly developed, much narrower, usually distinct only on IV-VI; sternites with pale scaling much more restricted, usually not forming complete bands.

MALE.—Essentially as in the female and differing from *albinervis* in same characters except as follows. *Palpus:* longer than in *albinervis,* with segments 3–5 broader, with denser scaling and more numerous hairs, segment 3 usually without pale scales. *Abdomen:* tergites with broader basal transverse pale bands than in female.

MALE GENITALIA (fig. **116**).—As figured; diagnostic characters as in the key; in general as in *albinervis,* differing chiefly in the following. *Sidepiece:* dorsal lateral hairs thinner. *Subapical Lobe:* more prominent; setae *a* and *b* heavier, more distinctly flattened; seta *c* slender, shorter than *b;* leaf (*g*) variable, usually very poorly developed; only 1 fairly well-differentiated accessory seta (*h*); sternal setae (*d-f*) usually 3,4, one heavier than others, all short. *Phallosome:* tergal angle of inner division more irregular, less spinelike, foliform spines longer; tergal spine of outer division longer. *Proctiger:* outer spines of crown of proctiger flattened, straight; basal sternal process longer; cercal setae longer, usually 3.

PUPA (fig. **116**).—*Abdomen:* 2.22 mm. *Trumpet:* 0.85 mm. *Paddle:* 1.12 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *albinervis* but heavily pigmented a deep brown and differing in the following. *Abdomen:* hairs 1-IV-VI heavier and longer, 1-VI of the same order of magnitude as 1-V. *Paddle:* inner part and semicircular apical spot of outer part a deep brown.

LARVA (fig. **117**).—*Head:* 0.8 mm. *Siphon:* 3.05 mm. *Anal Saddle:* 0.5 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *albinervis,* from which it differs chiefly in the following. *Head:* usually very lightly pigmented; hair 4-C branched; 5-C usually triple; 6-C usually double; 11,13-C usually both double. *Antenna:* spicules more numerous, hair 1-A inserted distinctly before middle. *Thorax:* hair 3-P single; 4-P usually double. *Abdomen:* hair 3-I-V usually double. *Segment VIII:* comb scales with longer apical spine; hairs 1,2-VIII on separate basal tubercles, 2-VIII branched. *Siphon:* index about 16.0–20.0; usually darkened apically, pecten restricted to basal 0.15 or less, teeth usually less than 10, denticles slender, distinct; subventral tufts (1,1a-S) smaller; hair 2-S short, simple.

MATERIAL EXAMINED.—567 specimens; 161 ♀; 132 ♂; 109 pupae; 165 larvae; 14 individual rearings (8 larval, 6 pupal).

SYSTEMATICS.—*C. squamosus* is quite variable in ornamentation of the mesonotum; in some specimens the anterior area is only slightly lighter than the posterior, and in the majority the pale scaling is dingy and includes a variable amount of intermediate darker scales. There is no indication of racial differences in the various populations I have examined. The affinities of *squamosus* appear to be with *albinervis,* but it is definitely a more recent derivative of the *bitaeniorhynchus* subgroup and seems to be extending its range at present. It also shows a number of similarities with the sympatric *omani,* which may have been formed through hybridization between a *squamosus*-like form and a member of the *sitiens* subgroup.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *squamosus* are typically found in dense mats of filamentous green algae in fresh ground water pools and stream margins and more rarely in open swamps with dense vegetation. Nothing is known of the bionomics and disease relations of the adults. Females are apparently not attracted to man; only 2 were collected in nature on Guadalcanal, one in a night catch and another resting on vegetation in the daytime.

DISTRIBUTION (fig. 89).—*Solomon Islands:* Bougainville; New Georgia; Pavuvu; Banika; Guadalcanal; Rennell. Also reported from *New Guinea* and *Australia* (Queensland) and probably present in intermediate areas; the records from the Moluccas, Amboina, Ceram, and Aroe may pertain to a different species (Brug, 1934:515–516).

20. Culex (Culex) bitaeniorhynchus Giles

Figs. **89, 118, 119**

1901. *Culex bitaeniorhynchus* Giles, Bombay Nat. Hist. Soc., J. 13:607. TYPE: sex not specified, Travancore, James (lost).

1913. *Culicelsa abdominalis* Taylor, Austral. Inst. Trop. Med., Rpt. 1911:53. TYPES: syntypes, ♀, Ayr and Townsville, Queensland (lost).

For complete synonymy, see Stone, Knight, and Starcke (1959).

C. (*C.*) *bitaeniorhynchus* of Edwards (1924:392; 1932:202); Taylor (1934:23); Lee (1944*a*:97); Knight, Bohart, and Bohart (1944:41); Laird (1954*a*:286–290); Iyengar (1955:33); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.70 mm. *Proboscis:* 1.83 mm. *Forefemur:* 1.91 mm. *Abdomen:* about 2.5 mm. In general similar to *albinervis,* from which it differs chiefly in the following; coloration extremely variable. *Head:* decumbent narrow scales bronzy to golden brown; erect scales dark to golden; decumbent broad lateral scales dark beige to whitish; labium with broad pale ring, usually about 0.33 of proboscis and beige in color, usually a more or less distinct apical pale ring and some scattered dark beige scales proximad of ring; palpus usually speckled with pale scales. *Thorax:* mesonotal scaling variable, from uniformly dark bronzy to golden brown in anterior part and darker posteriorly, sometimes with pair of submedian dark spots in lighter area or submedian lighter spots in front of prescutellar area, some long broadened dark erect scales in supraalar area; scutellar scales dark bronzy proximally, paler to golden on distal part of midlobe; *apn* and *ppn* with dark bronzy to golden brown scales; *ppl* with inconspicuous, indistinctly pale, moderately narrow scales; *acx* and *pst* apparently both without scales; *stp* with upper and lower scale patches small, scales elongate and dark to light beige; anterior median scale patch of *mep* small, scales elongate, pale beige; no scales in upper *mep* bristles. *Legs:* femora and tibiae extensively speckled with pale yellowish brown to beige scales; tarsal segments 1 sometimes with a few similar pale scales; tarsi with narrow basal and even narrower apical pale bands on segments 1–4 and narrow basal pale bands on segments 5. *Wing:* dorsal surface of veins with extensive speckling of pale yellowish brown scales, both squame and plume; crossveins and base of R_{4+5} and Rs dark; remigial bristles usually 4,5. *Haltere:* knob with rather dark scales on base as well as apex. *Abdomen:* tergites extremely variable in coloration of scales; tergite I with pale beige to dark scales; tergites II-VII with pale yellowish brown to beige scales forming more or less broad apical transverse bands, usually expanded proximad to sublateral apical patches, more or less extensive speckling of pale scales elsewhere, sometimes expanded to produce an almost completely pale-scaled dorsal surface, basal median portion of at least proximal segments usually dark-scaled, pale scaling sometimes restricted to very narrow apical bands which are widened laterally; sternites usually largely pale-scaled, with variable patches of dark scales basolaterally and subapically.

MALE.—Essentially as in the female. *Labium:* with narrow pale ring. *Palpus:* predominantly dark-scaled, usually some pale scales in middle of segment 3; segments 4 and 5 with small basal ventral and dorsal patches of beige scales; apical 0.4–0.5 of segment 5 with pale beige scales.

MALE GENITALIA (fig. **118**).—As figured; diagnostic characters as in the key; in general as in *albinervis* but differing markedly in the following. *Segment IX:* bristles of tergite lobe more numerous, usually 6–10. *Subapical Lobe:* seta *c* weaker and shorter; leaf (*g*) very narrow; 2 accessory setae (*h*), 1 of which is between leaf and group *a-c;* sternal group (*d-f*) diffuse, with 4 relatively slender setae and 1 longer, heavier, and flattened seta. *Phallosome:* inner division with submedian tergal process bearing 3,4 foliform spines, apical tergal angle spiculate and rather sharp, apical sternal angle produced as a sharp spiculate spine; outer division developed chiefly as a broad sternal lateral spine. *Proctiger:* basal sternal process weak, slender, and poorly pigmented, moderately long.

PUPA (fig. **118**).—*Abdomen:* 4.3 mm. *Trumpet:* 1.05 mm. *Paddle:* 1.2 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *albinervis* but more heavily pigmented and differing in the following characters. *Cephalothorax:* hairs 1-9-C all very short. *Abdomen:* hair 1-II usually single or forked, thickened; 1-III usually 4,5b; 1-VI same order of magnitude as 1-V, usually single; 1-VII thickened; 5-IV-VI usually shorter than tergite following. *Paddle:* inner part darkened, apex of outer slightly clouded; minute hair 2-P developed in addition to 1-P.

LARVA (fig. **119**).—*Head:* 0.8 mm. *Siphon:* 2.29 mm. *Anal Saddle:* 0.48 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *albinervis,* from which it differs chiefly in the following. *Head:* hair 1-C heavier; 4-C sometimes branched; 5-C usually 3-5b; 6-C usually 2,3b; 11,13-C usually 2,3b. *Antenna:* shorter; basal part sometimes more or less swollen; spicules numerous and rather heavy on basal part; hairs 2,3-A much closer to apex. *Thorax:* hair 3-P single; 4-P usually double; 7-P usually 3,4b; 9-P sometimes branched. *Abdomen:* hair 3-I-V usually branched. *Segment VIII:* comb consisting of less than 10 large spinelike scales, fringed at base. *Siphon:* index about 12.0; pecten usually composed of less than 8 teeth, restricted to widened basal part, very lightly pigmented, difficult to see; apparently sometimes 3 pairs of subventral tufts in South Pacific form, usually 4 pairs in others; hair 2-S thinner and shorter.

MATERIAL EXAMINED.—10 specimens; 2 ♀; 3 ♂; 1 pupae; 4 larvae; 1 individual larval rearing.

SYSTEMATICS.—*C. bitaeniorhynchus* is an extremely widespread and variable species which may actually consist of a complex of several distinct forms. The larvae as well as the adults, including the male genitalia, show a tremendous amount of variation even within a single population, and the same types of variation appear to occur throughout the range of this form. Therefore it seems likely that we are dealing with one extremely plastic species, but it is possible that some distinct segregates of the complex occur in certain areas. The South Pacific populations are known from only a few specimens which seem to be somewhat distinct from those I have seen from Queensland, but unfortunately no males are available. For the present they are considered to be *bitaeniorhynchus s. lat.*, pending a thorough revision of the complex, but they may prove to belong to a distinct species.

BIONOMICS AND DISEASE RELATIONS.—On New Caledonia, Laird (1954*a*:288) found immature stages of *bitaeniorhynchus* in clumps of *Spirogyra* in ponded ditches with clear fresh water. Elsewhere this species has usually been found to breed in mats of green algae but has been reported also from shaded breeding sites. Over much of the Oriental, Indomalayan, and southern Palaearctic regions, *bitaeniorhynchus* is considered an important species, since females attack man readily, particularly at night. This species has been suspected as a vector of encephalitides and has been reported to be naturally infected with larvae of *Wuchereria malayi* (Carter, 1948). Females have not been reported to bite man in the South Pacific.

DISTRIBUTION (fig. 89).—*New Caledonia:* Noumea. Also reported from *New Guinea, Australia* (Northern Territory; Queensland; New South Wales), *Western Pacific Islands,* and Oriental, Indomalayan, southern Palaearctic, Ethiopian, and Malagasy regions.

21. Culex (Culex) starckeae Stone & Knight

Figs. **89**, **120**, **121**

1958. *Culex* (*Culex*) *starckeae* Stone and Knight, Ent. Soc. Wash., Proc. 60:69; description in Edwards, B. Ent. Res. 13:96–97. *TYPE: holotype ♂, marked as type of *basicinctus* by Edwards, Townsville, Queensland, in house, June 9–10, 1920, G. F. Hill (BMNH).—New name for *basicinctus* Edwards (1922*a*:96–97) not Edwards (1921*a*:78); latter substitute name for *Leucomyia annulata* Taylor, 1914, preoccupied by *Culex annulatus* Schrank, 1776, and a synonym of *C.* (*C.*) *vicinus* Taylor, 1916; Edwards' specimens were not *annulata* but a different species, for which the name *basicinctus* cannot be used.

C. (*C.*) *starckeae* of Stone, Knight, and Starcke (1959).

C. (*C.*) *basicinctus* of Edwards (1924:393; 1932:202); Taylor (1934:23); Lee (1944*a*:99); Knight, Bohart, and Bohart (1944:42, 60); Perry (1946:15); Laird (1954*a*:286–287; 1956); Iyengar (1955:33); Rageau (1958*a*:877; 1958*b*:5); Rageau and Vervent (1958).

FEMALE.—*Wing:* 3.93 mm. *Proboscis:* 1.75 mm. *Forefemur:* 2.03 mm. *Abdomen:* about 2.91 mm. In general somewhat similar to dark form of *albinervis* but differing markedly in the following characters. *Head:* frontal tuft conspicuous, long; decumbent narrow scales predominantly pale beige or whitish; orbital line narrow but conspicuous and with whitish scales laterally; erect scales pale beige except for small lateral patch where decumbent narrow scales are also dark; decumbent broad lateral scales whitish; pale band of labium a little broader, with pure white scales; antennal torus and first flagellar segment with conspicuous small broad whitish scales. *Thorax:* mesonotum with light bronzy to beige scales, without distinct pattern, some broader scales laterally in front and at scutal angle, a conspicuous large patch of broad erect whitish or pale beige scales in supraalar area and in front of wing root; scutellum with beige scales except for some bronzy at base of midlobe; *apn* with narrow bronzy scales in middle, a patch of more or less broadened pale beige scales dorsally, in front, and ventrally; *ppn* scales predominantly bronzy except for paler scales in front and in back dorsally, sometimes along entire mesonotal margin, usually some more or less broadened scales caudally; *ppl, acx,* and *pst* with conspicuous large patch of broad whitish broad scales; upper and lower *stp* scale patches very large, scales broad and whitish; anterior median *mep* scale patch large, scales broad and whitish; numerous broad whitish scales among upper *mep* bristles. *Legs:* femora, midtibia, hindtibia, and sometimes foretibia with inconspicuous speckling of pale scales; foretarsus and midtarsus with conspicuous basal whitish or pale beige broad rings on segments 1-4, sometimes a few pale apical scales on 1-3, hindtarsus similar and in addition with narrow basal pale ring on segment 5. *Wing:* posterior surface of base of vein C with streak of pale scales; dorsal plume scales very long; crossveins and base of R_{4+5} and Rs dark. *Abdomen:* tergite I sometimes with a few of the scales in median caudal patch pale; tergites II-VII with basolateral patches of whitish scales produced mesad on distal segments, basal transverse whitish bands moderately broad on II-VI, very narrow on VII, some apical pale scales on V-VII, sometimes forming distinct narrow transverse apical bands; sternites largely dark-scaled, with basal transverse pale bands expanded laterally and some apical pale scales sometimes in more or less complete bands.

MALE.—Essentially as in the female. *Palpus:* very long, predominantly dark-scaled, a few pale scales on middle of segment 3; segments 4 and 5 with patch of white scales at base ventrally and dorsally; segment 5 with about apical 0.25–0.3 white-scaled. *Thorax:* scaling, including *apn* and *ppn*, generally lighter, broad scales more numerous. *Abdomen:* tergal pale scaling more extensive than in female; transverse basal bands broader; basolateral pale patches larger, particularly on VI, VII where they are dorsal.

MALE GENITALIA (fig. **120**).—As figured; diagnostic characters as in the key; in general similar to *bitaeniorhynchus*, markedly different from *albinervis* in the following characters. *Sidepiece:* lateral tergal bristles extending to base and to near mesal margin. *Subapical Lobe:* long hairs on tergal and mesal surfaces; setae *a* and *b* very heavy and apparently flattened, seta *c* apparently represented by a very slender attenuate hair; leaf (*g*) not developed, represented by a moderately long, slightly flattened seta, only one distant simple accessory seta (*h*); sternal setae (*d-f*) represented by a single slender hair. *Phallosome:* inner division without sternal apical angle, tergal apical angle produced into conspicuous short-spiculate spine directed outward; near base of inner division about 4 very short foliform spines, mesal surface sternad of these with long hairlike spicules; outer division in form of a long curved lateral spine. *Proctiger:* crown of paraproct with flattened spines laterally; basal sternal process not developed; cercal setae 4–6, spread over a wide area, more proximal quite long.

PUPA (fig. **120**).—*Abdomen:* 3.62 mm. *Trumpet:* 0.87 mm. *Paddle:* 0.95 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *albinervis* but lightly pigmented and differing as follows. *Cephalothorax:* hairs 1-9-C all very short. *Abdomen:* hairs 1-IV-VII all of the same order of magnitude; 1-III usually 6b. *Paddle:* a small dark cloud on apex of midrib.

LARVA (fig. **121**).—*Head:* 0.82 mm. *Siphon:* 1.81 mm. *Anal Saddle:* 0.49 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *albinervis,* from which it differs chiefly in the following. *Head:* pigmentation lighter; mental plate with distinct large lateral teeth distally, indistinct small teeth proximally; hair 5-C longer; 6-C usually double; 11,13-C shorter. *Antenna:* relatively shorter; spicules more numerous and conspicuous; hair 1-A usually more basal; 2,3-A farther from apex. *Thorax:* hair 3-P single; 4-P double, shorter; 9-P usually double. *Abdomen:* hair 6-I-IV with fewer branches; 7-II large; 3-I-V usually double or triple, shorter. *Segment VIII:* comb scales with longer apical spine; hair 2-VIII usually 2,3b. *Siphon:* index about 7.0; lightly to moderately pigmented, darkened distally; apex with rather long spicules dorsally; pecten usually composed of less than 8 teeth, denticles rather long; subventral tufts (1,1a-S) usually 5 pairs, often more conspicuous; hair 2-S more strongly developed, distinctly hooked apically, arising from strongly sclerotized tubercle. *Anal Segment:* ventral brush hairs with fewer branches.

MATERIAL EXAMINED.—383 specimens; 152 ♀; 117 ♂; 21 pupae; 93 larvae; 14 individual larval rearings.

SYSTEMATICS.—*C. starckeae* is a very interesting clearly marked species, which combines some features of the *bitaeniorhynchus* and *sitiens* subgroups and may have been formed through hybridization between ancient members of these 2 phylads. This species does not fit into either subgroup but, since the *bitaeniorhynchus* characters predominate, I am placing it provisionally in this subgroup. The mental plate and siphon of the larva appear to be quite similar to those of *cornutus* Edwards, 1922 and *sinensis* Theobald, 1903 from the Oriental region, but these species are markedly different in other characters.

Although there are some slight differences in the various stages, particularly in the male genitalia, between the various populations of *starckeae* in the South Pacific and in Australia, it appears that only 1 species is involved.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *starckeae* are found in mats of filamentous green algae in open sunlit ground pools and, in the New Hebrides, along the margins of streams and in stream bed pools. Females have not been collected attempting to bite men in the South Pacific. Nothing is known of the adult bionomics and disease relations of *starckeae*.

DISTRIBUTION (fig. 89).—*New Hebrides:* Espiritu Santo. *New Caledonia:* Houailou; LaFoa; APO 25; unspecified localities. Also known from *Australia* (Queensland; New South Wales).

Subgenus LUTZIA Theobald

1903. *Lutzia* Theobald, Monog. Culicidae 3:155. TYPE SPECIES: *Culex bigotii* Bellardi, 1861, Mexico; monobasic.

1906. *Jamesia* Christophers, India Med. Dept., Mem. (2)25:12. TYPE SPECIES: *Culex fuscanus* Wiedemann, 1820, East Indies; fixation by Edwards (1932:190). —Preoccupied by *Jamesia* Jeckel, 1861; the fixation of the type species must be validated by the International Commission on Zoological Nomenclature, since it involves a questionable synonymy of *fuscanus* with *concolor* Robineau-Desvoidy, 1827, 1 of the 2 included nominal species.

FEMALES.—Large species. *Head:* decumbent scales of vertex predominantly narrow except at sides, no broad scales on orbital line; eyes contiguous above antennae; frontal tuft distinct, incomplete; palpus 4-segmented in *halifaxii,* segments 1,2 distinct; antenna longer than proboscis, torus with numerous conspicuous broad scales. *Thorax:* acrostichals numerous but short; scutellum with narrow scales; pleuron with conspicuous patches of scales on *stp,* below *pra,* and on *mep;* scales also present on *apn, ppn,* and *ppl,* latter extending on *acx* but not *pst; psp* without scales; lower *mep* bristles usually at least 6. *Buccopharynygeal Armature:* strongly developed; not studied.

MALES.—*Palpus:* longer than proboscis; segments 4 and 5 upturned; segment 5 usually longer than 4; segments 3–5 with numerous long hairs ventrally on inner and outer surfaces.

MALE GENITALIA.—*Segment VIII:* apex of tergite rounded. *Segment IX:* tergite a narrow transverse strip with 2 groups of bristles. *Sidepiece:* without scales. *Subapical Lobe:* short, simple; setae simple or sometimes thickened; leaf not developed. *Clasper:* simple, tapered; spiniform short, flattened. *Phallosome:* simple, lateral plate not divided; with tergal and sternal transverse sclerotized bridges; a pair of strong mesal spines and shorter denticles on processes. *Proctiger:* basal sternal process usually small, slender, and curved; paraproct with dense crest of numerous rather slender and short spinules; cercal setae usually 5 or more.

PUPAE.—*Cephalothorax:* hairs short; hair 1-C far from caudal border of sclerite; 2,3-C very close together. *Trumpet:* relatively short. *Metanotum:* hair 10-C with few branches. *Abdomen:* hairs generally short; hair 5-II close to 4-II; 6-VII short, inconspicuous; 1-IX well developed. *Paddle:* broad, sometimes emarginate apically; hairs 1,2-P both present.

LARVAE.—Predaceous. *Head:* rather elongate; labral area strongly developed, produced; mouthbrushes thickened, curved, strongly pectinate apically, reduced in number to about 40, and inserted laterally; mandible with strong, heavily pigmented teeth; mental plate with strong teeth; ventral surface of head capsule very long; hairs 4-6-C far caudad of level of antennae; hairs 16,17-C not developed. *Antenna:* very short, simple; integument roughened but without distinct spicules. *Thorax:* hairs relatively short; hairs 1-3-P on small, well defined tubercle, somewhat removed from middorsal line; 2,3-P distinctly smaller than 1-P; large hairs with well-developed and strongly pigmented basal tubercles. *Abdomen:* hairs 7-I,II and sometimes 7-III strongly developed, similar to hair 6 and on same tubercle; hair 1-III-VII usually single. *Segment VIII:* comb a patch of several rows of small fringed scales; hairs 1,2,4,5-VIII all single or double. *Siphon:* varied in length; acus small or large; pecten varied; hairs 1,1a-S numerous, ventrad of pecten, in a single midventral row or in a pair of lateral rows; valves small to moderate; median caudal filament poorly developed. *Anal Segment:* saddle complete, produced dorsally, strongly diagonally emarginate for ventral brush; integument strongly spiculate; hair 1-X usually single; 2,3-X both single; ventral brush with 8,9 pairs of hairs; gills shorter than saddle.

SYSTEMATICS.—As indicated by Edwards (1932:191), the subgenus is composed of 2 quite distinct groups: group A (*Lutzia*), restricted to the New World, and group B (*Jamesia*), restricted to the Old World. In most respects, group A seems to be the more generalized. The species currently recognized within both groups are poorly defined and extremely variable, and Edwards (1932:191) suggested that there may be only 1 species in each group.

Lutzia is a very ancient derivative of the genus; its affinities appear to be strongest with the subgenus *Culex,* although some characters are suggestive of *Culiciomyia.* It is represented in the South Pacific by a single species, *halifaxii,* which is widespread in the Oriental, Indomalayan, and Australasian regions.

BIONOMICS AND DISEASE RELATIONS.—Species of *Lutzia* utilize a wide variety of habitats for breeding. They are predominantly ground pool-breeders but at times may utilize treeholes. Several species breed very commonly in artificial containers and tolerate or even appear to prefer water with a high organic content. The larvae of all species are predaceous, chiefly on mosquito larvae but also on other insects.

Females seldom attack man. Very little is known of the bionomics of the adults (Horsfall, 1955:550–551). None of the species seem to be involved in disease transmission, in spite of their abundance and sometimes rather close association with man.

DISTRIBUTION (fig. **122**).—In the New World, group A is represented from Mexico southward to Argentina. In the Old World, group B is found throughout the tropical belt from Africa to the Solomons and extends into the southern Palaearctic. In the South Pacific, *Lutzia* is represented only in the Solomons.

KEYS TO SPECIES

See keys to subgenera, pp. 180–182

1. Culex (Lutzia) halifaxii Theobald

Figs. **122-124**

1903. *Culex halifaxii* Theobald, Monog. Culicidae 3:231–233. *TYPE: holotype ♀, Dindings, Straits Settlements, Malaya, Dec. 4, 1900 (BMNH).

1908. *Culex multimaculosus* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):155–157. *TYPES: syntypes, 2♂, 7♀, Malaya (BMNH).—Synonymy of Edwards (1922*b*:470).

1910. *Culex ? aureopunctis* Ludlow, Canad. Ent. 42:195–196. *TYPE: holotype ♀, Cottabato, Mindanao, Philippines, Dec. (USNM).—Synonymy of Edwards (1922*b*.470).

C. (*L.*) *halifaxi*(*i*) of Edwards (1932:191); Taylor (1934:22); Lee (1944*a*:88); Knight, Bohart, and Bohart (1944:45, 47, 62); Iyengar (1955:31); Laird (1956); Stone, Knight, and Starcke (1959).

Lutzia halifaxi(*i*) of Edwards (1924:391); Paine and Edwards (1929:307).

FEMALE.—*Wing:* 5.33 mm. *Proboscis:* 3.25 mm. *Forefemur:* 2.75 mm. *Abdomen:* about 4.2 mm. *Head:* decumbent scales and frontal tuft pale beige to whitish; erect scales dark laterally, pale centrally; labium entirely dark-scaled; palpus predominantly dark-scaled, speckled with pale scales on segments 3 and 4; antenna distinctly longer than proboscis; torus with beige scales. *Thorax:* mesonotum predominantly with dark narrow scales, a variable number of pale beige or whitish scales along the anterior and lateral borders, in fossa, prescutellar space and usually a conspicuous spot behind fossa external to dorsocentral bristles and continued as line caudad; scutellum with narrow pale beige or whitish scales; *apn* with narrow pale beige scales, more numerous and broader ventrally; *ppn* with numerous narrow scales, predominantly pale but some darker in middle; *ppl* with numerous pale beige scales, quite broad on anterior face; scales of *stp, pra,* and *mep* broad and white or whitish, 2 patches on *stp* and *mep;* lower *mep* bristles usually 6 or more. *Legs:* forecoxa extensively speckled with dark beige or yellowish scales, midcoxa and hindcoxa with whitish scales; trochanters chiefly with pale scales; forefemur with pale yellowish or dark beige scales on apex and at base dorsally and with extensive speckling of similar scales on lower anterior and posterior surfaces; midfemur similar to forefemur except that anterior surface is usually extensively speckled with pale scales; hindfemur similar to midfemur but more extensively pale-speckled on anterior surface but without distinct continuous pale line to apex; all tibiae predominantly dark-scaled, with variable speckling or spotting of pale scales, particularly conspicuous along lower anterior face, apex with pale scales; tarsi dark-scaled, paler ventrally and sometimes at base of segments 1 posteriorly. *Wing:* dorsal scales all dark, small; dorsal plume scales sparse; remigial bristles conspicuous; alula with continuous marginal fringe of short hairlike scales; upper calypter with continuous dense fringe of long hairs. *Haltere:* stem light; knob dark-scaled. *Abdomen:* tergite I with small median posterior patch of dark-scales; tergites II-VII largely dark-scaled, without transverse pale bands, usually small basolateral pale spots on distal segments; sternites predominantly pale-scaled, usually with dark-scaled apical or subapical bands on IV-VII.

MALE.—*Labium:* with false joint in distal third. *Palpus:* exceeding proboscis from about middle of segment 4; largely dark-scaled; segment 3 with line of whitish scales on inner ventral surface; segments 4 and 5 with patch of whitish scales at base ventrally and extending on mesal surface dorsally. *Thorax:* scaling usually lighter than in female. *Legs:* scaling usually lighter than in female; claws of foreleg and midleg enlarged, unequal, both anterior and posterior of each pair with premedian or submedian tooth. *Abdomen:* with long lateral hairs; tergites VI,VII usually with conspicuous basolateral pale spots.

MALE GENITALIA (fig. **123**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe not definite, represented on each side by narrow transverse sclerotization with about 6-12 bristles. *Subapical Lobe:* with 3 heavy long spiniform setae (*a-c*), 1 slightly thickened seta (*g*), and 3 or 4 slender setae (*d-f*); base tergally and mesally with several slender undifferentiated setae. *Phallosome:* mesal spine long, strong, and with a variable denticulate lobe at base. *Proctiger:* tergal sclerotization well developed; a distinct dorsolateral basal sclerotization; basal sternal process slender; cercal setae usually 5,6.

PUPA (fig. **123**).—*Abdomen:* 4.8 mm. *Trumpet:* 0.9 mm. *Paddle:* 1.05 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* rather uniformly moderately pigmented a bright light yellowish brown; hairs moderately pigmented. *Trumpet:* short and broad; rather darkly pigmented, blackened on tracheoid; pinna about 0.5, apex truncate; tracheoid about 0.2. *Metanotum:* darkened. *Abdomen:* moderately to strongly uniformly pigmented; hairs strongly pigmented. *Paddle:* only slightly longer than wide; apex emarginate; margins with very small indistinct spicules; uniformly very lightly pigmented, midrib and external buttress darkened.

LARVA (fig. **124**).—*Head:* 1.15 mm. *Siphon:* 0.6 mm. *Anal Saddle:* 0.84 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately pigmented except for usual lighter and blackened areas; labral area strongly produced; mental plate long and narrow, with 4–6 large teeth on each side of median tooth; hair 1-C arising on distinct small protuberance from sclerotized portion of head capsule; hair 3-C close to 0-C; 5-C laterad of 6-C and caudad of 8-C; 5-7-C all long and single; 4-C short, branched. *Antenna:* uniformly lightly pigmented; hair 1-A small, single, very close to base. *Thorax* and *Abdomen:* integument without conspicuous spiculation; hairs and tubercles strongly pigmented. *Siphon:* very short, index about 1.5; uniformly moderately pigmented except for basal black ring and blackish large attached acus; spicules small, dense, uniformly distributed; pecten of 10–12 teeth absent from base and apex, more distal teeth larger, heavier and simple or with 1 denticle, the proximal smaller and usually with 1–3 denticles; hairs 1,1a-S in a more or less straight single midventral line and a single pair of small branched hairs dorsad of pecten subapically. *Anal Segment:* saddle very long and strongly produced dorsocaudad; uniformly moderately pigmented; spicules more conspicuous than on siphon; ventral brush usually with 8 pairs of hairs; gills very short.

MATERIAL EXAMINED.—863 specimens; 146 ♀; 126 ♂; 153 pupae; 458 larvae; 14 individual rearings (12 larval, 2 pupal).

SYSTEMATICS.—The assignment of the South Pacific form of *Lutzia* to *halifaxii* is provisional, as is also the recognition of the latter as a species distinct from *fuscanus* Wiedemann, 1820, *raptor* Edwards, 1922, and *vorax* Edwards, 1921. The taxonomic status of these forms cannot be settled without a comparative study of the whole complex throughout the entire reported range. The various forms are characterized by slight differences in the ornamentation of the abdomen and legs of the adults and supposedly constant differences in the phallosome of the male, but both characters are apparently quite variable. No differences have been found in the larvae.

The ornamentation of adults of South Pacific *halifaxii* is extremely variable in the amount of light scaling on the mesonotum and legs but is quite constant in showing no transverse apical pale bands on the abdominal tergites. In the latter character, the South Pacific populations are similar to those I have seen from New Guinea but are markedly different from some Australian populations, which also appear to differ in the ornamentation of the posterior pronotum. The phallosome of South Pacific males is extremely variable. The situation here appears to be quite similar to that in the *aurantius* complex of the subgenus *Mucidus* of *Aedes.* While it appears on superficial examination that only 1 plastic species is involved, it is quite possible that several distinct sibling allopatric forms may be present.

BIONOMICS AND DISEASE RELATIONS.—*C. halifaxii* utilizes a very wide range of habitats for breeding in the South Pacific. It is very commonly found in ground pools of various kinds, permanent or temporary, and occurs frequently in artificial containers of all types—wood, metal, rubber, and canvas. Several collections have been made in rock pools, stream margins, and treeholes. This species tolerates a considerable amount of organic matter in its breeding sites but has been reported from coconut shells or husks only once (Bick, 1951:415). The larvae are normally predaceous on other mosquitoes but will also prey on other insects and are strongly cannibalistic.

The females are rarely attracted to man. Only a few specimens were collected in routine night catches on Guadalcanal, although the immature stages were very common and widespread on this island. Nothing is known of the adult bionomics or disease relations of *halifaxii.* This species may play a minor beneficial role in reducing the populations of economically important species utilizing the same types of habitat.

DISTRIBUTION (fig. 122).—*Solomon Islands:* Bougainville; Gizo; Vella Lavella; Sasavele; New Georgia; Rendova; Russell; Guadalcanal; Malaita; Bellona. Also reported from the *Bismarcks, New Guinea, Australia* (Northern Territory, Queensland, New South Wales), *Indonesia, Philippines, Malaya, Thailand, China, Assam,* and *Ceylon.*

Subgenus ACALLYNTRUM Stone & Penn

1948. *Acallyntrum* Stone and Penn, Ent. Soc. Wash., Proc. 50:109–110. *TYPE SPECIES: *C.* (*A.*) *perkinsi* Stone & Penn, 1948, Guadalcanal, Solomon Islands; original designation.—As subgenus of *Culex*.

FEMALES.—Medium-sized to rather small species. *Head:* decumbent scales of vertex narrow except for considerable distance laterally; orbital line without broad scales in central portion; eyes contiguous above antennae; no frontal tuft; labium and palpus dark-scaled; palpus 4-segmented in South Pacific species, segments 1 and 2 ankylosed; torus and flagellar segment 1 without distinct scales. *Thorax:* acrostichals strongly developed, about as large as dorsocentrals; other mesonotal bristles strong; mesonotal scales narrow, sparse, giving a rough appearance; scutellar scales narrow; pleural scaling completely absent; in South Pacific species *ppn* with an upper line of bristles joining the posterior bristles; 1,2 strong lower *mep* bristles. *Legs:* hindfemur almost completely whitish, at most with a dark apical ring and a dark posterodorsal patch or line; tarsi dark-scaled. *Wing:* dorsal scales all dark; remigial bristles very short and inconspicuous; dorsal plume scales long and narrow on Rs and R_{2+3}; alula with sparse marginal fringe of short hairlike scales; upper calypter with complete fringe of long hairs. *Abdomen:* tergites with inconspicuous basolateral pale spots, more distinct on segments VI,VII. *Buccopharyngeal Armature:* not studied.

MALES.—*Labium:* with several long hairs on ventral surface. *Palpus:* longer than proboscis; in South Pacific species segment 3 with a ventral row of long specialized setae bent near base and continued as long filament directed distad; segments 4 and 5 narrow, upturned, with moderate number of long hairs on both faces ventrally; segments 4 and 5 subequal or segment 5 slightly longer than 4. *Antenna:* normal; usually a little shorter than proboscis.

MALE GENITALIA.—*Segment VIII:* Apex of tergite rounded. *Segment IX:* tergite lobe not differentiated, bristles numerous, sometimes continuous across tergite; a group of short setae or spicules between tergite and base of proctiger. *Sidepiece:* long; irregular in shape; without scales. *Subapical Lobe:* prominent; more or less divided, setae in 2 groups; 3 setae in group *a-c*, progressively stronger and longer; 4 setae in group *d-f*, simple or foliform; a tergal seta (*g* or *h*) present or absent, not distinctly foliform; usually a group of specialized tergal setae on sidepiece distad of lobe. *Clasper:* simple, irregular; without crest of spicules; with a single seta beyond middle dorsally and a smaller ventrally; spiniform short and broad. *Phallosome:* simple; with dorsal and ventral sclerotized bridges; lateral plate long, with several to numerous heavy short tergal denticles and sometimes lateral denticles. *Proctiger:* very broad; sometimes a very broad basal sternal process with distal spine or sternal margin with denticles; apex of paraproct with short fine spicules tergally, longer curved spicules laterally, and short heavy blunt spicules or denticles on process sternally; cercal setae not developed.

PUPAE (South Pacific species).—*Cephalothorax:* hair 1-C much larger than 2,3-C. *Trumpet:* moderately long and slender; apex not markedly flared; tracheoid at least to 0.35; pinna less than 0.35. *Abdomen:* hair 3-I usually single; 2-III-VII strongly mesad of 1-III-VII which is usually strongly displaced laterad; hair 1-IX sometimes present. *Paddle:* external margin simple, serrate or with hairlike spicules; both hairs absent or 1-P developed.

LARVAE (South Pacific species).—Conspicuously different from other subgenera in the reduction of the ventral brush of the anal segment to 1 pair of hairs. *Head:* labral area, mouthbrushes and mandible normal; hair 1-C moderate; 4-C branched; 5,6-C in cephalic half; hairs 16,17-C not developed. *Antenna:* moderately long; basal part not swollen; spicules distinct on basal part; hair 1-A large, near middle; 2,3-C near apex. *Thorax:* hairs 1-3-P far removed from midline; 3,4,7-P multiple, long; 8-P multiple, short. *Abdomen:* hair 6-I,II relatively short; 7-I-II both strong; 1-I-VII removed laterad, multiple or stellate. *Segment VIII:* comb scales in relatively small patch. *Siphon:* moderately long; acus strong and attached; 3 pairs of long branched subventral tufts (1,1a-S), usually distad of pecten; median caudal filament moderately developed. *Anal Segment:* saddle incomplete; marginal spicules distinct; hair 1-X large, single or branched; 2-X branched; 3-X single; ventral brush (4-X) with only 1 pair of short hairs, single or branched; gills long, constricted near middle (simple in *binigrolineatus*).

SYSTEMATICS.—The subgenus *Acallyntrum* includes 5 nominal species at present: *belkini* and *perkinsi* from the Solomons and *pallidiceps* Theobald, 1905, *bicki* Stone & Penn, 1947, and *binigrolineatus* Knight & Rozeboom, 1945 from New

Guinea. Stone (1957*a*:172) synonymized *perkinsi* with *pallidiceps*, but it seems unlikely that this is correct taxonomically, as indicated below under *perkinsi*.

The affinities of *Acallyntrum* are not clear, but on most characters this subgenus appears to be closest to *Culiciomyia*. It differs markedly from the latter in the adult stage in lacking broad scales on the central part of the orbital line of the vertex, in possessing strongly developed acrostichal bristles, and in many details of the male genitalia. The male palpus is quite similar to that of *Culiciomyia;* in the South Pacific species, the bristles on the lower surface of segment 3 are peculiarly modified. The larva is also strongly suggestive of *Culiciomyia*, particularly of the *fragilis* type. On the whole, it seems that *Acallyntrum* may be an ancient offshoot from the *Culiciomyia* stem which has been specialized for breeding in the leaf axils of plants.

There are 2 distinct groups in *Acallyntrum:* (1) the *perkinsi* group, which also includes *belkini* and probably *pallidiceps*, and (2) the *bicki* group, which also includes *binigrolineatus*. Only the *perkinsi* group is represented in the South Pacific. This group is distinguished as follows: mesonotal scaling uniformly brown; proctiger with large, toothed basal sternal process, sternal margin distad of process not serrate; pupal paddle with fine spicules on outer margin and hair 1-P present; larval head hairs 5,6-C multiple, abdomen with dorsal stellate tufts (hair 1), gills constricted near middle.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of species of *Acallyntrum* have been found only in the leaf axils of plants such as pandanus, taro, and sago palm. It is probable that the eggs of *Acallyntrum* species are laid singly, since egg rafts have never been found in leaf axils of plants on Guadalcanal where *perkinsi* is frequently quite common. Nothing is known of the bionomics and disease relations of the adults of species of *Acallyntrum*, but apparently females do not attack man.

DISTRIBUTION (fig. **125**).—At present *Acallyntrum* is known only from New Guinea and the Solomon Islands.

KEYS TO SPECIES

(Keys to subgenera, pp. 180–182)

ADULTS

1. Males 2
   Females 3
2(1). Specialized setae of palpus usually less than 10, restricted to apical 0.3 of segment 3 . . . . 1. *belkini*
   Specialized setae of palpus usually more than 15, occupying about 0.5 or more of segment 3 . . . . 2. *perkinsi*
3(1). Palpus about 0.2 of proboscis, segment 4 less than 2.0 of segment 3; base of forefemur and midfemur dark on anterior surface . . . . 1. *belkini*
   Palpus about 0.25 of proboscis, segment 4 about 3.0 of segment 3; base of forefemur and midfemur light on anterior surface . . . . 2. *perkinsi*

MALE GENITALIA

1. Lateral plate of phallosome smoothly curved externally in tergal aspect, without submedian external tooth; seta *b* of subapical lobe strongly sinuate and with widened recurved apex, a strong differentiated seta (*g*) present dorsally . . . . 1. *belkini*
   Lateral plate of phallosome with conspicuous submedian external tooth in tergal aspect; seta *b* of subapical lobe rather evenly curved and with simple recurved apex, no strong differentiated seta dorsally . . . . 2. *perkinsi*

PUPAE

1. Hair 10-C usually triple or double; paddle narrow, length over 2.0 maximum width; pigmentation light . . . . 1. *belkini*
   Hair 10-C multiple, usually over 5b; paddle broader, length less than 2.0 maximum width; pigmentation moderate to strong . . . . 2. *perkinsi*

LARVAE

1. Pecten teeth in form of broad fringed scales; hair 2-X at least 5b . . . . 1. *belkini*
   Pecten teeth with a large apical spine; hair 2-X at most 4b . . . . 2. *perkinsi*

1. Culex (Acallyntrum) belkini Stone & Penn

Figs. **125-127**

1948. *Culex* (*Acallyntrum*) *belkini* Stone and Penn, Ent. Soc. Wash., Proc. 50:114–116. *TYPE: holotype ♂ with associated larval and pupal skins (JNB, 461-15), from leaf axil of pandanus, West Cape, Guadalcanal, Solomon Islands, June 28, 1944, J. N. Belkin (USNM, 58629).

C. (*A.*) *belkini* of Iyengar (1955:32); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.03 mm. *Proboscis:* 1.25 mm. *Forefemur:* 1.33 mm. *Abdomen:* about 2.16 mm. Very similar to *perkinsi* but usually smaller, darker, and differing chiefly in the following additional characters. *Head:* broad decumbent scales darker, more numerous and extending about 0.67 to center; erect scales longer and more slender; palpus about 0.2 of proboscis, segment 4 less than 2.0 of segment 3. *Thorax:* mesonotal integument darker, scales appearing lighter; mesonotal bristles proportionally longer; pleural integument dark. *Legs:* forefemur and midfemur without pale scales at base of anterior surface; hindfemur sometimes with some dark scales in a streak on apical 0.33 of posterior surface. *Abdomen:* basolateral pale markings even less conspicuous.

MALE.—Differing from *perkinsi* in the same characters as the female and in the following. *Labium:* apparently without conspicuous elongated ventral hairs. *Palpus:* a little shorter; segment 3 with specialized setae usually less than 10 and restricted to distal 0.3.

MALE GENITALIA (fig. **126**).—As figured; diagnostic characters as in the key; in general similar to *perkinsi* and differing chiefly in the following. *Segment IX:* patch of setae or spicules near base of proctiger less extensive. *Sidepiece:* bristles in distal patch heavier, not continued as line basad; basal tergal area with separate patch of longer thinner bristles. *Subapical Lobe:* seta *a* shorter and thinner; seta *b* and usually *c* strongly sinuate, apex widened; seta *c* distant from *b* at base; a strong specialized tergal seta (*g* or *h*) near base of lobe. *Clasper:* distal portion expanded before apex. *Phallosome:* lateral plate without distinct apical digitiform process; tergal denticles smaller, extending from apex and arranged in 2 rows proximally; submedian area without external tooth. *Proctiger:* basal sternal process longer, narrower, and with 2 or more sternal denticles.

PUPA (fig. **126**).—*Abdomen:* 2.25 mm. *Trumpet:* 0.5 mm. *Paddle:* 0.7 mm. Chaetotaxy as figured, diagnostic characters as in the key; very similar to *perkinsi,* differing chiefly in much lighter coloration, lighter and weaker hairs, and the following. *Metanotum:* hair 10-C usually long and double or triple; 11-C not as strongly thickened; 12-C usually double or triple. *Paddle:* narrower, length usually at least 2.0 maximum width.

LARVA (fig. **127**).—*Head:* 0.68 mm. *Siphon:* 0.78 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured, diagnostic characters as in the key; in general very similar to *perkinsi,* from which it differs chiefly in generally lighter coloration and in the following. *Head:* mental plate smaller, less strongly pigmented, usually with 8 teeth on each side of median tooth, usually only 2 proximal teeth widely separated. *Abdomen:* stellate tufts (hair 1) usually smaller. *Segment VIII:* comb usually in 3 or more rows, with at least 25 longer scales with more slender apical spine. *Siphon:* longer, index about 4.0–5.0; much lighter in pigmentation; pecten of 3–7 short broad scales which are evenly fringed. *Anal Segment:* dorsal marginal spicules weaker, majority broad and apically fringed; hair 2-X usually at least 5b; 4-X usually 3b or less.

MATERIAL EXAMINED.—42 specimens; 11♀; 9♂; 6 pupae; 16 larvae; 3 individual larval rearings.

SYSTEMATICS.—Females of *belkini* are superficially very similar to those of *perkinsi* but the males, larvae, and pupae of the 2 species are easily differentiated. Not enough material is available to determine the variation in *belkini,* but it appears that this species (like *perkinsi*) is quite variable, particularly in the presence of a dark line apically on the posterior surface of the hindfemur.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *belkini* have been collected only in the leaf axils of pandanus. I have never taken this species together with *perkinsi* on Guadalcanal, where *belkini* has been found only on the south coast. Nothing is known of the adult bionomics as all adult specimens have been reared.

DISTRIBUTION (fig. **125**).—*Solomon Islands:* Treasury (Sterling); Rendova; Sasavele; New Georgia; Guadalcanal. Not known elsewhere.

2. Culex (Acallyntrum) perkinsi Stone & Penn

Figs. **125, 128, 129**

1948. *Culex* (*Acallyntrum*) *perkinsi* Stone and Penn, Ent. Soc. Wash., Proc. 50:110–114. *TYPE: holotype ♂, with associated larval and pupal skins (JNB, 670-19), from leaf axil of pandanus, Umasani River Valley, Guadalcanal, Solomon Islands, Oct. 4, 1944, J. N. Belkin (USNM, 58628).

C. (*A.*) *perkinsi* of Iyengar (1955:32); Laird (1956).
C. (*A.*) *pallidiceps* of Stone (1957*a*:172); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.5 mm. *Proboscis:* 1.67 mm. *Forefemur:* 1.71 mm. *Abdomen:* about 2.41 mm. *Head:* narrow decumbent scales largely pale; broad decumbent scales largely whitish, extending in a patch cephalomesad almost halfway from most external erect scales to midline; erect scales rather short, strongly broadened apically, largely brown to light brown; palpus about 0.25 of proboscis, segment 4 (apical) about 3.0 or more of segment 3. *Thorax:* mesonotal scales very narrow, sparse, bronzy throughout; scutellar scales bronzy; *ppn* with about 5 short bristles along upper margin cephalad of stronger posterior bristles; pleural integument sometimes greenish. *Legs:* forecoxa with predominantly dusky scales, some pale at base; midcoxa and hindcoxa with small patches of pale scales; trochanters with pale scales; forefemur and midfemur pale-scaled at base and on lower and posterior surfaces, largely dark-scaled on anterior; hindfemur completely white-scaled except for variable but small apical dark ring; tibiae predominantly dark-scaled, with variable amount of pale scaling on lower and posterior surfaces; tarsi dark-scaled except for variable amount of pale scaling on lower surface of segments 1, particularly on hindleg. *Haltere:* stem light, knob with light brown scales. *Abdomen:* tergite I with very small median caudal patch of dark scales; tergites II-VII largely dark-scaled, with inconspicuous basal lateral pale spots which are larger and usually extend dorsad on VI,VII, and sometimes V; sternites largely pale-scaled; pale scaling beige or sometimes whitish.

MALE.—*Labium:* with long ventral hairs near middle and beyond. *Palpus:* usually exceeding proboscis by full length of segment 5; segment 3 ventrally on outer surface with a line of at least 15 specialized thin bristles occupying usually more than half the length of segment, each bristle bent near base, its distal part very long, directed anteriorly, in pinned specimens the distal ends of all bristles appear as a continuous line nearly parallel with shaft of palpus; segments 4 and 5 with a few moderately long bristles ventrally on both sides.

MALE GENITALIA (fig. 128).—As figured, diagnostic characters as in the key. *Segment IX:* tergite large, lobe indistinct, bristles in 2 lateral groups of about 2 rows; ventrad of external portion of tergite, near base of proctiger a large group of short setae or spicules on each side. *Sidepiece:* rather long and narrow; tergal surface with a patch of short bristles from level of lobe distad, continued as a single row basad. *Subapical Lobe:* very prominent; setae *a-c* in a very compact group; seta *a* slender, about 0.75 of *c; b* and *c* smoothly curved, apex not markedly widened, recurved; setae *d-f* 4 in number, in compact group, all distinctly foliform, sometimes striated, variable in development; no specialized tergal seta (*g* or *h*) on lobe. *Clasper:* basal portion widened, distal very narrow. *Phallosome:* lateral plate with strong apical digitiform process and an outwardly curving line of denticles, submedian part with conspicuous lateral tooth; number of teeth variable but apical process distinct. *Proctiger:* basal sternal process broad and short, with a long spine on distal sternal angle.

PUPA (fig. 128).—*Abdomen:* 2.5 mm. *Trumpet:* 0.55 mm. *Paddle:* 0.67 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* lower surface light, dorsal moderately pigmented; hairs moderately pigmented; hair 1-C very long, usually triple. *Trumpet:* moderately pigmented, tracheoid darker; pinna about 0.33, tracheoid 0.4. *Metanotum:* darkly pigmented except for large sublateral pale areas; hair 10-C short, thin, multiple, usually at least 5b; 11-C thickened, single; 12-C usually at least 4b. *Abdomen:* tergites I-III strongly pigmented, IV intermediate, remainder moderately to lightly; hairs moderately to rather strongly pigmented; hair 3-I single; 1-II strongly dendritic; 1-III-VII slender, weak, strongly displaced laterad; 2-III-VII strongly mesad of hair 1; 3-II,III single, long; 5-IV-VI heavy, usually double and reaching middle of second tergite following; 5-VII weak; 6-III-VI weak; 1-IX present. *Paddle:* lightly pigmented, midrib and external buttress brighter, apex slightly darkened; external margin with distinct, rather long, slender spicules distally; hair 1-P slender, long; 2-P possibly occasionally present as a very thin short hair.

LARVA (fig. 129).—*Head:* 0.74 mm. *Siphon:* 0.79 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately pigmented except for usual lighter and darkened areas; hairs moderately to lightly pigmented; mental plate heavily pigmented, with about 9,10 teeth on each side of median tooth, distal teeth small and uniform, proximal 3,4 larger and more widely spaced; hair 1-C moderately thick, long, light brown; 5,6-C multiple, with thin branches, 5-C usually at least 10b, 6-C usually 6b; 11-13-C all long and multiple. *Antenna:* moderately long; basal part rarely swollen; uniformly moderately pigmented, darkened on basal ring; spicules short, sharp, usually restricted to basal part; branches of hair 1-A not reaching apex of shaft. *Thorax:* hairs and tubercles moderately to strongly pigmented; large hairs very long. *Abdomen:* hairs and tubercles moderately to strongly pigmented; hairs 1-I-VII strong stellate tufts. *Segment VIII:* comb usually in a double row, with less than 20 small fringed scales with a short broad apical spine. *Siphon:* index about 3.0–4.0; moderately to rather strongly pigmented, darkened on basal ring and acus; pecten usually of 3,4 teeth, usually with small basal denticles; subventral tufts long, usually 5,6b; hair 2-S short, spiniform; trachea well developed. *Anal Segment:* saddle incomplete, occupying a little more than half the segment width, moderately to rather strongly pigmented, dorsal part of caudal margin with strong, short, sharp spinelike spicules, lower with thin hairlike spicules which also extend some distance on body of saddle; hair 1-X strong, usually double; 2-X usually 2-4b; 4-X usually at least 4b; gills very long, conspicuously constricted before middle, apex usually rounded.

MATERIAL EXAMINED.—277 specimens; 61 ♀; 56 ♂; 34 pupae; 124 larvae; 19 individual larval rearings.

SYSTEMATICS.—*C. perkinsi* as here interpreted appears to be a variable species, but it is possible that more than one species is involved. There is considerable variation in the larva and pupa as well as in the male genitalia. Unfortunately these variations cannot be correlated, as no individual rearings are available except from Guadalcanal.

Stone (1957*a*:172) has synonymized *perkinsi* with *pallidiceps* Theobald, 1905 from New Guinea after comparison of the male genitalia of the holotypes of the 2 forms. I have not seen the holotype of *pallidiceps* but strongly suspect that this is a different form in spite of the similarity in the genitalia. This group as a whole is prone to local speciation, as is true with all other leaf axil forms, and it seems very unlikely that the same form occurs in New Guinea and in the Solomons. There is a possibility that 2 or more forms are here confused under *perkinsi.* I have seen 1 male from Bougainville which appears to be quite distinct from the others in that the specialized setae of the male palpus are intermediate in number between *perkinsi* and *belkini* and the subapical lobe seems to be different from both. It seems probable that there may be a whole complex of species currently confused; therefore the synonymy should not be accepted until the various forms are studied in greater detail.

BIONOMICS AND DISEASE RELATIONS.—*A. perkinsi* occurs very commonly in the leaf axils of various Pandanaceae. A single collection (ABG, 35) is reported from a treehole, but this may be due to an error in labeling. Nothing is known of the adult bionomics of *perkinsi,* and it has never been taken biting man.

DISTRIBUTION (fig. **125**).—*Solomon Islands:* Bougainville; Arundel; Guadalcanal. Not known elsewhere.

Subgenus CULICIOMYIA Theobald

1905. *Trichorhynchus* Theobald, Bombay Nat. Hist. Soc., J. 16:241. *TYPE SPECIES: *T. fuscus* Theobald, 1905, Ceylon; monobasic.—Preoccupied by *Trichorhynchus* Balbiani, 1887.

1907. *Culiciomyia* Theobald, Monog. Culicidae 4:227. *TYPE SPECIES: *C. inornata* Theobald, 1907, Sarawak; the first of 6 included species, selection of Edwards (1912:33).

1912. *Trichorhynchomyia* Brunetti, Indian Mus., Rec. 4:477. *TYPE SPECIES: automatically *Trichorhynchus fuscus* Theobald, 1905.—Substitute name for *Trichorhynchus* Theobald, 1905, not *Trichorhynchus* Balbiani, 1887.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Small, medium-sized to large species. *Head:* decumbent scales of vertex broad at least on orbital line and at sides, narrow in center, in South Pacific species broad scales of orbital line in at least 2 rows; eyes contiguous above antennae; frontal tuft not developed; labium and palpus dark-scaled; palpus 4-segmented in South Pacific species; antenna longer than proboscis; torus without conspicuous scales. *Thorax:* acrostichals reduced, absent in South Pacific forms except a few near anterior promontory and occasionally in front of prescutellar space; mesonotal scaling narrow, short, and dense producing a smooth appearance; scutellar scales narrow; pleural scaling reduced, *ppn* with narrow scales, in South Pacific species no distinct flat scales on *ppl*, *stp*, *pra*, or *mep* but occasionally 1-3 erect hairlike scales, *apn* with or without scales; usually 1 or 2 strong lower *mep* bristles. *Legs:* tarsi dark-scaled. *Wing:* dorsal scales usually all dark, sometimes some paler scales on remigium; dorsal plume scales short and rather broad; remigial bristles distinct, often short; alula with nearly complete to very short fringe of narrow marginal scales; upper calypter with complete fringe of long hairs. *Abdomen:* tergites with or without basal transverse pale bands.

MALES.—*Labium:* with several long ventral hairs near middle. *Palpus:* longer than proboscis; ventral surface of segment 3 with a single row of long outstanding hairlike scales distinctly flattened and widened near middle; segments 4 and 5 narrow, upturned, with moderate number of long hairs on both faces ventrally; segment 5 usually longer than 4. *Antenna:* normal, usually a little shorter than proboscis.

MALE GENITALIA.—*Segment VIII:* apex of tergite rounded. *Segment IX:* tergite lobe poorly indicated. *Sidepiece:* without scales; sometimes with apical sternal spiculose lobe developed from subapical lobe. *Subapical Lobe:* strongly developed; setae *a-c* strongly developed, spiniform, *a* usually removed sternad from *b* and *c*; leaf (*g*) usually more or less foliform; seta *h* usually developed; setae *d-f* varied; sometimes numerous additional specialized tergal setae. *Clasper:* irregular in shape, distal portion recurved; usually with distinct outer crest of strong spicules; setae varied. *Phallosome:* simple; lateral plate with strong apical spine; tergal and sternal transverse sclerotized bridges distinct. *Proctiger:* basal sternal process usually long, slender, and curved; paraproct with large cluster of numerous fine spicules dorsomesad and heavy curved spinelike spicules in a single row lateroventrad; cercal setae varied, short.

PUPAE (South Pacific species).—Very similar to those of subgenus *Culex*, from which they are difficult to differentiate. *Cephalothorax:* hairs well developed; hair 1-C of same order of magnitude as 2,3-C; 2,3-C widely separated. *Trumpet:* moderately long, slender; pinna short; tracheoid 0.3 or more. *Abdomen:* hairs moderately to strongly developed; hair 5-II cephalad or caudad of 4-II; 1-II usually dendritic, with at least 15 branches; 6-VII well developed, conspicuous; 5-IV-VI usually single to triple; 1-IX present or apparently absent. *Paddle:* normal; marginal spicules inconspicuous or absent; hairs 1,2-P both present.

LARVAE (South Pacific species).—*Head:* moderate to small; labral area, mouthbrushes and mandible normal; mental plate with numerous well-differentiated teeth; hair 1-C slender; 2-C usually present; 4-7-C in cephalic half; 12-C mesad of 13-C; 15-C usually at least 4b and in cephalic half; hairs 16,17-C not developed. *Antenna:* at least 0.5 of head length; relatively simple; spicules more or less distinct; hair 1-A near middle or beyond; 2,3-A not far removed from apex. *Thorax:* hair 3-P about 0.5 of 2-P, single or branched; 12-P very strongly developed. *Abdomen:* hair 7-II only slightly larger than 7-III; hair 1 strongly developed at least on IV and V. *Segment VIII:* comb scales numerous, fringed; hair 5-VIII branched. *Siphon:* index and pecten varied; acus well developed; subventral tufts (1,1a-S) usually 3 or 4 pairs in line and distad of pecten; hair 2-S small;

valves small; median caudal filament moderately developed. *Anal Segment:* saddle complete, not distinctly emarginate for ventral brush; marginal spicules small but distinct; hair 1-X large, single or double; 2,3-X usually both single; ventral brush (4-X) with 4 pairs of hairs; gills always longer than saddle.

SYSTEMATICS (fig. **130**).—Edwards (1932:199) recognized 2 groups in *Culiciomyia:* group A (*fragilis* or *Culiciomyia*) occurring in the Oriental, Indomalayan, and Australasian regions and group B (*nebulosus* or *Pectinopalpus*) restricted to the Ethiopian region. In most respects group A appears to be the more specialized. In group B the acrostichals are usually developed, the pleuron is scaled in the adults, and the larva has a better developed ventral brush.

The affinities of *Culiciomyia* are not clear, but there appear to be similarities with *Culex, Lutzia, Lophoceraomyia,* and *Acallyntrum.* Females of *Culiciomyia* are very difficult to separate from those of *Lophoceraomyia.*

Culiciomyia is represented in the South Pacific by 3 (possibly more) variable forms. They are assigned provisionally to 3 widespread species, but it is possible that they are actually distinct forms peculiar to the area. It appears that at least *fragilis* and *pullus* are dominant species which are actively extending their ranges at the present.

BIONOMICS AND DISEASE RELATIONS.—The breeding sites of *Culiciomyia* range from ground pools to crabholes and leaf axils of plants. Several species have a wide range of habitats and have been found breeding in ground pools, treeholes, and artificial containers. They appear to tolerate water with a high organic content.

Although several species may be extremely abundant near human settlements, none have been reported to attack man. In the Solomons a number of specimens have been collected in night catches, but none have been found biting.

DISTRIBUTION (fig. **130**).—*Culiciomyia* is known only from the Old World, where most of the species occur in the tropical belt, although a few extend as far north as Japan and the Ryukyus. In the South Pacific the subgenus is represented by 3 species in the Solomons.

KEYS TO SPECIES

(Keys to subgenera, pp. 180–182)

ADULTS

1. Abdominal tergites with basal transverse pale-scaled bands . . . . 3. *pullus*
Abdominal tergites without basal pale bands 2

2(1). Dorsocentrals weak, of the same order of magnitude as bristles above paratergite; *female:* palpal segment 4 over 3 times as long as segment 3; *male:* use key to genitalia . . . . 1. *papuensis*
Dorsocentrals very strong, much larger than bristles above paratergite; *female:* palpal segment 4 about twice as long as segment 3; *male:* use key to genitalia . . . . . 2. *fragilis*

MALE GENITALIA

1. Lateral plate of phallosome with a single large denticle on inner tergal surface . . . . 3. *pullus*
Lateral plate of phallosome with a series of small denticles on inner tergal surface . . 2

2(1). Sidepiece with distinct long constricted portion distad of subapical lobe, no sternal apical area with very long hairlike spicules . . . . 2. *fragilis*
Sidepiece with very short constricted portion distad of subapical lobe, a prominent sternal apical lobe bearing very long hairlike spicules . . . . 1. *papuensis*

PUPAE

(See CULEX, p. 187)

1. Hair 1-V strong, about as long as 5-V,VI, and usually at least 4b . . . . 3. *pullus*
Hair 1-V weak, smaller than 5-V,VI, and usually double or triple 2

2(1). Hair 5-II cephalad of 4-II; 1-III usually 2,3b . . . . 2. *fragilis*
Hair 5-II caudad of 4-II; 1-III usually at least 6b . . . . 1. *papuensis*

LARVAE

1. Siphon with unsclerotized irregular ring in distal half . . . . 3. *pullus*
Siphon normal, without unsclerotized ring in distal half 2

2(1).	Siphon normal, not markedly swollen; head hairs 5,6-C usually at least 5b; 1-3-P all single; 1-IV,V double or triple .... 2. *fragilis*	Siphon strongly swollen in basal half; head hairs 5,6-C usually at most 4b; 1,3-P branched; 1-IV,V single .... 1. *papuensis*

1. Culex (Culiciomyia) papuensis (Taylor)

Figs. **130–133**

1914. *Melanoconion papuensis* Taylor, Roy. Ent. Soc. London, Trans. 1914 (62):201–202. TYPE: holotype ♀, Lakekamu Gold Field, Papua, Giblin (SYDN).

Culex (*Culiciomyia*) *papuensis* of Edwards (1924:397, in part); Knight, Bohart, and Bohart (1944:45, 62, in part); King and Hoogstraal (1946*c*:146–148); Iyengar (1955:32); Laird (1956); Stone, Knight, and Starcke (1959).

Culex (*Culiciomyia*) *pallidothorax* of Lee (1944*a*:95).

Culex (*Culiciomyia*) *fragilis* in part of wartime collections in New Guinea.

FEMALE.—*Wing:* 4.41 mm. *Proboscis:* 2.58 mm. *Forefemur:* 2.16 mm. *Abdomen:* about 3.0 mm. Large dark species without distinct abdominal pale markings. *Head:* narrow decumbent scales and erect scales brown, broad scales paler, becoming dingy white laterally; palpus about 0.2 proboscis, segment 4 very long, over 3.0 length of segment 3. *Thorax:* mesonotal scales uniformly brown; scutellar scales usually a little paler; dorsocentral bristles short; pleural integument light to greenish brown, sometimes with indistinct darkened areas, particularly on *psp* and lower *pra*, but without distinct longitudinal dark stripe; lower *mep* bristles often 2, one weaker. *Legs:* forecoxa with dark scales; midcoxa and hindcoxa with a few pale scales; femora dark except for usual pale ventral or posterior areas on foreleg and midleg and a complete or nearly complete whitish line on lower anterior surface of hindleg; tibiae dark, paler ventrally. *Wing:* dorsal scales all dark; dorsal plume scales short and rather broad; remigial bristles short. *Haltere:* stem light, knob dark-scaled. *Abdomen:* tergite I with very small patch of dark scales; tergites II-VII dark-scaled, without any indication of transverse pale bands and without distinct basolateral pale spots, but with indistinctly paler lateral areas on distal segments; sternites II-VII largely pale-scaled.

MALE.—*Labium:* with some very long hairs before the middle. *Palpus:* exceeding proboscis usually by at least full length of segment 5. *Antenna:* about as long as proboscis.

MALE GENITALIA (fig. 132).—As figured; diagnostic characters as in the key. *Segment VIII:* tergite lobe with about 8–10 bristles. *Sidepiece:* no distinct constricted portion distad of subapical lobe. *Subapical Lobe:* very large; a conspicuous sternal apical division with very long hairlike spicules; seta *a* strong, *b* very strong and flattened, *c* more slender; leaf (*g*) short, not distinctly foliform, accessory seta (*h*) not distinctly differentiated from the group of 12 or more thickened setae on distal tergal basal portion of lobe; sternal group (*d-f*) with 1 long, heavy, somewhat flattened seta and 2 shorter, slender setae. *Clasper:* crest usually with 6 or less sharp spicules. *Phallosome:* lateral plate mesally with several short blunt denticles sometimes in 2 rows and a larger more basal sharper denticle, externally with strong subbasal process. *Proctiger:* basal sternal process slender; apex of paraproct with short rounded sternal lobe; cercal setae about 5,6.

PUPA (fig. 132).—*Abdomen:* 3.38 mm. *Trumpet:* 0.76 mm. *Paddle:* 0.87 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately and rather uniformly pigmented, mesonotum darker; hairs moderately pigmented. *Trumpet:* moderately pigmented, tracheoid darker; pinna and tracheoid each about 0.33. *Metanotum:* darkened. *Abdomen:* proximal segments moderately to rather strongly pigmented, distal lighter; hairs moderately pigmented; hair 3-I usually single; 5-II caudad of 4-II or at same level; 1-V, weak, usually double or single, 1-VI short, usually 5,6b; 5-IV-VI strong, usually exceeding following tergite and double or single; 6-III-V weak; 1-IX apparently not developed, occasionally a weak one present on one side. *Paddle:* lightly pigmented, darker on midrib and external buttress.

LARVA (fig. 133).—*Head:* 0.98 mm. *Siphon:* 1.75 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately to lightly pigmented except for usual lighter and darkened areas; mental plate with 15 or more teeth on each side of median tooth, distal teeth small, uniform, proximal 5 or more markedly larger and widely spaced; hair 1-C moderately heavy; 5,6-C long, usually triple. *Antenna:* long, basal portion distinctly wider and sometimes somewhat swollen; uniformly lightly pigmented; spicules very fine and sparse; hair 1-A near middle; 2,3-A very near apex. *Thorax:* hairs 1,3-P usually triple or double; 7,8-P usually triple; 8,9-M,7,9-T relatively short. *Abdomen:* 6-I-VI,7-I relatively short; 1-IV,V very long and single. *Siphon:* index about 3.5–4.0; strongly swollen in basal half, apex narrowest; uniformly lightly pigmented except for black basal ring and acus; pecten usually reduced to 3,4 teeth on each side; usually 4 pairs of subventral tufts (1,1a-S), sometimes 5 on one side. *Anal Segment:* saddle moderately to lightly pigmented; spicules small, distinct on caudal margin; hair 1-X usually double or triple; gills pointed.

MATERIAL EXAMINED.—154 specimens; 47 ♀; 40 ♂; 14 pupae; 53 larvae; 6 individual larval rearings.

SYSTEMATICS.—This species had been confused with *fragilis* until King and Hoogstraal (1946*c*:146) examined the female type. *C. papuensis* is very similar to *pallidothorax* Theobald, 1905, which appears to be widely distributed in the Oriental and Indomalayan regions and which has several localized close relatives. All of these differ from *papuensis* in having distinct transverse pale tergal abdominal bands. *C. papuensis* from the South Pacific shows considerable variation in the subapical lobe of the male genitalia and in the larva. The pupa is quite different from other *Culiciomyia* from the South Pacific and completely different from that of "*papuensis*" of Penn (1949*a*:73–74). The male genitalia of the South Pacific form do not agree with the figures of King and Hoogstraal (1946*c*:152); it is possible that 2 distinct species are involved.

BIONOMICS AND DISEASE RELATIONS.—*C. papuensis* is apparently uncommon in the Solomons. The immature stages have been collected in large treeholes, artificial containers, and ground pools. Females have not been taken biting, and nothing is known of their bionomics and disease relations.

DISTRIBUTION (figs. **130**, **131**).—*Solomon Islands:* Bougainville; Ondanga; Guadalcanal. Also reported from *New Guinea* and ? *New Britain.*

2. Culex (Culiciomyia) fragilis Ludlow

Figs. **130**, **131**, **134**, **135**

1903. *Culex fragilis* Ludlow, N. Y. Ent. Soc., J. 11:142–143. *TYPE: lectotype ♂, genitalia on slide, Oras, Samar, Philippines, Aug. 6, 1902; selection of Stone and Knight, 1957*a*:50 (USNM).

1905. *Trichorhynchus fuscus* Theobald, Bombay Nat. Hist. Soc., J. 16:242–243. *TYPE: holotype ♀, Peradeniya, Ceylon, Dec., 1901 (BMNH).—Synonymy of Edwards (1922*b*:472).

1907. *Culiciomyia inornata* Theobald, Monog. Culicidae 4:227–230. *TYPES: syntypes, ♂ and ♀, Kuching, Sarawak, Nov., A. J. S. Barker (BMNH).—Synonymy of Edwards (1922*b*:472).

1907. *Culiciomyia ceylonica* Theobald, Monog. Culicidae 4:236–238. *TYPES: syntypes, ♂ and ♀, Peradeniya and Maskeliya, Ceylon, Feb. and Apr., E. E. Green (BMNH).—Synonymy of Edwards (1922*b*:472).

1908. *Culex graminis* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):158–159. TYPES: syntypes, ♂ and ♀, Malaya (lost).—Synonymy of Edwards (1932:199, questionable); Stone, Knight, and Starcke (1959).

C. (*Culiciomyia*) *fragilis* of King and Hoogstraal (1946*c*:148–149); Iyengar (1955:32); Laird (1956); Stone, Knight, and Starcke (1959).

C. (*Culiciomyia*) *papuensis* of Edwards (1924:397; 1932:199, in part); Paine and Edwards (1929:308); Taylor (1934:23); Lee (1944*a*:96); Knight, Bohart, and Bohart (1944:45, 62).

FEMALE.—*Wing:* 3.25 mm. *Proboscis:* 1.83 mm. *Forefemur:* 1.66 mm. *Abdomen:* about 2.16 mm. In general similar to *papuensis* but smaller in size, lighter in coloration, and differing most conspicuously in the following. *Head:* scales all lighter; broad scales of orbital line not markedly lighter than others; palpus about 0.15 of proboscis length, segment 4 about 2.0 of segment 3. *Thorax:* mesonotal integument lighter; all bristles longer except above paratergite, dorsocentrals very long; pleural integument lighter; *apn* usually with a few broad scales; 1 strong lower *mep* bristle. *Legs:* hindfemur with less extensive and less conspicuous pale line, not reaching apex.

MALE.—*Palpus:* shorter than in *papuensis* and with less numerous hairs on segments 4 and 5; exceeding proboscis usually by less than length of segment 5.

MALE GENITALIA (fig. 134).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe with about 6–10 bristles. *Sidepiece:* a distinct constricted portion distad of subapical lobe. *Subapical Lobe:* large; no sternal apical division; seta *a* strong, *b* strong but not markedly flattened, *c* weaker; leaf (*g*) strongly developed and foliform, 2 strong differentiated accessory setae (*h*) laterad of leaf markedly different in form from long slender specialized setae which form a single row on tergal surface of sidepiece; sternal group (*d-f*) with 1 long heavy somewhat flattened seta, 1 medium-sized seta, and 1 very short slender seta. *Clasper:* crest usually with more than 8 short spicules; lower surface with 2 or more setae near base; distal portion with 1 upper and 1 lower seta. *Phallosome:* essentially as in *papuensis* except that external subbasal process indistinct. *Proctiger:* essentially as in *papuensis;* basal sternal process stronger; apex of paraproct with sharp, curved, spinelike sternal process in addition to rounded lobe; cercal setae usually 2 on each side.

PUPA (fig. 134).—*Abdomen:* 2.75 mm. *Trumpet:* 0.58 mm. *Paddle:* 0.81 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general quite similar to *papuensis,* from which it differs chiefly in the smaller size and the following characters. *Trumpet:* tracheoid about 0.4; pinna about 0.25 or less. *Abdomen:* hair 5-II distinctly cephalad of 4-II; 1-II with fewer branches, finely dendritic; 1-III,IV usually 3,4b; 1-V-VII usually 2,3b; 1-VI not shortened; 5-IV-VI usually 2,3b and a little shorter; 9-VIII sparsely dendritic; 1-IX developed. *Paddle:* usually narrower.

LARVA (fig. 135).—*Head:* 0.88 mm. *Siphon:* 1.15 mm. *Anal Saddle:* 0.29 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately pigmented, ocular areas lighter, postocular darkened; mental plate with 11–13 teeth on each side of median tooth, distal teeth small, uniform, proximal 3–5 larger and widely spaced; hair 1-C very slender; 5,6-C usually at least 6b, similar in size to 7-C. *Antenna:* moderately long; basal portion only slightly wider, not distinctly swollen; uniformly moderately pigmented except for blackened base; spicules conspicuous, short, and heavy; hair 1-A slightly beyond middle; 2,3-A distinctly removed from apex. *Thorax:* hairs 1-3-P all single; 7-P usually triple; 8-P single or double; 8,9-M,7-9-T long. *Abdomen:* hairs 6-I-VI,7-I relatively long; 1-III-VII usually double or triple. *Siphon:* index variable, usually about 4.5–5.5; rather uniform in width; moderately pigmented, darkened apically and blackish on basal ring and acus; pecten usually with 15 or more short triangular teeth with irregular short denticles; usually 3 pairs of subventral tufts (1,1a-S) on each side. *Anal Segment:* saddle moderately pigmented, darkened dorsally; marginal spicules short; hair 1-X usually single; gills rounded, usually very long, over 2.5 saddle length.

MATERIAL EXAMINED.—936 specimens; 228 ♀; 229 ♂; 26 pupae; 453 larvae; 18 individual larval rearings.

SYSTEMATICS.—The South Pacific populations are referred only provisionally to *fragilis.* It is possible that more than 1 species is involved and that neither is conspecific with *fragilis* from the Philippines. This problem cannot be settled until more material is available and the entire complex of variable and widespread forms of *fragilis* is studied in detail. This complex seems to be a dominant one actively extending its range at the present.

BIONOMICS AND DISEASE RELATIONS.—In the Solomons immature stages of *fragilis* have been collected most commonly in artificial containers and in coconut shells. Other collections have been made in treeholes, sago and papaya stumps, and ground pools. In almost every instance, the water is foul and contains a great deal of organic material. Females of *fragilis* have not been taken biting man even in the vicinity of breeding sites; nothing is known of their bionomics and disease relations.

DISTRIBUTION (figs. 130, 131).—*Solomon Islands:* Bougainville; Gizo; New Georgia; Roviana; Rendova; Guadalcanal; Malaita; Rennell. Also reported from the *Bismarcks, New Guinea, Indonesia, Borneo, Philippines, Malaya, Thailand, India,* and *Ceylon.*

3. Culex (Culiciomyia) pullus Theobald

Figs. **130, 131, 136, 137**

1905. *Culex pullus* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:87–88. TYPE: holotype ♀, Muina, New Guinea, 1900, Biro (BUDA).

1923. *Culex (Culiciomyia) muticus* Edwards, B. Ent. Res. 14:6–7. *TYPE: holotype ♂, with genitalia mount (1583), marked as type by Edwards, Rabaul, New Britain, G. F. Hill (BMNH).—Synonymy of Edwards (1926:121; 1932:199).

C. (*Culiciomyia*) *pullus* of Edwards (1926:121; 1932:199); Taylor (1934:23); Lee (1944*a*:94); Knight, Bohart, and Bohart (1944:47, 63); King and Hoogstraal (1946*c*:149); Iyengar (1955:32); Laird (1956); Stone, Knight, and Starcke (1959).

C. (*Culiciomyia*) *muticus* of Edwards (1923*a*:6–7); Hill (1925:74); Brug (1934:517).

C. (*Culiciomyia*) *pallidothorax* of Bonne-Wepster (1938).

FEMALE.—*Wing:* 3.63 mm. *Proboscis:* 2.00 mm. *Forefemur:* 1.91 mm. *Abdomen:* about 2.6 mm. Small to medium-sized species with conspicuous transverse tergal abdominal pale bands. *Head:* decumbent scales light brown, broad scales paler, dingy white or beige laterally and anteriorly on orbital line; erect scales light brown; palpus about 0.15 proboscis, segment 4 about 1.66 of segment 3. *Thorax:* mesonotal scales light brown; scutellar scales usually a little paler; dorsocentral bristles moderately long; pleural integument light brown, usually with a very conspicuous longitudinal dark stripe from *apn* to upper *mep* and another shorter dark line on *ppl* and anterior lower *stp;* 1 lower *mep* bristle. *Legs:* as in *papuensis* but pale scaling not as distinct. *Wing:* as in *papuensis* but dorsal plume scales longer and narrower. *Haltere:* stem light, knob with light brown scales. *Abdomen:* tergite I with very small patch of dark scales; tergites III-VI with distinct variable basal transverse pale bands, often widened centrally on IV,V and expanded laterad on VI; tergite VII with large usually unconnected basal lateral pale spots; apex of tergites III-V sometimes with some pale scales; sternites largely pale-scaled.

MALE.—*Palpus:* essentially as in *papuensis* but segments 4 and 5 with fewer hairs. *Antenna:* usually slightly shorter than proboscis. *Abdomen:* tergal pale bands usually broader than in female.

MALE GENITALIA (fig. **136**).—As figured; diagnostic characters as in the key; in general very similar to *fragilis* but differing conspicuously in the following. *Segment IX:* tergite lobe usually with more numerous bristles. *Subapical Lobe:* smaller; seta *a* not as strong; only 1 strong accessory seta (*h*) distinctly separated from the line of weaker shorter tergal setae; larger seta in sternal group heavier and more flattened. *Clasper:* crest with more numerous and stronger spicules; basal part with more numerous ventral setae. *Phallosome:* conspicuously different from *fragilis* and *papuensis;* apical process of lateral plate longer; curved; only 1 long dorsal submedian sharp tooth, directed laterad. *Proctiger:* basal sternal process stronger and more heavily pigmented; apex of paraproct without distinct sternal process.

PUPA (fig. **136**).—*Abdomen:* 2.78 mm. *Trumpet:* 0.61 mm. *Paddle:* 0.85 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, darker on mesonotum; hairs moderately pigmented. *Trumpet:* moderately to rather strongly pigmented; tracheoid darker, about 0.4; pinna about 0.2. *Metanotum:* darkened. *Abdomen:* moderately uniformly pigmented, a little darker on anterior segments; hairs moderately pigmented; hair 3-I usually double; 5-II cephalad of 4-II; hair 1 strong on all segments, 1-III-VI as strong as or stronger than hair 5, usually with more than 3 branches; 6-IV,V usually strong; 1-IX distinct. *Paddle:* lightly pigmented, midrib and external buttress darker.

LARVA (fig. **137**).—*Head:* 0.72 mm. *Siphon:* 1.7 mm. *Anal Saddle:* 0.3 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* lightly to moderately pigmented and with usual lighter and darkened areas; mental plate usually with 15 or more teeth on each side of median tooth, distal teeth small and uniform, proximal 2–4 only slightly larger but more widely spaced; hair 1-C slender; 5,6-C usually 3,4b, rather long. *Antenna:* moderately long; basal part only slightly widened and not swollen; somewhat darkened distally; spicules short, conspicuous; hair 1-A distinctly beyond middle; 2,3-A distinctly removed from apex. *Thorax:* hairs 1-3-P all single; 4,7,8-P usually all double; 8,9-M,7,9-T moderately long. *Abdomen:* 6-I-VI,7-I moderately long; 1-IV,V very long and single. *Siphon:* index variable, usually 10.0–14.0; a conspicuous break in the sclerotization beyond middle; uniformly moderately to lightly pigmented except for blackish basal ring and short broad acus and often darkened apex; pecten variable, teeth usually 12 or less; usually 3 pairs of short subventral tufts (1,1a-S). *Anal Segment:* moderately uniformly pigmented; a few short marginal spicules; hair 1-X usually single; gills variable in length, usually pointed.

MATERIAL EXAMINED.—1,614 specimens; 561 ♀; 474 ♂; 118 pupae; 461 larvae; 19 individual larval rearings.

SYSTEMATICS.—*C. pullus* is easily differentiated from the other *Culiciomyia* of the South Pacific by the adult coloration, the male phallosome, the larval siphon, and the size and branching of hair 1 on abdominal segments V and VI of the pupa. This species has been confused in the past with *nigropunctatus* Edwards, 1926 from the Oriental and Indomalayan regions but is quite distinct in the pleural coloration and the male genitalia. In the South Pacific *pullus* shows a great deal of variation in the larval siphon, pupal chaetotaxy, and amount of pale scaling on the abdominal tergites of the adults, but it appears that only one plastic dominant variable species is involved and that it is actively extending its range at present.

BIONOMICS AND DISEASE RELATIONS.—*C. pullus* utilizes an extremely wide range of breeding sites. In the Solomons it is one of the commonest mosquitoes and is found most frequently in ground pools of all types. It often breeds in artificial containers and in large treeholes and sometimes in coconut husks and shells.

Both sexes of *pullus* have been collected commonly in night catches on Guadalcanal, but I have no records of females biting. In spite of its great abundance and rather close association with man, *pullus* does not appear to be of any economic importance.

DISTRIBUTION (figs. **130**, **131**).—*Solomon Islands:* Bougainville; Treasury; New Georgia; Roviana; Sasavele; Banika; Pavuvu; Florida; Guadalcanal; Rennell. Also reported from the *Bismarcks, New Guinea, Australia* (Queensland), and the *Moluccas.*

Subgenus MOCHTHOGENES Edwards

1930. *Mochthogenes* Edwards, B. Ent. Res. 21:305. *TYPE SPECIES: *Aedes malayi* Leicester, 1908, Malaya; original designation.—As subgenus of *Culex*.

FEMALES.—Rather small dark species. *Head:* decumbent scales varied, all narrow in *femineus;* palpus less than 0.2 of proboscis, 4-segmented, segments 1 and 2 ankylosed; labium and palpus dark-scaled. *Thorax:* mesonotal scales all dark, narrow; acrostichals distinct, usually large; dorsocentrals strongly developed; scutellum with narrow scales; pleuron without distinct scales; 1 lower *mep* bristle present. *Legs:* tarsi dark. *Wing:* dorsal scales all dark; plume scales varied. *Abdomen:* tergites without distinct pale-scaled bands. *Buccopharyngeal Armature:* not studied.

MALES.—*Palpus:* as in the female. *Antenna:* with more or less elongated flagellar whorls, sometimes not numerous; no specialized scales or hairs.

MALE GENITALIA.—*Segment VIII:* posterior margin of tergite indistinct. *Segment IX:* tergite with hairs. *Sidepiece:* without scales. *Subapical Lobe:* varied; with or without leaf. *Clasper:* simple or bifid; spiniform short or heavy. *Phallosome:* simple; lateral plates connected by dorsal and ventral bridges; ventral paramere extending to base. *Proctiger:* apparently as in *Neoculex;* cercal hairs few.

PUPAE and LARVAE.—Varied; see *femineus*.

SYSTEMATICS.—Edwards erected *Mochthogenes* for Old World species of *Culex* with short palpi in the male and narrow scutellar scales in both sexes. This seems to be a heterogeneous polyphyletic assemblage. The South Pacific *femineus* is referred to the subgenus only provisionally. It appears to have little in common with the type species of the subgenus (*malayi* Leicester, 1908) and should probably be placed in a distinct subgenus of its own or possibly one including also *cataractarum* Edwards, 1923 from New Britain. However its affinity cannot be determined until the *Neoculex-Mochthogenes-Lophoceraomyia* complex is revised on a worldwide basis. It seems to me that the various species of *Mochthogenes* may have been derived from very different groups of *Neoculex* and *Lophoceraomyia.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of species of *Mochthogenes* have been reported from treeholes, rock pools, and ground pools. Very little is known of the adult bionomics, and no biting records have been reported. Adults of both sexes are sometimes found resting on tree trunks and moist stream banks.

DISTRIBUTION (fig. 138).—Species assigned to *Mochthogenes* have been reported from the Ethiopian, Oriental, Indomalayan, and Australasian regions. In the South Pacific, the endemic *femineus* is known only from the New Hebrides.

KEYS TO SPECIES

See keys to subgenera, pp. 180–182

1. Culex (Mochthogenes) femineus Edwards

Figs. **138-140**

1926. *Culex femineus* Edwards, B. Ent. Res. 17:107. *TYPE: holotype ♂, Espiritu Santo, New Hebrides, July, 1925, P. A. Buxton (BMNH).

C. (*M.*) *femineus* of Edwards (1932:195); Taylor (1934:22); Lee (1944*a*:89); Knight, Bohart, and Bohart (1944:46, 61); Perry (1946:14); Iyengar (1955:32); Laird (1956); Rageau (1958*a*:878); Rageau and Vervent (1958); Stone, Knight, and Starcke (1959).

C. femineus of Buxton and Hopkins (1927:86–87).

FEMALE.—*Wing:* 3.33 mm. *Proboscis:* 2.03 mm. *Forefemur:* 1.96 mm. *Abdomen:* about 1.86 mm. *Head:* eyes contiguous above antennae; no frontal tuft; decumbent scales all narrow except laterally and ventrally, light bronzy, paler caudally and on orbital line; broad lateral and ventral scales largely dark, a few paler dorsad; erect scales numerous, long, and slender, slightly broadened and forked distally, all brown; palpus less than 0.15 proboscis length; antenna distinctly longer than proboscis; torus without scales; flagellar whorls with 6,7 hairs. *Thorax:* mesonotal and scutellar scaling sparse, uniformly bronzy to light bronzy; acrostichals moderate to strong; dorsocentrals very strong; pleuron brown, with darkened areas, without distinct scales; *ppn* usually with 2,3 strong posterior bristles and 2–4 weaker hairs; upper *stp* bristles weak, 1 of the lower *stp* bristles very strong; lower *mep* bristle strong, upper bristles short, usually 5,6. *Legs:* forefemur and midfemur largely dark-scaled, indistinctly paler ventrally; hindfemur similar except that lower surface pale-scaled on basal 0.7, pale scaling extending to anterior and posterior surfaces; remainder of legs dark-scaled. *Wing:* plume scales narrow and slender on R_{2+3} and base of R_2 and R_3; alula with marginal fringe of short slender hairlike scales; upper calypter with complete fringe of long hairs. *Haltere:* stem pale; knob with bronzy scales. *Abdomen:* tergite I with very small posterior central patch of dark scales; tergites II-VII largely dark bronzy, with short basolateral pale beige transverse spots which are usually visible from above but are not connected dorsally; sternites largely dark-scaled, with more or less complete basal transverse lines of beige scales.

MALE.—*Labium:* without distinct false joint; without long hairs dorsally or ventrally. *Palpus:* as in the female. *Antenna:* flagellar whorls with 8,9 bristles which are only about twice as long as in female; flagellar segments 12 and 13 only moderately elongate, together only about 0.3 of entire flagellum. *Abdomen:* pale markings less conspicuous than in female.

MALE GENITALIA (fig. **139**).—As figured; diagnostic characters as in the key; short and inconspicuous. *Segment VIII:* posterior margin of tergite indistinct, central caudal area with short hairs, lateral with long bristles. *Segment IX:* tergite narrow, lobe short and wide, with about 4-12 hairs and numerous rather long spicules extending ventrad toward proctiger. *Sidepiece:* short and broad; dorsal, lateral, and ventral surfaces with rather uniform vestiture of short bristles, no longer bristles laterally. *Subapical Lobe:* short, arising slightly distad of middle; setae *a-c* on distinct lobe, *a* and *b* heavy, flattened dark spiniforms with rounded apex, *c* more slender; setae *g* and *h* possibly represented by 1 slightly differentiated acuminate thickened seta on tergal surface of sidepiece; sternal group (*d-f*) distant from group *a-c*, on very slight tubercle, represented by 1 long thickened, acuminate seta and usually 2 or more undifferentiated hairs, sometimes 1 of these longer; lobe bearing *a-c* with numerous short hairs. *Clasper:* short, uniform in width; heavily pigmented except at base; upper surface with 1 seta on very small tubercle before middle and a series of 4 or 5 setae along outer edge; spiniform heavy, curved, pointed, and heavily pigmented, arising under a long hood. *Phallosome:* lateral plate with very long narrow distal portion curved dorsally on apex, without denticles; the 2 plates connected by membrane tergally. *Proctiger:* very broad, with strong basolateral sclerotization continued sternad but without basal sternal process; paraproct with crown of several short sharp spicules in a patch mesally and sternally and an outer tergal line of blunt longer and broader spinules; cercal setae usually 2–4, near crown.

PUPA (fig. **139**).—*Abdomen:* 2.2 mm. *Trumpet:* 0.45 mm. *Paddle:* 0.8 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* very lightly pigmented except for moderately to strongly pigmented mesonotum; hairs lightly to moderately pigmented; hairs 1-3-C short, 1-C very near caudal margin of sclerite, 2,3-C widely separated, 2-C very near caudal margin of sclerite; 8,9-C moderately long. *Trumpet:* relatively short, uniformly strongly pigmented; gradually widened distally; pinna about 0.2, tracheoid less than 0.4. *Metanotum:* moderately to strongly pigmented. *Abdomen:* very lightly pigmented except for slightly darker tergites I-III; hairs lightly to moderately pigmented; integumentary sculpturing distinct on tergite II; hair 1-II with very heavy basal stem and broomlike branching; 1-III,IV moderate, multiple; 1-V-VII short, weak, with few branches; 2-III-VII slightly to moderately mesad of hair 1; 3-V,VI single or double, at least as long as hair 1, usually longer; 5-IV-VI long, usually double; 6-III-VI weak; 1-IX apparently not developed. *Paddle:* very lightly pigmented, midrib brighter; margins without distinct spicules; hairs 1,2-P both present.

LARVA (fig. **140**).—*Head:* 0.72 mm. *Siphon:* 1.23 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately pigmented except for usual lighter and darkened areas, caudal portion sometimes darkened; labral area, mouthbrushes, and mandible normal; labial area rather long; mental plate usually with 9,10 teeth on each side of enlarged median tooth, proximal 2,3 teeth larger, sharper, and more widely spaced; hair 1-C brown to dark brown, moderately heavy and rather short; 4-6-C removed caudad from level of antenna; 4-C single, unusually long; 5,6-C very long, heavy, usually single; 12,13-C removed cephalad; hairs 16,17-C developed as elongate spicules. *Antenna:* very long; basal part slightly wider; uniformly lightly to moderately pigmented except for darkened basal ring; spicules conspicuous on basal part; hair 1-A distad of middle, strongly developed; 2,3-A removed short distance from apex, long. *Thorax:* 1-3-P all single, 1,2-P very long, at least 2.0 of hair 3; all large hairs very long; 13-T long. *Abdomen:* hairs 6-I,II moderately long; 6-III-VI rather short; 7-I moderately long; 7-II short; 1-I,II minute; 1-III-VI weak, moderate in length, with few branches, not markedly displaced laterad. *Segment VIII:* comb scales numerous, elongate, fringed apically. *Siphon:* index about 8.0–10.0; lightly to moderately pigmented, somewhat darkened apically and on basal ring and acus; pecten usually with 12 or more teeth, each with large subbasal spine and numerous subapical fringes; subventral tufts (1,1a-S) about 18–20, all except 2 apical pairs in a single midventral line, apical 2 pairs much shorter, distinctly lateral. *Anal Segment:* saddle complete, strongly emarginate on ventral caudal margin; caudal margin with very short spicules dorsally; hair 1-X usually double or triple; 2,3-X both single; ventral brush with 5,6 pairs of hairs, all on very strongly developed grid whose lateral bars are joined to saddle; gills variable in length.

MATERIAL EXAMINED.—695 specimens; 133 ♀; 36 ♂; 54 pupae; 472 larvae; 8 individual rearings (7 larval, 1 pupal).

SYSTEMATICS.—*C. femineus* is a very clearly marked form quite unlike any other species currently placed in *Mochthogenes* except perhaps for *cataractarum* Edwards, 1923 from New Britain. The latter does not seem to be closely related to *femineus,* as it differs in a number of important features, such as broad scales on the orbital line of the vertex, reduced number of erect scales on the vertex, absence of lower *mep* bristle, and longer hairs in the flagellar whorls of the antenna.

This species appears to be an early derivative of the *Neoculex* or *Lophoceraomyia* stocks. The male genitalia are so distinctive that I am tempted to erect a separate subgenus for this form. However, I prefer to leave it in *Mochthogenes* pending a revision of this subgenus, *Neoculex,* and *Lophoceraomyia.*

Considerable variation has been observed in all stages of *femineus,* but these cannot be correlated in any way; it appears that only 1 plastic species is involved.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *femineus* are most commonly found in rock pools along streams. They are occasionally found in ground pools and have been collected once each in a shallow brackish well and in a hole among tree roots. Females of *femineus* are not known to bite man. Both sexes have been found resting on tree trunks and moist overhanging banks of streams.

DISTRIBUTION (fig. 138).—*New Hebrides:* Espiritu Santo; Tutuba; Pentecost; Vao; Malekula; Efate; Eromanga; Tana. Not known elsewhere.

Subgenus NEOCULEX Dyar

1905. *Neoculex* Dyar, Ent. Soc. Wash., Proc. 7:45, 48–49. TYPE SPECIES: *Culex territans* Walker, 1856, U.S.A.; original designation.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Small to medium-sized species; ornamentation variable but tarsi always dark-scaled. *Head:* decumbent scales varied; palpus less than 0.2 of proboscis, usually 4-segmented but sometimes with very small fifth segment. *Thorax:* acrostichals always developed, usually large; dorsocentrals strongly developed; scutellum with narrow scales; pleuron with numerous scales or with practically none; strong lower *mep* bristle present or absent, sometimes with numerous short hairs on middle and lower part of *mep*. *Wing:* dorsal scales all dark; plume scales varied. *Abdomen:* tergites with or without basal or apical pale markings or bands. *Buccopharyngeal Armature:* varied; not studied in South Pacific species.

MALES.—*Labium:* apparently without long hairs dorsally or ventrally. *Palpus:* usually about as long as proboscis or longer, sometimes reduced to about 0.6 of proboscis; 5-segmented, segment 3 at most with short hairs in a mesoventral line, segments 4 and 5 with or without long hairs. *Antenna:* normal, usually only slightly shorter than proboscis; flagellar whorls with numerous long bristles; flagellar segments 12 and 13 elongate, usually more than 0.35 of total flagellar length, without specialized hairs or scales.

MALE GENITALIA.—*Segment VIII:* tergite often not sclerotized in middle of caudal margin. *Segment IX:* tergite varied; tergite lobe distinct or not, with or without bristles. *Sidepiece:* varied, sometimes swollen; scales absent, lateral bristles usually long. *Subapical Lobe:* varied; in South Pacific species divided and with only 2 setae in *a-c* group borne on long proximal division. *Phallosome:* simple but varied; composed of 2 lateral plates with or without sclerotized transverse tergal bridges; aedeagus not projecting proximad of ventral paramere when at rest. *Proctiger:* varied; without long spinelike basal sternal process; with or without apical sternal process; paraproct apex with varied spicules, in South Pacific species with crown of long curved spines in single row; cercal sclerites varied; cercal setae apparently always present, varied in number.

PUPAE (South Pacific species).—Apparently quite similar to some species of *Lophoceraomyia;* differing from latter chiefly in hair 9-VIII being at or immediately adjacent to caudolateral angle of tergite.

LARVAE (South Pacific species).—In general as in *Lophoceraomyia* and differing from it chiefly in the following. *Head:* shape and chaetotaxy varied; labrum and mandible normal; inner mouthbrushes sometimes pectinate; hairs 16,17-C apparently not developed in South Pacific species, distinct in some Nearctic species. *Antenna:* long; spicules distinct; hair 1-A near middle or beyond; 2,3-A removed only short distance from apex. *Thorax:* 1-3-P on strong tubercle near midline; 3-P single or branched, always shorter than 1,2-P. *Segment VIII:* comb scales in large triangular patch, small and apically fringed. *Siphon:* long, slender; pecten varied; subventral tufts (1,1a-S) varied but numerous, at least 1 pair out of line, usually 2 or 3; valves very small; spiracular apparatus without long hairlike median caudal filament. *Anal Segment:* long; saddle complete, more or less emarginate for ventral brush, without distinct caudal marginal spicules; hair 2-X usually with at least 2 branches; 3-X single; ventral brush (4-X) with 6,7 pairs of hairs on grid and at least 1 detached hair (usually 2) proximad on saddle or in emargination of saddle; gills varied, never very long, always pointed and subequal.

SYSTEMATICS (fig. 141).—The subgenus *Neoculex* is a very complex one, as it contains several distinct lines which show relatively few characters in common. As indicated by Mattingly and Marks (1955:170), the groups recognized by Edwards (1932:193; 1941:249–252) and King and Hoogstraal (1947*a*) give little idea of relationships, since they are based on arbitrary superficial characters. A phylogenetic classification of the subgenus must await a thorough study and evaluation of all characters. At the present time most species are very superficially, inadequately, and sometimes erroneously described. *Neoculex* shows a number of resemblances to *Mochthogenes, Lophoceraomyia* and *Culiciomyia* and even to the Neotropical *Melanoconion* and *Mochlostyrax.*

The South Pacific species of *Neoculex* fall into 2 very distinct groups: (1) the *pseudomelanoconia* group, which includes *cheesmanae, millironi, gaufini,* and *dumbletoni,* and (2) the *leonardi* group, represented by the nominate species in the Solomons. In the *pseudomelanoconia* group, *cheesmanae* appears to be the most ancient derivative of the line, *millironi* a more recent derivative, and there is a suggestion that *gaufini* and *dumbletoni* arose through hybridization of the *millironi* line with a *Lophoceraomyia* of the *buxtoni* complex. In connection with this possibility, it is of interest to note that Laird (1954*a*:291) collected a mosquito larva on Art Island in the Belep group, northwest of New Caledonia, which he identified as *Culex* (*Lophoceraomyia*) *fraudatrix* but which seems to be very close to but distinct from *buxtoni* of the New Hebrides. *C. leonardi* also suggests introgression of the *Lophoceraomyia* stock with *Neoculex*. Its larva is very similar to *gaufini* and, to a lesser extent, *buxtoni*, and the male phallosome and the head ornamentation show some features of *Lophoceraomyia*.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of species of *Neoculex* have been reported from permanent and temporary ground waters of various types and from rockholes, crabholes, treeholes, and artificial containers. The females apparently do not attack man. Some of the species have been reported to feed on frogs and water rats in nature and have been fed on birds in the laboratory. At present none of the species are known to be involved in the transmission of disease to man.

DISTRIBUTION (fig. 141).—*Neoculex* is predominantly an Old World genus but is represented by several species in the Nearctic region. In the South Pacific it is represented by at least 4 species on New Caledonia and by 1 species in the Solomons.

KEYS TO SPECIES

(Keys to subgenera, pp. 180–182)

ADULTS

(4. *dumbletoni* not included)

1. Abdomen with complete basal transverse pale bands on at least tergites IV and V; vertex of head with broad scales extending dorsad on orbital line from lateral patch .... 5. *leonardi*

Abdomen without transverse pale bands; vertex of head without broad scales, latter confined to lateral patch 2

2(1). Sternopleuron with a large continuous patch of pale scales; *mep* with numerous pale hairs conspicuous along anterior border to at least lower 0.2 .... 1. *cheesmanae*

Sternopleuron without scales; *mep* at most with a few very short pale hairs in upper half ... . 2. *millironi*; 3. *gaufini*

MALE GENITALIA

1. Lateral plates of phallosome divergent apically in tergal aspect, without any indication of subapical tergal sclerotized bridge. .... 5. *leonardi*

Lateral plates of phallosome convergent apically and ending in a tooth in tergal aspect, at least an indication of a subapical tergal sclerotized bridge 2

2(1). A patch of specialized setae between the proximal and distal divisions of the subapical lobe; distal division with 6 setae, the 3 most sternal barbed .... 1. *cheesmanae*

At most a few simple hairs between the proximal and distal divisions of the subapical lobe; distal division with 5 setae, at most 2 of the most sternal setae barbed 3

3(2). Tergite lobe of segment IX with 2 or 3 bristles; a patch of simple hairs between proximal and distal divisions of subapical lobe .... 4. *dumbletoni*

Tergite lobe of segment IX without bristles; no hairs between proximal and distal divisions of subapical lobe 4

4(3). Middle tergal seta of the distal division of the subapical lobe widened and flattened to apex which is bent .... 3. *gaufini*

Middle tergal seta of the distal division of the subapical lobe only slightly thickened in basal half, distal half attenuate .... 2. *millironi*

PUPAE

(2. *millironi*, 3. *gaufini*, and 4. *dumbletoni* not included)

1. Hair 5-IV-VI heavy, double or triple, much longer than hair 1 ...... 1. *cheesmanae*

Hair 5-IV-VI slender, multiple, subequal to or smaller than hair 1 .... 5. *leonardi*

LARVAE

1. Head hairs 5,6-C with 4 or more branches; hair 3-P branched .... 1. *cheesmanae*

Head hairs 5,6-C single or double, rarely triple; hair 3-P usually single 2

2(1). Pecten teeth 13 or more 3

Pecten teeth 12 or less 4

3(2). Head hair 5-C single, weak, distinctly shorter than antenna and usually less than 0.6 of hair 6-C; hair 8-P usually single .... 2. *millironi*

Head hair 5-C double or triple, strong, about as long as antenna and subequal to hair 6-C; hair 8-P usually double. ... 4. *dumbletoni*

4(2). Hair 2-X usually double; 14-C single .... 3. *gaufini*

Hair 2-X usually 3,4b; 14-C multiple .... 5. *leonardi*

1. Culex (Neoculex) cheesmanae Mattingly & Marks

Figs. 142-144

1955. *Culex (Neoculex) cheesmanae* Mattingly and Marks, Linn. Soc. N. S. Wales, Proc. 80:166–171. *TYPE: holotype ♂, Nassirah, near Bouloupari, New Caledonia, from rock pools in river, Aug., 1954, M. O. T. Iyengar (BMNH).

C. (*N.*) *cheesmanae* of Rageau (1958*a*:878; 1958*b*:6); Rageau and Vervent (1958); Stone, Knight, and Starcke (1959).

C. (*N.*) *pseudomelanoconia* of Williams (1943:217, 218); Perry (1950*a*); in part of Laird (1954*a*:286; 1956); Iyengar (1955:31); and wartime collections on New Caledonia.

FEMALE.—*Wing:* 3.33 mm. *Proboscis:* 2.0 mm. *Forefemur:* 1.73 mm. *Abdomen:* about 2.16 mm. A small deep black species. *Head:* eyes contiguous above antennae; no frontal tuft; decumbent scales all narrow except for small lateral patch of broad scales, predominantly dark beige to pale coppery; broad lateral scales whitish; no broad scales on orbital line; erect scales long, narrow, slightly expanded and forked apically, all dark; labium dark-scaled; palpus about 0.2 proboscis, dark-scaled, 5-segmented, segment 5 minute and hidden in apical scales and hairs of segment 4; antennae slightly shorter than proboscis; torus apparently without scales. *Thorax:* integument deep black with some lighter areas on pleuron; mesonotal scales sparse, narrow, dark to light bronzy; acrostichals strong; dorsocentrals very strong; scutellar scales very sparse, particularly on lateral lobe, all bronzy; *apn* with a few pale hairlike scales in addition to bristles and hairs; *ppn* with 2,3 strong dark posterior bristles and a row of weaker dark hairs cephalad along dorsal margin, a large dense patch of dark and light hairs on disc almost halfway to lower margin; *ppl* with numerous long pale bristles on outer surface, a very conspicuous patch of these mesally near *pst*, and rather numerous long broad beige scales; *stp* with very numerous long and short pale bristles in usual curved line but not in single row, a large continuous patch of dark beige long broad scales and short pale hairs covering posterior half; *pra* with numerous pale hairs from lower part to upper and a few dark bristles above; upper *mep* bristles pale, very numerous, continued as shorter pale hairs to middle part, longer along anterior margin where they may extend to extreme lower margin, usually at least to lower 0.2, much shorter and inconspicuous posteriorly, no distinct differentiated lower *mep* bristle; other pleural sclerites without scales or hairs. *Legs:* coxae with pale scales, few to numerous dark ones on forecoxa; femora dark-scaled on base, apex, and dorsal surface, pale ventrally and posteriorly, on hindfemur pale scaling extending on anterior surface; tibiae and tarsi dark-scaled. *Wing:* dorsal scales all dark; plume scales of Rs, R_{2+3} and M very long and slender, dense; remigial bristles usually 3, long and conspicuous; alula with conspicuous marginal fringe of rather long narrow scales; upper calypter with complete marginal fringe of long hairs. *Haltere:* stem light below, dark above; knob with dark scales. *Abdomen:* tergite I without scales but with numerous hairs; tergites II-VII entirely dark-scaled; proximal sternites with indistinctly light golden brown scales, distal with dark bronzy scales, sometimes a few paler scales present; caudal marginal and particularly lateral hairs very numerous, pale and short, sometimes a few on disc of distal tergites. *Buccopharyngeal Armature:* not studied; "teeth of lower row sharply pointed, those of upper row difficult to distinguish, apparently blunt. Six teeth in the middle narrower and somewhat longer than remainder. Lateral and ventral flaps normal for the subgenus" (Mattingly and Marks, 1955:167–168).

MALE.—*Palpus:* from a little shorter to a little longer than proboscis, very slender; segment 5 a little shorter than 4, segments 4 and 5 without long lateral hairs but with a few moderately long stout hairs on apices and numerous very short hairs; segment 3 with a few stout hairs apically and a few short hairs ventrally. *Legs:* claws of foreleg and midleg enlarged, all with 1 tooth.

MALE GENITALIA (fig. 143).—As figured; diagnostic characters as in the key. *Segment VIII:* tergite rounded on caudal margin, only slightly emarginate. *Segment IX:* tergite poorly sclerotized, without bristles. *Sidepiece:* short, swollen, part beyond lobe narrowed; without scales; lateral and sternolateral surfaces with long strong bristles; tergal surface with poorly sclerotized bare area laterad of lobe. *Subapical Lobe:* divided; proximal part prominent, bearing 2 long specialized setae with recurved apex; distal part less prominent, bearing in order from sternal to tergal surface 3 delicately barbed setae, 1 long slender seta with hooked tip, 1 flattened acuminuate seta, and 1 thickened simple bristle, sometimes a short simple seta near the barbed setae; tergal surface between the 2 parts with a patch of specialized hairs of varying size, about 10 of which are usually long and bent before apex, patch continued basad by short hairs in area mesad of unsclerotized part of tergal surface. *Clasper:* strongly widened before apex; 2 setae in distal half; spiniform subapical. *Phallosome:* simple, poorly pigmented; broadened apically; subapical sclerotized bridge usually incomplete; each lateral plate ending in a short blunt apical tooth; no denticles developed. *Proctiger:* paraproct with crown of a single curved row of long curved blunt spines, usually 8,9, longer laterosternad; cercal sclerite distinct, bearing distally near paraproct crown a patch of about 8–10 rather long setae.

PUPA.—Described in detail by Mattingly and Marks (1955:168, 169); available material too poor to be figured; apparently in general similar to *leonardi* but differing markedly in having hairs 5-IV-VI long, stout, double or triple. *Cephalothorax:* chaetotaxy apparently as in *leonardi. Trumpet:* very similar to *leonardi.*

LARVA (fig. 144).—*Head:* 0.65 mm. *Siphon:* 1.3 mm. *Anal Saddle:* 0.38 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* relatively narrow; uniformly very strongly pigmented, lighter on ocular areas; labrum relatively short; inner mouthbrushes short, heavy, and very conspicuously pectinate; mandible normal; mental plate very dark, with 5,6 large teeth on each side of median tooth, most proximal usually sharp and more widely spaced; hair 1-C long and rather heavy; 4-6-C not very far caudad of level of antennae; 3-C rather long, conspicuous; 4-C long, single; 5,6-C multiple, at least 4b; 8-C long, usually single; 11-13-C long, multiple, 12 and 13 at same level; 14-C long, single; basal maxillary hair very large, heavy, usually double. *Antenna:* moderately long, shorter than head; strongly pigmented, distal part usually darker; spicules strong and numerous on proximal part; hair 1-A near middle, strong, multiple; 2,3-A near apex; 2-4-A heavy. *Thorax:* hairs and tubercles strongly to moderately pigmented; hair 3-P relatively short, usually 3,4b; 4-P usually triple; 14-P long and single; 1-M rather large; 1,3,5-T unusually large. *Abdomen:* hairs and tubercles strongly to moderately pigmented; hair 6-I,II heavy; 6-III-VI moderate, usually 3-5b; 7-I heavy; 7-II moderate, usually triple; 1-I,II conspicuous, rather large, usually 4b; 1-III-VII large, usually at least 4-6b; 3-III-VI usually single; 13-II simple, usually 4b; 13-III-V unusually large, usually at least 4b; large single hairs unusually long. *Segment VIII:* comb a large patch of about 4 rows of small elongate apically fringed scales; hair 1-VIII on small basal plate; 2-VIII on very large basal plate; 3-VIII on moderate basal plate. *Siphon:* index about 12.0–13.5; uniformly darkly pigmented, blackened on basal ring; integumentary sculpturing distinct; acus very broad, with long dorsal extension; pecten of about 16 or more teeth, each with heavy basal denticles and weaker subapical denticles; subventral tufts (1,1a-S) in 2 groups, 5 long ventral pairs and 3 short lateral pairs; hair 2-S rather heavy, hooked; valves very small. *Anal Segment:* saddle distinctly emarginate for ventral brush, uniformly darkly pigmented; integumentary sculpturing distinct throughout but more conspicuous caudodorsad, no strong marginal spicules; hair 1-X long, heavy, usually triple; 2-X multiple, 1 branch heavier; 3-X single; ventral brush with 6 or 7 pairs of hairs on grid whose lateral sclerotization is not joined to saddle, usually 1 detached hair proximad of grid inserted in emargination of saddle; gills usually long and pointed.

MATERIAL EXAMINED.—114 specimens; 30 ♀; 35 ♂; 4 pupae; 45 larvae; no individual rearings.

SYSTEMATICS.—*C. cheesmanae* is apparently the most generalized *Neoculex* known from the South Pacific and adjacent areas. Its affinities are undoubtedly with *pseudomelanoconia* Theobald, 1907 from Queensland, as well as with *millironi, gaufini,* and *dumbletoni* from New Caledonia.

The association of the stages of *cheesmanae* is presumptive only, since no individual rearings have been made, but it seems probable that it is correct. Although there is considerable variation in all stages, there is no indication in the material that I have examined that more than 1 species is involved.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *cheesmanae* have been collected only in rock pools in stream beds. Adults have not been collected in nature.

DISTRIBUTION (fig. 142).—*New Caledonia:* Pouebo; Poindimie; Houailou; Nassirah (near Bouloupari); APO 25. *Loyalty Islands:* Mare. Not known elsewhere.

2. Culex (Neoculex) millironi Belkin, n. sp.

Figs. 142, 143, 145

TYPE.—*Holotype:* ♂ with genitalia slide (45·IX·3b), Poindimie, New Caledonia, May 12, 1945, H. E. Milliron, No. 3 (USNM, 64756).—This species is dedicated to the collector in recognition of his contributions to the knowledge of the mosquitoes of the South Pacific.

C. (*N.*) *cheesmanae* in part of Mattingly and Marks (1955:166–171).
C. (*N.*) *pseudomelanoconia* in part of Laird (1954*a*:288, 289).
C. (*Lophoceraomyia*) sp. of wartime collections on New Caledonia.

FEMALE.—Not definitely associated with male; 1 damaged specimen only; apparently quite similar to *gaufini* but possibly lighter in coloration and without middle *mep* hairs; palpus apparently with segment 5 developed.

MALE.—Head missing; thorax largely denuded; apparently differing from *gaufini* by same characters as female.

MALE GENITALIA (fig. 143).—As figured; diagnostic characters as in the key; in general similar to *cheesmanae* and differing chiefly in the following. *Sidepiece:* more uniform in width, not distinctly swollen; poorly sclerotized tergal area less defined. *Subapical Lobe:* tergal surface between the 2 divisions without specialized hairs; distal division with only 5 setae, 2 most sternal apparently with much finer subapical barbs, next seta in tergal order hooked apically and essentially as in *cheesmanae,* following seta not markedly flattened, most tergal seta simple. *Clasper:* apparently not as wide; setae not visible; spiniform shorter, nearly apical. *Phallosome:* essentially as in *cheesmanae,* apical tooth more prominent. *Proctiger:* spines of paraproct crown longer, more acuminate; cercal setae apparently minute and only 2 or 3.

PUPA.—Unknown.

LARVA (fig. 145).—*Head:* 0.69 mm. *Siphon:* 1.45 mm. *Anal Saddle:* 0.33 mm. Chaetotaxy as figured; diagnostic characters as in the key; somewhat resembling *cheesmanae* but differing markedly in the following. *Head:* much wider; uniformly moderately pigmented except for usual lighter and darkened areas; labrum longer; inner mouthbrushes simple, filamentous; mental plate less strongly pigmented, with about 6 teeth on each side of median tooth; hair 1-C much more slender and shorter, pair more widely separated; 3-C short, inconspicuous; 4-6-C farther removed caudad from level of antennae; 5-C usually single, rarely with short slender branch, relatively weak and moderately long, shorter than antenna; 6-C very long and heavy, usually double; 8-C branched; 11-C weak, with few branches; 12-C shorter than and caudad of 13-C; 14-C short; basal maxillary hair short, weak, single. *Antenna:* very long; distal part and basal ring darkly pigmented, greater portion of proximal part pale, distinctly lighter than head capsule; spicules numerous but weak on proximal part, much stronger near hair 1-A and on base of distal part; hair 1-A distinctly distad of middle; 4-A weak. *Thorax:* hair 3-P single; 4-P usually double; 7-P usually triple; 8-P usually single; 14-P short, usually double; 1-M very small; 1,3,5-T short. *Abdomen:* hairs 6-III-VI, 7-II somewhat weaker; 1-I,II inconspicuous, very small; 1-III-VII weaker; 13-II dendritic; 13-III-V smaller, usually double. *Segment VIII:* essentially as in *cheesmanae. Siphon:* index about 18.0; slightly but distinctly flared apically; moderately to strongly pigmented, sometimes with broad darkened rings near middle and apex, basal ring darkened; pecten usually with 16 or more teeth, rarely with only 13, each tooth with 1,2 slender basal denticles and 1,2 weaker subapical denticles; subventral tufts essentially as in *cheesmanae* but ventral ones usually only 5 pairs, closer together near midventral line and much shorter, lateral apical tuft more ventral, other lateral single or double. *Anal Segment:* saddle strongly pigmented dorsally, light ventrally; hair 1-X short, weak, usually 4b; 2-X usually double; lateral bar of grid of ventral brush narrowly joined to saddle; usually 2 detached small hairs on saddle proximad of grid; gills usually short.

MATERIAL EXAMINED.—38 specimens; 1 ♂; 1 ♀; no pupae; 36 larvae; no individual rearings.

SYSTEMATICS.—The single known male of *millironi* lacks the head and is so badly damaged that its characters cannot be determined, but its genitalia are quite distinct from the other species of *Neoculex* known from New Caledonia. The single damaged female and the larvae are not definitely associated with the male since there are no individual rearings, but it seems probable that the sexes and stages are correctly associated. There is a great deal of variation in the larval stage, particularly in the length of the siphon and of the subventral tufts, and it is possible that more than 1 species is involved. Some of the specimens from St. Louis are particularly aberrant and are included here only provisionally.

C. millironi has been recorded as *pseudomelanoconia* by Williams (1943:217) and Laird (1954*a*:288, 289). These records were erroneously ascribed to *cheesmanae* by Mattingly and Marks (1955:168–170), who believed that Laird figured ventral head hairs as dorsal; in fact, he represented the head chaetotaxy and the terminal abdominal segments quite accurately as they are in *millironi.* This species does resemble *pseudomelanoconia* Theobald, 1907 from Queensland as well as *cheesmanae* but seems to be more closely related to the latter on the basis of similarity in the male phallosome.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *millironi* have been collected in rock pools and rockholes and in a ponded creek. No adults have been collected in nature, and nothing is known of their bionomics and disease relations.

DISTRIBUTION (fig. **142**).—*New Caledonia:* Bouerabate; Poindimie; ? St. Louis. Not known elsewhere.

3. Culex (Neoculex) gaufini Belkin, n. sp.

Figs. **142, 143, 146**

TYPE.—*Holotype:* ♂ with genitalia slide (44·XII·23*a*), New Caledonia (APO 25), Nov. 4, 1944, from stagnant pool, A. R. Gaufin (USNM, 64757). *Paratypes:* 2 ♂, same locality as holotype, Oct. 24, 1944, A. R. Gaufin.—This species is dedicated to the collector in recognition of his contributions to the knowledge of the mosquitoes of the South Pacific.

Culex (*Lophoceraomyia*) sp. of wartime collections on New Caledonia.

FEMALE.—*Wing:* 3.33 mm. *Proboscis:* 1.83 mm. *Forefemur:* 1.58 mm. *Abdomen:* about 2.06 mm. Not definitely associated with male; in general similar to *cheesmanae* but somewhat lighter in coloration and differing chiefly in the following characters. *Head:* lateral broad scales darker; erect scales longer and more numerous. *Thorax: apn* without distinct scales; *ppn* with only the posterior and upper bristles present, no hairs on disc; *ppl* without scales, bristles dark, less numerous, a few light hairs; *stp* without scales, bristles largely dark, in a single curved row, lower light, a few light hairs near bristles in upper and middle part; *pra* bristles all dark, about 6–9; upper *mep* bristles light, less numerous, only a few small light hairs in middle. *Haltere:* stem light except dorsally on apex. *Abdomen:* lateral hairs less numerous.

MALE.—Differing from *cheesmanae* in same characters as female. *Palpus:* exceeding proboscis by at least full length of segment 5, sometimes 4 and 5 combined; segments 4 and 5 with numerous long hairs on inner and outer surfaces. *Antenna:* about as long as proboscis.

MALE GENITALIA (fig. **143**).—As figured; diagnostic characters as in the key; very similar to *millironi* but differing chiefly in the following. *Subapical Lobe:* setae in proximal division apparently longer; the 2 sternal setae of distal division apparently longer and with distinct subapical barbs, following seta very slender and curved apically, next seta strongly flattened, foliform, and with bent apex, most tergal seta a simple long bristle; mesal tergal area of sidepiece proximad of lobe with some short hairs. *Proctiger:* paraproct crown with 10–12 spines; 3 distinct cercal setae.

PUPA.—Unknown.

LARVA (fig. **146**).—*Head:* 0.73 mm. *Siphon:* 2.1 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *millironi* but differing markedly in the following. *Head:* moderately to lightly pigmented; mental plate with 7–9 teeth on each side, all somewhat pointed, proximal 2–4 more widely spaced and larger; 5-C moderately heavy, usually double or triple and not much more than 0.6 of hair 6; 5,6-C both with rather distinct long barbs. *Antenna:* largely concolorous with head capsule, basal ring darker, distal part sometimes somewhat darkened; spicules stronger and more conspicuous. *Thorax:* hair 8-P usually double or triple. *Abdomen:* hair 1-III-VI usually shorter; 3-III-V usually branched; 13-III-V usually at least triple. *Segment VIII:* comb scales more numerous, narrower; hair 2-VIII on very small, poorly sclerotized basal plate. *Siphon:* index about 23.0; usually rather uniformly darkly to moderately pigmented, a little lighter near base, basal ring darkened; apex not distinctly flared; pecten usually with about 10 teeth, never more than 12, teeth appearing narrower, distal with 2,3 moderately heavy subbasal and submedian denticles and with several indistinct fine subapical spicules; subventral tufts very inconspicuous and short, single or double and all lateral in position with 3 pairs more distinctly dorsal; hair 2-S shorter, straight. *Anal Segment:* saddle more uniformly pigmented but somewhat darker dorsally; hair 2-X double or triple; ventral brush usually with 3 detached hairs midventrally on saddle proximad of grid.

MATERIAL EXAMINED.—40 specimens; 5 ♀; 3 ♂; no pupae; 32 larvae; no individual rearings.

SYSTEMATICS.—*C. gaufini* is a very interesting species which superficially resembles *cheesmanae* in the adult stage but differs in lacking pleural scales and in the male genitalia. Its larva is superficially very similar to species of *Lophoceraomyia* but has detached hairs in the ventral brush. Although there are no individual rearings, the 2 sexes and the larva appear to be correctly associated. There is considerable variation in the length of head hairs 5-C in the larva, but usually this hair is markedly shorter than in *dumbletoni*, which is superficially quite similar.

This species as well as *dumbletoni* have been informally labeled in wartime collections as an unidentified species of *Lophoceraomyia*.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *gaufini* have been collected in "a stagnant swamp," "potholes along a stream" (A. R. Gaufin), and "shaded grassy pools with many leaves" (H. E. Milliron). Apparently this species does not breed in rockholes. Nothing is known of the bionomics and disease relations of *gaufini;* all the adults have been reared.

DISTRIBUTION (fig. **142**).—*New Caledonia:* Poindimie; Tontouta; Dumbea Valley; APO 25. Not known elsewhere.

4. Culex (Neoculex) dumbletoni Belkin, n. sp.

Figs. **142, 143, 147**

TYPE.—*Holotype:* ♂ genitalia on slide (49·VII·11), St. Louis, New Caledonia, Oct., 1944 (USNM, 64758).—This species is dedicated to L. J. Dumbleton in recognition of his contributions to the knowledge of the mosquitoes of the South Pacific.

Culex (*Lophoceraomyia*) sp. of wartime collections on New Caledonia.

FEMALE.—Unknown.

MALE.—Apparently lost.

MALE GENITALIA (fig. **143**).—As illustrated; diagnostic characters as in the key; very similar to *millironi* and differing chiefly in the following. *Segment IX:* tergite lobe with 2,3 bristles. *Sidepiece:* apparently without poorly sclerotized tergal area; sternomesal margin with many small hairs. *Subapical Lobe:* setae of proximal division long and rather heavy; 2 most sternal setae of distal division straight, with simple acuminate apex and no indication of barbs; following seta long, moderately thickened, twisted, and with recurved apex; next seta only slightly flattened and with acuminate apex; most tergal seta simple; tergal surface between the 2 divisions with small thin erect simple hairs. *Phallosome:* subapical tergal sclerotized bridge widely incomplete; apical tooth more slender and longer, hooked apically. *Proctiger:* crown of paraproct with about 12 spines rounded apically; 3,4 distinct cercal setae.

PUPA.—Unknown.

LARVA (fig. **147**).—*Head:* 0.95 mm. *Siphon:* 2.5 mm. *Anal Saddle:* 0.39 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *millironi* and *gaufini* but larger and differing from the latter chiefly in the following. *Head:* moderately to rather darkly pigmented; mental plate broader, proximal teeth more prominent; hair 5-C usually double and nearly as long as hair 6, rarely triple; 6-C usually double, rarely single or with heavy main stem and 2 weak basal branches; 5,6-C both with strong barbs. *Antenna:* uniformly strongly pigmented, darker than head capsule, basal ring blackened; spicules very numerous on basal part. *Thorax:* hairs 7,8-P both usually double; 4-M weak, usually double; 13-T usually very small. *Abdomen:* hair 6-III-VI usually double; 1-IV,V usually triple; 3-IV,V single or double; 13-III-V usually longer. *Segment VIII:* posterior comb scales enlarged, strongly fringed; hair 2-VIII on small but well-sclerotized basal plate. *Siphon:* index about 25.0; very darkly pigmented, sometimes completely black, usually with somewhat lighter area near base; apex not distinctly flared; pecten usually with about 16 teeth, generally similar in structure to *gaufini;* subventral tufts (1,1a-S) generally as in *gaufini,* usually 6 ventral pairs, each with 2 to 4 branches, and only 2 distal dorsal, each usually double or single; hair 2-S rather long but slender, hooked. *Anal Segment:* saddle unevenly pigmented, dorsal area strongly darkened; proximal hairs on grid of ventral brush stronger; usually 2 detached hairs midventrally on saddle proximad of grid, these hairs much stronger and with more branches.

MATERIAL EXAMINED.—9 specimens; 1 male genitalia; 8 larvae; no females, pupae, or individual rearings.

SYSTEMATICS.—*C. dumbletoni* is known in the adult stage only by the holotype male genitalia mounted on a slide; apparently the remainder of the specimen was lost in wartime transit. The larva is only provisionally associated with this male. In spite of this, I am describing this species since the male genitalia are very distinctive.

The presumed larva of *dumbletoni* is superficially very similar to *gaufini* but can usually be readily recognized by the diagnostic characters given above. Both these species are superficially very similar to some species of *Lophoceraomyia* in the larval stage and have been provisionally identified as a species of this subgenus in wartime collections.

In several respects, larvae of *dumbletoni* are intermediate between *millironi* and *gaufini.* This suggests the possibility that the former arose through hybridization of ancient stocks of the other 2 forms.

BIONOMICS AND DISEASE RELATIONS.—This species has been collected in association with *millironi* in rock pools and rockholes. Nothing is known of the bionomics and disease relations of the adults.

DISTRIBUTION (fig. 142).—*New Caledonia:* St. Louis. Not known elsewhere.

5. Culex (Neoculex) leonardi Belkin, n. sp.

Figs. **142, 148, 149**

TYPES.—*Holotype:* ♂ (JNB, 708-5) with genitalia slide (590107-3), West Poha swamp, Guadalcanal, Solomon Islands, from dense grassy swamp, Nov. 1, 1944, J. N. Belkin (USNM, 64759). *Allotype:* ♀ (JNB, 676-21) with associated larval and pupal skins, same data as holotype, Oct. 16, 1944, J. N. Belkin (USNM). *Paratypes:* 6 ♀, 5 ♂, 5 pupae, 19 larvae, same locality as holotype as follows; 1 ♂ (RKL, 140-3) with associated larval and pupal skins, palpal, antennal, and genitalia slides, Oct. 16, 1944, J. Laffoon; 1 larva (RKL, 152), Oct. 24, 1944, L. E. Rozeboom; 1 ♀, 1 ♂, 2 larvae (JNB, 676-2), same data as allotype; 2 ♀, 2 ♂, 2 larvae (JNB, 708-5), same data as holotype; associated larval and pupal skins, ♀ apparently lost (JNB, 713-41), Nov. 3, 1944, J. N. Belkin *et al.*; 1 ♂ (JNB, 714-4), Nov. 3, 1944, J. Laffoon; 1 ♀ with associated larval and pupal skins (JNB, 802-24), 3 larvae (JNB, 802-2), Jan. 5, 1945, M. Cohen *et al.*; 1 larva (JNB, 816-3), Jan. 12, 1945, M. Cohen *et al.*; 2 ♀ with associated larval and pupal skins (JNB, 921-101, 102), 4 larvae (JNB, 921), Mar. 20, 1945, J. N. Belkin *et al.*—This species is dedicated to Justin W. Leonard in recognition of his contributions to the knowledge of the mosquitoes of Guadalcanal.

C. (*Culiciomyia*) sp. of wartime collections on Guadalcanal.

FEMALE.—*Wing:* 2.53 mm. *Proboscis:* 2.05 mm. *Forefemur:* 1.33 mm. *Abdomen:* about 1.7 mm. A small dark species, much more like a species of *Lophoceraomyia* of the *buxtoni* complex than other South Pacific species of *Neoculex*, except for the presence of acrostichal bristles. *Head:* eyes contiguous above antennae; no frontal tuft; decumbent scales largely narrow except for broad scales laterally, this patch of broad scales extending along orbital line in several rows for almost half the distance from lower part of patch to frontal bristles, narrow scales dark beige to bronzy, broad scales pale dingy; erect scales long and slender, all dark, rather numerous; labium dark-scaled; palpus less than 0.15 of proboscis, projecting beyond clypeus for less than length of latter, apparently 4-segmented, dark-scaled, segment 4 less than 2.0 of segment 3; antenna about as long as proboscis or slightly shorter; torus apparently without scales. *Thorax:* mesonotal and scutal integument brown to dark brown; scales very sparse and very narrow, hairlike, all bronzy to dark bronzy, very few on lateral scutellar lobe; acrostichals well developed; dorsocentrals very strong; pleural integument light brown, with darkened upper 0.67 or more and sometimes slightly greenish paler membranes; scales absent except for a few broad translucent pale metallic scales on *stp*, most conspicuous in middle posterior part near bristles, a few scattered above and possibly in middle; *ppn* with 3,4 dark posterior bristles continuous with upper row of short dark hairs extending cephalad to beyond level of the strong humeral bristles of mesonotum, no hairs elsewhere; *ppl* usually with only 2 light bristles and 1 light hair on external surface, none on mesal; *stp* bristles light, in a single curved, interrupted row; *pra* bristles usually 3 dark and 2,3 short light hairs; 3–6 upper *mep* bristles, no lower. *Legs:* coxae with a few pale scales, forecoxa with dark scales; forefemur and midfemur dark-scaled dorsally and anteriorly, pale ventrally and posteriorly; hindfemur predominantly pale-scaled except for dark-scaled apex and dorsal line in apical 0.67, latter expanded ventrad on anterior and posterior surfaces; tibiae and tarsi dark-scaled. *Wing:* dorsal scales all dark; plume scales apparently not developed on dorsal surface of Rs and M, short and broad on base of R_2 and R_3; remigial bristles usually 1,2, short and very inconspicuous; alula with extensive marginal fringe of short hairlike scales; upper calypter with complete marginal fringe of long hairs. *Haltere:* stem light except for dorsal dark line (vein C), knob dark-scaled. *Abdomen:* tergite I with very small posterior central patch of dark scales; tergites II-VII predominantly dark-scaled, IV-V with variable narrow basal transverse more or less complete pale bands slightly widened laterally, VI,VII with small narrow basal transverse pale spots; sternites apparently largely pale-scaled, more distal with progressively broader apical dark bands; hairs short, not numerous, and inconspicuous.

MALE.—*Head:* scales paler than in female, broad scales more extensive. *Labium:* without long hairs dorsally or ventrally. *Palpus:* exceeding proboscis by at least entire length of segment 5; segments 4 and 5 subequal or 5 a little shorter, upturned, both with numerous very long hairs on both margins ventrally; segment 3 with a few long hairs on outer apical angle and a long line of very short curved hairs on inner margin ventrally. *Antenna:* about as long as proboscis or a little shorter; hairs in flagellar whorls very long and numerous. *Legs:* claws not studied. *Abdomen:* tergites III-VII with complete broad basal transverse whitish bands, sometimes widened laterally; tergite II with small central basal whitish patch; hairs moderate.

MALE GENITALIA (fig. **148**).—As figured; diagnostic characters as in the key; markedly different from other species of *Neoculex* from the South Pacific. *Segment VIII:* caudal margin of tergite poorly sclerotized, central part poorly sclerotized and with short hairs. *Segment IX:* tergite small, lobe indistinct but with 2 short bristles. *Sidepiece:* rather narrow, not distinctly swollen; usual long lateral hairs; tergal surface with short hairs except for a few long bristles near base laterally and 1 or more long thin hairs proximad of lobe mesally. *Subapical Lobe:* with very prominent long slender proximal division (*a-c*) bearing a strong twisted flattened seta with recurved apex and a long, smoothly curved, nearly straight seta with recurved apex; distal division with only the sternal group on a slight process bearing 3 setae (*d-f*) with slender base and expanded distal portion, most tergal seta foliform; tergal intermediate group (*g,h*) with an apically rounded or truncate moderate leaf and 2 simple acuminate setae, the more sternal stronger. *Clasper:* strongly broadened; with 2 setae beyond middle; spiniform short, nearly apical. *Phallosome:* lateral plates divergent apically, connected by indistinct narrow subapical tergal bridge; each plate poorly sclerotized, elongate, composed of a sternal wrinkled portion and a tergal broad thin leaf-like lobe. *Proctiger:* with very broad short truncate lateral unsclerotized lobe; crown of paraproct with about 10 long curved flattened poorly pigmented spines, the most lateral and sternal pointed; cercal sclerite indistinct, apparently 1–3 very small and inconspicuous cercal setae near paraproct crown.

PUPA (fig. **148**).—*Abdomen:* 2.41 mm. *Trumpet:* 0.71 mm. *Paddle:* 0.69 mm. Chaetotaxy as figured; diagnostic features as in the key. *Cephalothorax:* uniformly strongly pigmented, anterior ventral portion a little lighter; hairs moderately to strongly pigmented; hairs 1-3-C short; 1-C removed some distance from caudal margin of sclerite; 2,3-C widely separated; 7-C usually triple; 8,9-C both usually double. *Trumpet:* long and very narrow, only slightly widened distally, apex not at all flared; uniformly strongly pigmented, a little darker on tracheoid; tracheoid usually at least 0.5; pinna less than 0.15. *Metanotum:* hairs 10,11-C both usually double. *Abdomen:* uniformly strongly to moderately pigmented, distal segments lighter; hairs moderately pigmented; hair 1-II broomlike, dendritic; 1-III-VI relatively large, multiple; 1-VII multiple; 3-II,III usually double; 5-IV,V about same size as hair 1, multiple; 5-VI,VII multiple, shorter than hair 1; 6-V,VI relatively large; 9-VII thickened, relatively short, usually triple or double; 9-VIII relatively weak, usually 3-5b; 1-IX distinct. *Paddle:* index about 1.6; lightly pigmented, midrib brighter; margins without distinct spicules; hair 2-P sometimes double; 1-P very weak.

LARVA (fig. **149**).—*Head:* 0.68 mm. *Siphon:* 2.22 mm. *Anal Saddle:* 0.38 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *gaufini* and differing from it chiefly in the following. *Head:* hair 1-C dark, shorter; 4-C usually double; 5-C usually relatively weaker and shorter; 14-C multiple. *Segment VIII:* comb scales of distal row with more spatulate apex and with less distinct fringes; tubercle of hair 2-VIII larger and more heavily sclerotized. *Siphon:* index about 28.0; wider at base and usually with strongly concave dorsal margin; apex more strongly flared; usually only 7 pairs of hairs 1,1a-S, only 1 pair usually distinctly dorsal. *Anal Segment:* hair 2-X usually with 3 short branches at base of long main stem; usually only 2 detached hairs 4-X on saddle proximad of grid.

MATERIAL EXAMINED.—49 specimens; 10 ♀; 7 ♂; 7 pupae; 25 larvae; 5 individual larval rearings.

SYSTEMATICS.—*C. leonardi* is markedly different from other species of *Neoculex* in the South Pacific in all stages except the larva. The latter is very similar to *gaufini,* as well as to some species of

Lophoceraomyia, in particular members of the *buxtoni* complex. There are a number of resemblances in the general ornamentation and the male genitalia with *pedicellus* King & Hoogstraal, 1947 from New Guinea, but the 2 species are undoubtedly distinct.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *leonardi* have been collected only in jungle swamps with dense vegetation, in association with several species of the subgenera *Lophoceraomyia* and *Culex*. Nothing is known of the bionomics and disease relations of the adults, all of which have been reared.

DISTRIBUTION (fig. 142).—*Solomon Islands:* Bougainville; Guadalcanal. Not known elsewhere.

Subgenus LOPHOCERAOMYIA Theobald

1905. *Lophoceraomyia* Theobald, Bombay Nat. Hist. Soc., J. 16:245, Apr. 15. *TYPE SPECIES: *L. uniformis* Theobald, 1905, Ceylon; monobasic.—Considered as a lapsus for *Lophoceratomyia* by some authors.

1905. *Lophoceratomyia* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:93, May. TYPE SPECIES: *L. fraudatrix* Theobald, 1905, New Guinea; the first of 2 included species, selection of Brunetti (1914:64).—Considered as a lapsus for *Lophoceraomyia* by some authors, as a valid emendation by others.

1907. *Philodendromyia* Theobald, Monog. Culicidae 4:623. *TYPE SPECIES: *P. barkerii* Theobald, 1907, Sarawak; monobasic.

1910. *Cyathomyia* de Meijere, Buitenzorg Lands Plant., Ann. Jard. Bot., Sup. 3:921–922. TYPE SPECIES: *C. jenseni* de Meijere, 1910, Java; monobasic.

FEMALES.—Small to medium-sized species; ornamentation variable but labium, palpus, and tarsi always dark-scaled. *Head:* vertex usually with a more or less distinct orbital line of broad decumbent scales; eyes contiguous above antennae; frontal tuft not developed; labium very slender, particularly at base, with rather numerous short hairs; palpus less than 0.25 of proboscis, 4-segmented; antenna distinctly longer than proboscis; torus without distinct scales. *Thorax:* acrostichals always absent except on anterior promontory; dorsocentrals strong; mesonotal scales sparse, all narrow, usually long, dark, and producing a rough appearance; scutellar scales narrow; pleural scaling practically absent, sometimes a few narrow scales on upper part of *ppn* and a few broad translucent scales along *stp* bristles, no scales on *apn, ppl, acx, pst, psp, pra,* or *mep;* pleural bristles varied, *apn* sometimes with a few hairs in addition to bristles, *ppn* usually with a few to numerous hairs cephalad of posterior bristles; 1 lower *mep* bristle always present, rarely 2. *Wing:* dorsal scales all dark, usually very scanty except distally; remigial bristles usually small and inconspicuous; alula in South Pacific species with only 5,6 short narrow marginal scales distally; upper calypter with complete fringe of long hairs. *Abdomen:* tergite I with a very small caudal median patch of scales; tergites II-VIII entirely dark-scaled or with lateral, basal, basolateral, or basal transverse pale markings in South Pacific species. *Buccopharyngeal Armature:* not studied.

MALES.—*Labium* (South Pacific species): without false joint; dorsal surface with conspicuous long slender curved hairs laterally on at least apical 0.2, sometimes on apical 0.6 or more, shorter straighter hairs present ventrolaterally in same region; base with 8–12 or more thickened bristles quite different from the 2–4 simple longer bristles of female. *Palpus:* variable in length, sometimes reduced to 0.4 of proboscis; in South Pacific species 5-segmented, always slightly longer than proboscis; segment 1 with a fingerlike slender process on each side, segment 2 about 0.5 of segment 3, segment 3 with a line of short or medium-sized hairs ventrally from base to varied distance distally; segments 4 and 5 slender, upturned, with only a few or with numerous hairs or bristles, segment 5 subequal to 4 or a little shorter or a little longer and with 1 heavy apical differentiated bristle and sometimes 2 less strongly differentiated subapical bristles. *Antenna:* about as long as proboscis; torus simple or with blunt prominence on inner side; flagellar whorls usually long and dense; flagellar segment 8 with a matted tuft of specialized setae, segments 5–7,9,10 often with scales or specialized setae; in South Pacific species flagellar segments 6–8,10 as described for *buxtoni* (fig. **154**), segments 5,9 with varied development of scales. *Legs* (South Pacific species): claws of foreleg and midleg enlarged, unequal; anterior claw of midleg with rather large subbasal or premedian tooth, the others all simple.

MALE GENITALIA (South Pacific species).—Small and inconspicuous, withdrawn and sometimes apparently folded into segment VIII on lower surface. *Segment VIII:* large; tergite without distinct caudal margin, long bristles in a pair of lateral groups separated in the middle and appearing as a pair of lateral lobes, membrane caudally with short setae. *Segment IX:* tergite poorly sclerotized; tergal lobes poorly defined, widely separated, with short hairs or fairly large bristles; sternite large, without hairs. *Sidepiece:* small; moderately swollen in basal half when viewed in dorsal aspect, distal half more or less narrowed; tergomesal margin with a conspicuous sclerotization from near base toward subapical lobe; scales absent, long bristles largely in a single row on ventrolateral surface; tergal surface with short or moderate hairs and sometimes specialized setae but no heavy bristles; sternal surface with short bristles and hairs of varied size; sternoapical area with 1 short differentiated seta. *Subapical Lobe:* strongly differentiated, prominent, directed dorsomesad; simple, not divided, all the setae closely packed but a proximal and distal group discernible; proximal group with setae *a-c* all strongly differentiated, long, thickened, and with modified apex; distal group (*d-g*) always with the most distal sternal seta a long broad leaf, the most distal tergal seta (? *g*) varied from a short simple hair to a large broad leaf, intermediate setae very closely packed, apparently 5, possibly 6 or even more numerous, and arranged in 2 transverse rows so that it is practically impossible to determine accurately their development but apparently all are more or less flattened or leaflike; accessory seta (*h*) varied in development, placed near base of seta *a*; usually 1,2 poorly differentiated setae proximad of setae *b* and *c*. *Clasper:* relatively simple; narrow and uniform in basal half or more, sometimes moderately widened subapically; 2 distal setae and rarely 1,2 in basal half; spiniform nearly apical, under a small hood. *Phallosome:* simple; broad and bulbous at base in dorsal aspect and with a rather broad basal tergal sclerotized bridge; lateral plate with a strong sternal apical curved spine bent tergally; ventral paramere very broad; very similar in all species. *Proctiger:* large and prominent but poorly sclerotized; paraproct crown with a few short, inconspicuous poorly pigmented spicules; apex with short mesal and lateral sternal processes; no basal sternal process; cercal setae usually 2,3, inconspicuous.

PUPAE (South Pacific species).—In general as in subgenus *Culex* but differing conspicuously in the following. *Trumpet:* longer and much narrower; index usually 7.0 to 11.0; pinna much smaller, usually less than 0.25; tracheoid usually to 0.5 or more. *Metanotum:* hair 10-C usually double or single, sometimes weak. *Abdomen:* hair 9-VIII well removed cephalad from caudolateral angle. *Paddle:* usually narrower and with very strong midrib.

LARVAE (South Pacific species).—In general as in subgenus *Culex* but differing conspicuously in the following. *Head:* mouthbrushes all filamentous and simple; hair 1-C moderately thickened, never flattened; 2-C rarely present; 3-C usually short, rarely long; 4-C usually single or with forks in distal half; 5,6-C double or triple, usually at least as long as antenna, rarely shorter; 14-C usually with 2 divergent branches from base, rarely with more; hairs 16,17-C developed as rather long slender spicules. *Antenna:* usually at least 0.7 of head capsule, rarely shorter; proximal part wider than distal but not swollen; spicules usually distinct; hair 1-A distinctly beyond middle; 2,3-A removed short distance from apex. *Thorax:* strong long hairs usually proportionately much longer than in the subgenus *Culex;* 3-P much shorter than 1,2-P, usually less than 0.3 of 1-P, usually single or double, rarely triple. *Abdomen:* hairs 6-III-VI usually proportionately much shorter than in the subgenus *Culex,* often 3-5b. *Segment VIII:* comb in a large triangular patch of several rows of numerous small fringed scales, those of caudal row rarely enlarged. *Siphon:* usually long, index 8.0 to 25.0; acus strongly developed, attached; pecten usually with 10–14 or more teeth, more or less evenly fringed or spiculate on proximal face or with widened base; subventral tufts (1,1a-S) usually from 4 to 6 pairs, rarely 3 on one side, varied in length, all distad of pecten, none strongly displaced dorsad, subapical frequently out of line; 2-S a short simple weak spiniform or conspicuous palmate tuft; valves short; median caudal process of spiracular apparatus conspicuous or short and hidden; hair 9-S slightly thickened, hooklike; other valve hairs usually single and simple. *Anal Segment:* saddle always complete; without acus; without strong marginal spicules but usually with some short spicules present on saddle and caudal membrane; hair 1-X usually short and weak, rarely longer and stronger; 2-X with heavy principal stem and with 1–4 weaker basal branches, 1 of which is sometimes subequal to main stem; ventral brush with 5 or 6 pairs of hairs all on grid, latter strongly developed and with its lateral sclerotization joined to saddle.

SYSTEMATICS (figs. **151-153**).—The subgenus *Lophoceraomyia* is most strikingly characterized by the unique modifications of the male antenna. It shows a number of similarities with *Neoculex, Mochthogenes,* and *Culiciomyia,* but its true affinities cannot be determined at present. *Lophoceraomyia* appears to replace *Neoculex* in the Indomalayan region and the tropical portion of the Australasian region much as does *Melanoconion* in the Neotropical region; indications are that it may contain a very large number of species.

Lophoceraomyia is a very difficult and very poorly known group at present. Superficially the females of most species are unrecognizable since they are largely nondescript dark forms without obvious color pattern. However, differences in chaetotaxy, head characters, and the buccopharyngeal armature do exist and may prove reliable when studied in detail. In the South Pacific forms, the male genitalia do not show striking differences and are most difficult to study because the setae of the subapical lobe are numerous and densely packed. The palpus and the labium of the male show a number of good characters, but these have not been studied outside the South Pacific. The greatest reliance has been placed in the past for the diagnosis of species on the peculiar modifications of the male antenna. While these are certainly valuable diagnostic characters, I find that they are most difficult to study and, furthermore, that there appears to be a considerable amount of individual variation. In this preliminary study of the South Pacific forms, I have found that the characters of the immature stages are the most reliable and that once differences in the larva and pupa are determined, adult characters become more obvious.

The only attempt at a subdivision of *Lophoceraomyia* was made by Edwards (1932:196), who divided it into 3 more or less natural groups, chiefly on the basis of male antennal and palpal characters. A more natural classification must await detailed study of the immature stages. Since all the South Pacific species of *Lophoceraomyia* obviously belong to group B (*Lophoceratomyia* or *fraudatrix* group), I have made no attempt to study the other 2 groups.

Prior to this work, only 2 forms of *Lophoceraomyia* (*buxtoni* and *solomonis*) had been recognized from the South Pacific, and some authors considered both of these as conspecific with *fraudatrix* Theobald, 1905 from New Guinea. I find in this preliminary study that there are at least 23 distinct forms represented in the area and suspect that there are many additional species to be recognized. Eleven of the 23 forms are not named now since they are insufficiently known, but I believe that, when the stages are properly associated and more material is available, the majority of these will prove to be distinct species. In no other group is it as important as in *Lophoceraomyia* to have individual rearings, since several species may be found in one single breeding site. The lack of individual rearings from all islands except Guadalcanal and Espiritu Santo has made this study particularly difficult. It is very probable that I have erred in the association of stages in several species because of this. This study is only preliminary in nature; great caution must be utilized in using the keys. As noted under *solomonis,* all the miscellaneous material of *Lophoceraomyia* from the Solomons without adequate data or that reared from ground pools has been identified as this species but may consist of several species.

The South Pacific species of *Lophoceraomyia* fall into 4 or possibly 5 complexes: (1) the *buxtoni* complex (fig. **151**), with *buxtoni, franclemonti, lairdi,* sp. 14 from Belep Island, and sp. 23 from Rennell and Bellona Islands; (2) the *bergi* complex (fig. **152**), with *bergi, oweni, winkleri, laffooni,* probably sp. 16 from aroid leaf axils, sp. 18 from rock pools, and sp. 21 from Guadalcanal; (3) the *solomonis* complex (fig. **153**), with *solomonis, walukasi, becki,* and sp. 17, 19, and 20 from the Solomons; (4) the *hurlbuti* complex (fig. **153**), with *hurlbuti, perryi,* and sp. 22 from the New Georgia group; and (5) the Santa Cruz complex (fig. **151**), with sp. 13 from Aoba and sp. 15 from the Santa Cruz Islands. This last complex may be a part of the *bergi* complex, or some of the forms within the latter may belong here.

It appears that much of the speciation in the South Pacific *Lophoceraomyia* may have occurred through hybridization; for example, *bergi* combines features of the *buxtoni* complex with the *solomonis* complex (or, more probably, the Santa Cruz complex). There is a possibility that interspecific hybridization is occurring at present within the *solomonis* complex, which appears to be the most recent derivative.

The subgenus *Lophoceraomyia* is fully as interesting as the *kochi* and *scutellaris* complexes and the subgenus *Geoskusea* of *Aedes* and may shed light not only on the zoögeography of the area but also on the pattern of speciation and evolution in the genus *Culex.* Apparently the majority of species of *Lophoceraomyia* of the South Pacific have small breeding populations, short flight range, and a tendency to specialization in small breeding sites. This, I believe, is the explanation for the numerous sympatric forms in the Solomons and the preservation of relict forms in the Belep group, New Hebrides, the Santa Cruz group, and even in the Solomons.

It is impossible at present to reconstruct with any degree of accuracy the phylogeny and history of the species of *Lophoceraomyia* in the South Pacific; however, on the basis of the fragmentary knowledge of their morphology and distribution, the following tentative inferences seem warranted. As in the other groups of mosquitoes, 2 or more waves of dispersal took place in the South Pacific. The most primitive forms occur in the islands to the east and south. The *buxtoni* complex appears to be the most primitive and is represented in the Belep group, the New Hebrides, and the Solomons. The *solomonis* complex is undoubtedly the most recently derived group. The *bergi* complex combines features of the *buxtoni, solomonis,* and Santa Cruz complexes and, together with the poorly known Santa Cruz complex, may consist of relict forms from 1 or 2 intermediate invasions as well as species of hybrid origin between the other complexes. The affinities of the *hurlbuti* complex are obscure, but this complex is closer to the *solomonis* and *bergi* complexes than to the *buxtoni* complex. It is of interest to note that there are a number of similarities between the *buxtoni* complex and some of the species of *Neoculex* in New Caledonia.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of species of *Lophoceraomyia* have been reported from ground pools, treeholes, bamboo stumps, *Nepenthes* pitchers, and artificial containers in areas outside the South Pacific. In the South Pacific they have been found in all types of ground waters (swamps, streams, temporary pools), crabholes, rockholes, treeholes, the leaf axils of aroids and Pandanaceae, and artificial containers. Species utilizing rockholes and small pools in rocky stream beds are particularly numerous in the Solomons.

Very little is known about the bionomics and disease relations of species of *Lophoceraomyia,* but apparently even the females of common ground pool- and artificial container-breeders do not attack man. In the Solomons adults of most species have been found only in the vicinity of the breeding sites resting on the vegetation or moist, shaded stream banks. Apparently only *lairdi* and *solomonis* adults are attracted to artificial lights at night.

DISTRIBUTION (fig. **150**).—*Lophoceraomyia* is confined to the Old World and is predominantly Oriental, Indomalayan, and Australasian in distribution. A few forms are present in the southeastern Palaearctic region, but the subgenus is not represented in the Ethiopian or Malagasy regions. In the South Pacific *Lophoceraomyia* has been recorded only in the Solomons, the Santa Cruz Islands, the New Hebrides, and the Belep group northwest of New Caledonia. It is possible that the subgenus occurs also in New Caledonia proper.

KEYS TO SPECIES

(Keys to subgenera, pp. 180–182)

ADULTS

1\. *Females* (separation of species not at all reliable; 6. *winkleri* and sp. 13, 14, 16, 18, 20, 21, and 23 not included) 2
Males (sp. 13–15, 20, 23 not included) . . 7

2(1). Abdominal tergites with distinct discrete basolateral pale markings on at least V-VII, sometimes more or less produced as incomplete basal transverse bands . . . . 1. *buxtoni;* . . . . 2. *franclemonti;* 3. *lairdi*
Abdominal tergites entirely dark or with more or less distinct narrow pale lateral area from base to apex on tergites V-VII 3

3(2). Hindfemur with dark or dingy scales extending dorsally into at least basal 0.2, sometimes to extreme base 4
Hindfemur completely whitish in at least basal 0.35 5

4(3). Posterior pronotum with only a few hairs cephalad of posterior bristles . . . . 7. *laffooni*
Posterior pronotum with numerous hairs and usually a few scales cephalad of posterior bristles . . . . 8. *solomonis;* . . . . 9. *walukasi;* 10. *becki;* sp. 17 and 19

5(3). Prealar sclerite with only 1 or 2 weak hairs . . . . 11. *hurlbuti;* 12. *perryi*
Prealar sclerite with 4–6 strong bristles . . 6

6(5). Mesonotal fossa with numerous thin hairs in addition to usual bristles . . . . . . 4. *bergi*
Mesonotal fossa with usual bristles only . . . . 5. *oweni;* sp. 15 and 22

7(1). Scale tuft of flagellar segment 5 with at least 10 long subequal scales, linear or broadened at base and acuminate apically 8
Scale tuft of flagellar segment 5 with some shorter broader scales *or* if with linear scales, then scales fewer and not subequal 9

8(7). Scale tuft of flagellar segment 5 predominantly dark, relatively short, scales black or brown, somewhat broadened basally, acuminate distally . . . . 2. *franclemonti*
Scale tuft of flagellar segment 5 predominantly whitish, very long, scales rather uniform in width, rounded or truncate apically, more or less darkened at base, more dorsal sometimes more extensively dark . . . . 1. *buxtoni;* 3. *lairdi*

9(7). Palpal segment 4 with at most 6 pairs of lateral hairs 10
Palpal segment 4 with at least 8 pairs of lateral hairs 12

10(9). Hindfemur with dark or dingy scales extending dorsally into at least basal 0.2, sometimes to extreme base . . . 10. *becki;* sp. 19
Hindfemur completely whitish in at least basal 0.35 (sp. 22 not separated) 11

11(10). Labium with dorsal hairs in distal half or more; hairs of palpal segment 4 weak . . . . 11. *hurlbuti*

Labium with dorsal hairs in distal 0.4 or less; hairs of palpal segment 4 stronger . . . . 12. *perryi*

12(9). Hindfemur with dark or dingy scales extending dorsally into at least basal 0.2, sometimes to extreme base 13

Hindfemur completely whitish in at least basal 0.35, usually more 15

13(12). Most dorsal scales of flagellar segment 5 linear, narrow or bristlelike, *or* if somewhat broadened, then acute or acuminate apically . . . . 7. *laffooni;* sp. 18

Most dorsal 2 or 3 scales of flagellar segment 5 moderately broad and usually rounded apically (sp. 17 not separated) 14

14(13). Scale tuft of flagellar segment 5 with 5–7 broad scales, the upper 2 or 3 usually conspicuously longer, the remaining shorter and acuminate . . . . 8. *solomonis*

Scale tuft of flagellar segment 5 with 7–9 broad scales, upper 2 or 3 usually not markedly longer, the remaining usually acute not acuminate . . . . 9. *walukasi*

15(12). Mesonotal fossa with numerous thin hairs in addition to usual bristles . . . . 4. *bergi;* sp. 16

Mesonotal fossa with usual bristles only, sometimes with a few inconspicuous short hairs 16

16(15). Most dorsal seta of flagellar segment 5 a broad scale with rounded apex . . . sp. 21

Most dorsal seta of flagellar segment 5 bristlelike . . . . 5. *oweni;* 6. *winkleri*

MALE GENITALIA

(sp. 13–15, 20, and 23 not included)

1. Tergal surface of sidepiece with 1 to 4 long differentiated setae toward mesal margin 2

Tergal surface of sidepiece with short hairs only 6

2(1). Most distal tergal seta of subapical lobe a simple tapered hair . . . . 7. *laffooni*

Most distal tergal seta of subapical lobe a large broad leaf 3

3(2). Tergal surface of sidepiece with numerous long hairs laterad of row of 4 differentiated setae . . . . 4. *bergi;* sp. 16

Tergal surface of sidepiece with short to moderately long hairs laterad of 1–4 differentiated setae 4

4(3). Accessory seta of subapical lobe long and thin; tergal hairs laterad of specialized setae moderately long . . . . 3. *lairdi*

Accessory seta of subapical lobe shorter, more or less distinctly flattened; tergal hairs laterad of specialized setae very short . . 5

5(4). Specialized tergomesal setae very strong and long, usually 3, sometimes 4. . . . . 2. *franclemonti*

Specialized tergomesal setae thinner and shorter, always (?) 3 . . . . 1. *buxtoni*

6(1). Clasper with at least 1 seta in proximal half . . . . sp. 18

Clasper without setae in proximal half . . . 7

7(6). Lobe of ninth tergite with several long heavy hairs . . . . 6. *winkleri;* sp. 21

Lobe of ninth tergite with short weak hairs only 8

8(7). Seta *a* of subapical lobe very sharply bent before the middle . . . . 5. *oweni*

Seta *a* of subapical lobe rather evenly curved, not sharply bent (sp. 22 not separated) 9

9(8). Most distal tergal seta of subapical lobe very weak, distant at base from other setae of group; intermediate setae of distal group very long and broad foliforms . . . . 11. *hurlbuti;* 12. *perryi*

Most distal tergal seta of subapical lobe relatively stronger, approximate at base to other setae of group; intermediate setae of distal group shorter and narrower . . . . 8. *solomonis;* 9. *walukasi;* . . . . 10. *becki;* sp. 17 and 19

PUPAE

(7. *laffooni* and sp. 13–16 and 21–23 not included)

1. Hairs 6-IV,V usually at least 4b; 6-I,II very long, over 2.0 of hair 7; 1-C usually at least 4b 2

Hairs 6-IV,V usually at most triple; 6-I,II shorter, less than 2.0 of hair 7; 1-C at most 3b 4

2(1). Hair 1-C with equal branches; 7-C usually 4b; 7-I usually 4,5b; trumpet with very short slit . . . . 1. *buxtoni*

Hair 1-C with unequal branches; 7-C usually triple; 7-I usually double or triple; trumpet with long slit 3

3(2). Hairs 2,3-C triple; 6-III,VI triple; 1-VI much shorter than hair 5 . . . . . 2. *franclemonti*

Hairs 2,3-C usually at least 5b; 6-III,VI usually at least 4b; 1-VI about as long as hair 5 . . . . 3. *lairdi*

4(1). Hairs 6-III-VI all single; 8-C single; 9-VII long, its length about 3.0 distance from caudal border; paddle hairs long and strong 5

At least 2 pairs of hairs double in 6-III-VI; 8-C usually double; 9-VII shorter, its length usually less than 2.0 distance from caudal border; paddle hairs short and usually weak 6

5(4). Hair 1-C very weak and short; 5-IV-VI usually all at least 5b from base . . . . 11. *hurlbuti*

Hair 1-C strong and long; 5-IV-VI usually double or triple, sometimes with additional secondary branches . . . . 12. *perryi*

6(4). Hair 5-VI usually about as long as tergite VII (sp. 18 not separated) 7

Hair 5-VI usually less than 0.7 of tergite VII (sp. 17 and 19 not separated) 9

7(6). Hair 3-I single; 1-C usually triple; 11-C usually single; 12-C very weak and short . . . . 4. *bergi*

Hair 3-I double; 1-C usually double; 11-C double; 12-C stronger and longer 8

8(7). Hair 5-IV usually triple; 10-C usually single; 12-C usually double . . . . 5. *oweni*

Hair 5-IV usually 5b; 10-C double; 12-C usually 5b . . . . 6. *winkleri*

9(6). Hair 5-IV usually at least 5b; 1-VI usually 4b . . . . 8. *solomonis;* sp. 20

Hair 5-IV at most 4b; usually double . . . 10

10(9). Hair 1-III usually 4b; 1-VI usually triple . . . . 9. *walukasi*

Hair 1-III usually at least 7b; 1-IV usually 5b . . . . 10. *becki*

LARVAE

(sp. 16 and 21 not included)

1. Hair 8-P very short, of the same order of magnitude as 11-P; ventral brush with 5 pairs of hairs; pecten teeth with a broad basal part (sp. 22 not separated) 2

Hair 8-P long, of the same order of magnitude as 7-P; ventral brush with 6 pairs of hairs; pecten teeth without broadened basal part 3

2(1). Hair 5-C usually double; 3-P usually double; 6-II longer than 6-III; 6-III-VI weak . . . . 11. *hurlbuti*

Hair 5-C usually triple; 3-P usually single; 6-II shorter than 6-III; 6-III-VI strong . . . . 12. *perryi*

3(1). Hair 2-VIII always double; 6-IV,V at least 4b; median caudal filament of spiracular apparatus very strongly developed (sp. 14 not separated) 4

Hair 2-VIII always single; 6-IV,V usually double or triple, rarely 4b, median caudal filament of spiracular apparatus usually moderate or weak (except in *becki*) 6

4(3). Siphon with 5 or 6 pairs of subventral tufts . . . . 3. *lairdi*

Siphon with 4 pairs of subventral tufts, rarely with 5 hairs on one side (sp. 23 not separated) 5

5(4). Hair 3-P usually single; pecten usually with at least 14 teeth; hair 1-X usually double or triple . . . . 2. *franclemonti*

Hair 3-P usually double; pecten usually with less than 14 teeth; hair 1-X usually at least 4b . . . . 1. *buxtoni*

6(3). Hair 2-S palmate; mental plate with about 25 teeth on each side of median tooth . . . . 4. *bergi*

Hair 2-S simple; mental plate at most with 15 teeth on each side of median tooth 7

7(6). Hair 3-C long, projecting well beyond anterior margin of head capsule; antenna usually less than 0.5 of head length . . . . 5. *oweni;* sp. 18

Hair 3-C very short, never reaching anterior margin of head capsule; antenna moderate to long, at least 0.6 of head length 8

8(7). Siphon with 4 pairs of subventral tufts, rarely with 3 or 5 on one side 9

Siphon with 5 or 6 pairs of subventral tufts 10

9(8). Hair 1-III-VI single and long, usually thickened on IV,V . . . . . . 9. *walukasi;* sp. 17

Hair 1-III-VI usually triple, rarely double . . . . 8. *solomonis;* 10. *becki;* sp. 19 and 20

10(8). Siphon with 5 pairs of subventral tufts, rarely with 6 on one side . . . . . . sp. 13 and 15

Siphon with 6 pairs of subventral tufts . . 11

11(10). Hair 12-C single or forked apically; 7-II usually triple . . . . 6. *winkleri*

Hair 12-C usually 3,4b from base; 7-II usually at least 5b . . . . 7. *laffooni*

1. Culex (Lophoceraomyia) buxtoni Edwards

Figs. 151, 154-156

1926. *Culex* (*Lophoceratomyia*) *hilli* var. *buxtoni* Edwards, B. Ent. Res. 17:106–107. *TYPE: holotype ♂, with attached genitalia mount and associated larval and pupal skins (NH, 5*a*), Vila, Efate, New Hebrides, July, 1926, P. A. Buxton (BMNH).

C. (*L.*) *hilli* var. *buxtoni* of Buxton and Hopkins (1927:90–91); Edwards (1928*a*:276; 1932:197); Taylor (1934:23); Lee (1944*a*:93); Mattingly (1949*b*:223, 227).

C. (*L.*) *hilli buxtoni* of Iyengar (1955:32); Rageau (1958*a*:878).

C. (*L.*) *fraudatrix* of Knight, Bohart, and Bohart (1944:44, 61; in part); Perry (1946:15); Laird (1956); Rageau and Vervent (1958:24); Stone, Knight, and Starcke (1959, in part).

C. (*L.*) *solomonis* of Rageau (1958*a*:878); Rageau and Vervent (1958:25).

FEMALE.—*Wing:* 2.5 mm. *Proboscis:* 1.66 mm. *Forefemur:* 1.3 mm. *Abdomen:* about 1.81 mm. *Head:* narrow decumbent scales pale bronzy or coppery, restricted to a central anterior dorsal triangle which is widened caudally; broad decumbent scales largely dark dorsally, dingy white laterally; erect scales all dark, slender, only slightly widened apically; palpus about 0.22 proboscis length, 4-segmented, segment 3 a little over 0.5 of segment 4. *Thorax:* mesonotal and scutellar integument uniformly dark brown, scales all narrow, rather numerous, uniformly bronzy, somewhat lighter on scutellum; bristles strongly developed, dark; pleural integument usually dark, pruinose, rarely slightly greenish or grayish; *apn* with a few coppery hairs caudad of bristles; *ppn* usually with at least 4 posterior bristles, 3 of which are very strong, area cephalad of bristles with rather numerous short darkish hairs and sometimes a few narrow dark scales; *ppl* with 3,4 bristles and several short hairs; *stp* bristles usually strong and dark in upper half and weaker and lighter in lower; *stp* with several pale hairs cephalad of lower bristles, sometimes (usually?) with a few broad semierect translucent scales; *pra* usually with at least 5 short dark hairs; 1 lower *mep* bristle and usually at least 5 light upper bristles or hairs. *Legs:* forecoxa predominantly dark-scaled, a few paler scales at base; midcoxa and hindcoxa with pale scales; forefemur dark-scaled on anterior and dorsal surfaces from base to apex, with whitish scales on lower posterior surface from base to near apex; midfemur similar except that pale scaling extends on lower part of anterior surface; hindfemur with more extensive whitish scaling, particularly at base but dorsal surface with a narrow dingy dark line extending to base; tibiae and tarsi dark-scaled. *Wing:* all dorsal scales dark; dorsal plume scales short and broad, scanty; remigial hairs very short, inconspicuous; alula with sparse marginal fringe of short narrow scales, usually broken off; upper calypter with complete marginal fringe of long hairs. *Haltere:* stem light, except usually for narrow dorsal dark line; knob dark-scaled, lighter above. *Abdomen:* tergite I with very small median posterior patch of dark scales; tergites II-VII predominantly dark-scaled, IV-VII with basolateral pale to whitish spots, sometimes extended dorsomesad as incomplete basal pale bands on V,VI; sternites with pale to whitish scales.

MALE (figs. **154, 155**).—Essentially as in the female except that there is no indication of pale tergal abdominal spots or bands; dorsal broad scales of vertex paler, usually forming a narrow pale orbital line. *Labium:* base ventrally with about 10–12 or more short thickened bristles; apical 0.25 or less with a few rather long thin outstanding hairs dorsally. *Palpus:* exceeding proboscis by about full length of segment 5 or more; very slender, segments 4 and 5 not markedly swollen or widened, upturned; base of segment 1 with a long fingerlike spiculate light-colored process on each side (laterally and mesally) on ventral surface; segment 2 about 0.5 of segment 3 and without conspicuous hairs; segment 3 with a line of short hairs for entire distance ventrally and with 3,4 long dark bristles apically on outer surface; segment 5 slightly longer than 4, both with rather numerous long bristles on both sides ventrally; apex of segment 5 with 3 heavier, shorter dark bristles. *Antenna* (figs. **154, 155**): flagellar segment 5 with dorsolateral scale tuft of about 12 long slender acute subequal scales, largely whitish in color but the more dorsal darkened at base and sometimes through most of length, usually scales equal to length of 4 or 5 flagellar segments; segment 6 with complex ventrolateral tuft of numerous specialized setae, lateral setae twisted, ventral more smoothly curved; segment 7 with a complex ventrolateral tuft of numerous specialized setae, lateral shorter and with several twists, ventral longer and with single subapical twist; segment 8 with a ventromesal tuft of about 6,7 long close-set dark specialized setae with strong sigmoid twist in distal half, in dried specimen these appear to form a single structure; segment 9 with 2–4 long narrow lateral specialized setae and with 8–10 somewhat thickened ventral bristles; segment 10 with 3 very long slender acute scales; all setae and scales of segments 6–10 dark in color. *Legs:* claws of foreleg and midleg enlarged, unequal; anterior claw of foreleg with large acute subbasal tooth, all others simple.

MALE GENITALIA (fig. **155**).—As figured; diagnostic characters as in the key; very similar to *fraclemonti*. *Segment IX:* tergite poorly defined and poorly sclerotized, lobe indistinct and with a few short thin hairs and numerous spicules of varied size. *Sidepiece:* laterad of tergomesal sclerotization a row of rather long curved hairs, followed by a group of 3 specialized moderately long curved or sigmoid setae, the basal more mesal in position. *Subapical Lobe:* distal group with the most distal tergal seta differentiated as a very broad large leaf; intermediate setae of distal group 4, possibly more, all rather long and flattened but with acuminate apex; accessory seta (*h*) near base of seta *a* tergally, moderately long and usually distinctly flattened or broadened. *Clasper:* moderately widened before apex; 2 short setae subapically. *Proctiger:* paraproct crown with 3,4 short, slender, poorly pigmented spicules mesally and 4,5 heavier short spicules laterally; apex with poorly sclerotized sternal mesal projection and a strongly sclerotized short thumblike sternal lateral projection.

PUPA (fig. **155**).—*Abdomen:* 2.15 mm. *Trumpet:* 0.65 mm. *Paddle:* 0.6 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *franclemonti* and *lairdi;* all available material reared, lightly to moderately uniformly pigmented, field specimens possibly darker. *Cephalothorax:* hair 1-C very near caudal margin of sclerite; 2,3-C widely separated; 1-3-C all usually about 4b; 6-C with 2 primary branches. *Trumpet:* very long and slender, very slightly flared at extreme apex; index about 11.0; strongly pigmented, darker on tracheoid; tracheoid to about 0.6; pinna about 0.12; a short slit in meatus. *Metanotum:* hair 10-C strong, usually double. *Abdomen:* hair 1-II secondarily branched; 1-III-V multiple; 1-VI,VII rather strongly developed; 3-II,III usually double; 5-IV usually 5b; 5-V,VI usually double, 5-VII weaker and shorter; 6-III-VI rather strongly developed, 6-V usually 4b; 9-VII usually 3,4b; 1-IX distinct. *Paddle:* lightly pigmented, apex slightly darkened, midrib very strong and heavily pigmented; margins without distinct spicules; hairs 1,2-P both present and short.

LARVA (fig. **156**).—*Head:* 0.7 mm. *Siphon:* 1.71 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *franclemonti* and *lairdi. Head:* moderately uniformly pigmented except for usual light and darkened areas; hairs strongly to moderately pigmented; labrum and mandible normal; mouthbrushes all filamentous; mental plate usually with 7 teeth on each side of median tooth, basal 1,2 teeth more widely separated; hair 1-C strong, darkly pigmented, relatively short; 2-C not developed; 3-C very short, not reaching labrum; 4-6-C near middle of frontoclypeus; 4-C rather long, slender, forked in apical 0.25; 5,6-C usually double; 6-C longer than antenna; 5-C about as long as antenna; 7-C long, multiple; 8,9-C short, multiple; 11-C rather weak, usually 5b; 12-C short, multiple, mesad of 13-C; 13-C rather strong, usually at least 5b; 14-C short, branched from base; 15-C short, multiple. *Antenna:* about as long as head capsule; strongly curved; basal part wider than distal but not swollen; darker than head capsule, usually lighter in middle; spicules slender and numerous in basal part, shorter and heavier distally and on proximal portion of distal part; hair 1-A usually in distal 0.3; 2,3-A long, strongly pigmented, distinctly removed from apex. *Thorax:* hairs and tubercles strongly pigmented; spiracular sensilla distinct; tubercle of 1-3-P close to middorsal line; hairs 1,2-P more than 2.0 head length; 3-P less than 0.3 of 1,2-P, weak, usually double; 4-P very long, usually double; 5,6-P long, single; 7-P usually triple; 8-P similar to 7-P, usually double; 10,12-M, 10-T extremely long, more than 2.0 head length; 13-T usually large, multiple. *Abdomen:* hairs and tubercles strongly to moderately pigmented; spiracular and dorsal sensilla distinct; hair 1-I,II minute, usually single or double; 1-III-VI usually 4,5b; 3-III-VI all rather long and branched; 6-I,II heavy, 6-I usually triple, 6-II usually double; 6-III-VI moderately strong, usually at least 4b, rarely 2 or 3 of these triple; 13-II,VI dendritic; 13-III-V well developed, usually 3-5b. *Segment VIII:* comb scales small, fringed, in a large patch of several rows; hair 2-VIII usually double. *Siphon:* length variable, index about 16.0–20.0; moderately to strongly pigmented except for black basal ring and darkened apex, sometimes with variable darkened band near middle; pecten usually of 12–14 slender, moderately to lightly pigmented teeth with uniform spicules on proximal border from base to apex; usually with 4 pairs of subventral tufts (1,1a-S), occasionally 5 hairs on one side; hair 2-S small, moderately thickened; valves short; spiracular apparatus with conspicuous median caudal filament. *Anal Segment:* saddle complete, moderately emarginate for ventral brush; moderately to strongly pigmented, somewhat darkened dorsally, without strong marginal spicules but with fine spicules toward caudal margin and on caudal membrane; hair 1-X short, usually 4b; 2-X with long main stem and usually 3,4 short basal branches; ventral brush with 6 pairs of hairs all on grid whose lateral sclerotization is joined to saddle; gills usually shorter than saddle, pointed.

MATERIAL EXAMINED.—150 specimens; 38 ♀; 51 ♂; 10 pupae; 51 larvae; 8 individual rearings (7 larval, 1 pupal).

SYSTEMATICS.—*C. buxtoni* is considered here as a species distinct from *hilli* Edwards, 1922 from Northern Territory, Australia. It is closely related to *franclemonti* and *lairdi* from the Solomons. The male antennal characters of *buxtoni* are very similar to *lairdi*, its larva resembles *franclemonti*, and the male genitalia appear to be intermediate. The larva figured by Laird (1954*a*:289, figs. 9-12) from Art Island in the Belep group north of New Caledonia is very similar to *buxtoni* and undoubtedly belongs to the same complex, but its taxonomic status cannot be determined at present (see sp. 14 following). Species 23 from Rennell and Bellona appears to be very close to *buxtoni* and the related forms.

Although there is considerable variation in all stages of *buxtoni* from different breeding sites and islands, there is no overlap with the Solomons forms and no indication in the limited material I have seen that more than 1 species of the complex occurs in the New Hebrides.

BIONOMICS AND DISEASE RELATIONS.—According to Perry (1946:15), the immature stages of *buxtoni* (as *fraudatrix*) have been found "in shaded areas in permanent swamps among the roots of trees, along shaded, grassy stream margins, and occasionally in rocky pools and abandoned road ruts."

Females do not attack man readily. Both sexes are numerous in the vicinity of breeding sites in shaded areas on the vegetation, tree trunks, and stream banks (Perry, 1946:15). *C. buxtoni* does not appear to be of any economic importance.

DISTRIBUTION (fig. **151**).—*New Hebrides:* Espiritu Santo; Tutuba; Aore; Malekula; Efate; ? Aneityum (Laird, 1956:22; as *fraudatrix*). Not definitely known elsewhere.

2. Culex (Lophoceraomyia) franclemonti Belkin, n. sp.

Figs. **151**, **157**, **158**

TYPES.—*Holotype:* ♂ with genitalia slide (590114-10), Munda, New Georgia, Nov., 1943–Oct., 1944, J. G. Franclemont (USNM, 64760). *Paratypes:* 6 ♂, same data as holotype.—This species is dedicated to John G. Franclemont in recognition of his numerous contributions to the knowledge of the mosquitoes of the Solomon Islands.

FEMALE.—*Wing:* 3.2 mm. *Proboscis:* 2.25 mm. *Forefemur:* 1.66 mm. *Abdomen:* about 2.33 mm. Not definitely associated with male; probably included among material identified provisionally as *lairdi;* 1 individually reared specimen (JNB, 676-24) which appears to be this species on larval characters is very similar to *buxtoni* and *lairdi;* remigial hairs of wing apparently stronger than in *buxtoni.*

MALE (fig. **157**).—In general very similar to *buxtoni* and *lairdi* but differing from both in the following. *Labium:* at least distal half with very long dorsal hairs. *Antenna* (fig. **157**): scale tuft of flagellar segment 5 much shorter, with about 10–12 subequal brown scales broadened and darker proximally, slender and lighter distally but not whitish; lateral scales of segment 9 usually 5,6, longer, broad throughout most of length, and abruptly long-acuminate at apex.

MALE GENITALIA (fig. **157**).—As figured; diagnostic characters as in the key; very similar to *buxtoni* and differing from the latter chiefly in the following; the 3 or sometimes 4 specialized tergomesal setae of sidepiece longer, heavier, and straighter; 5 or possibly 6 setae between the 2 large foliforms on the subapical lobe, all apparently simple, rodlike or only slightly broadened; accessory seta of subapical lobe usually shorter, broader, rather distinctly flattened.

PUPA (fig. **157**).—*Abdomen:* 2.25 mm. *Trumpet:* 0.68 mm. *Paddle:* 0.7 mm. As figured; diagnostic characters as in the key; not definitely associated with male; known from a single female skin; very similar to *buxtoni* and particularly *lairdi;* pigmentation intermediate.

LARVA (fig. **158**).—*Head:* 0.7 mm. *Siphon:* 1.74 mm. *Anal Saddle:* 0.38 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *buxtoni* and differing from it chiefly in the following. *Antenna:* usually more extensively pale in basal part. *Thorax:* hair 3-P usually single. *Abdomen:* hairs 6-III-VI usually all 4b; 13-III-V usually 3,4b. *Siphon:* index about 20.0–25.0; pecten usually with 14 or more teeth; subventral tufts (1,1a-S) usually 4 pairs, sometimes 5 hairs on one side, hairs usually double or triple. *Anal Segment:* hair 1-X usually double or triple.

MATERIAL EXAMINED.—47 specimens; 10 ♀; 21 ♂; 1 pupa; 15 larvae; 1 individual larval rearing.

SYSTEMATICS.—*C. franclemonti* is closely related to *buxtoni* and *lairdi.* It is most easily differentiated in the male, by the hairs of the labium, the scale tuft of flagellar segment 5, and the specialized tergomesal setae of the sidepiece of the genitalia. The sexes and the larval and pupal stages are not definitely associated since no individual rearings of males have been made, but it is probable that the provisional associations are correct. The larva is very similar to *buxtoni* but can be fairly easily differentiated, as indicated in the key.

There is considerable variation in *franclemonti* from the different islands and even on the same island, but all available males conform quite well to a type which is easily distinguished from *lairdi* and *buxtoni*.

BIONOMICS AND DISEASE RELATIONS.—The immature stages, presumably belonging to *franclemonti*, have been collected on several occasions in dense jungle swamps and in swamp pools and once along the margin of a stream. Nothing is known of the bionomics and disease relations of the adults.

DISTRIBUTION (fig. **151**).—*Solomon Islands:* Bougainville; New Georgia; Guadalcanal. Not known elsewhere.

3. Culex (Lophoceraomyia) lairdi Belkin, n. sp.

Figs. **151, 154, 159, 160**

TYPES.—*Holotoype:* ♂ with genitalia slide (JNB, 971-1, 590106-6), Poha swamp, Guadalcanal, Solomon Islands, from swamp with dense vegetation, May 6, 1945, J. N. Belkin (USNM, 64761). *Allotype:* ♀ with associated larval and pupal skins (JNB, 971-11), same data as holotype (USNM). *Paratype:* 1 ♂, same data as holotype (JNB, 971-1, 590106-5).—This species is dedicated to Marshal Laird in recognition of his numerous contributions to the knowledge of the mosquitoes of the South Pacific.

C. (*L.*) *fraudatrix* in part of Stone, Knight, and Starcke (1959).

C. (*L.*) *hilli buxtoni* of Paine and Edwards (1929:308); in part of Iyengar (1955:32).

FEMALE.—*Wing:* 2.66 mm. *Proboscis:* 1.75 mm. *Forefemur:* 1.53 mm. *Abdomen:* about 2.15 mm. Very similar to *buxtoni* and *franclemonti;* at present indistinguishable from these species; apparently with fewer hairs and more upper scales on *ppn* and with remigial bristles stronger than in *buxtoni;* abdominal tergal pale markings variable.

MALE (fig. 159).—Very similar to *buxtoni;* possibly differing in the following. *Labium:* dorsal apical hairs apparently more numerous and longer but restricted to apical 0.3 or less. *Palpus:* bristles and hairs more numerous on segments 4 and 5. *Antenna* (fig. **159**): tuft of flagellar segment 5 usually with about 10 scales, more lateral apparently broader; lateral scales of segment 9 apparently broader.

MALE GENITALIA (fig. **154, 159**).—As figured; diagnostic characters as in the key; very similar to *buxtoni* and differing chiefly in the following; the 3 specialized tergal mesal setae of sidepiece usually weaker, sometimes reduced to 2 or 1, tergal hairs laterad of group distinctly longer; accessory hair of subapical lobe longer, weaker, and very slender, not at all thickened; apical sternal processes of proctiger stronger.

PUPA (fig. **159**).—*Abdomen:* 2.6 mm. *Trumpet:* 0.8 mm. *Paddle:* 0.7 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *buxtoni* and particularly *franclemonti;* differing from former chiefly in the generally darker pigmentation and the following. *Cephalothorax:* hair 1-C with unequal branches; 2,3-C usually at least 5b; 4-C usually with branches beyond middle; 7-C usually triple. *Trumpet:* meatus with longer slit.

LARVA (fig. **160**).—*Head:* 0.7 mm. *Siphon:* 1.85 mm. *Anal Saddle:* 0.37 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *buxtoni,* differing most conspicuously in having usually 5 pairs of subventral hair tufts (1,1a-S) on the siphon, sometimes 6 pairs; hairs 1,3,13-III-V weaker, shorter and with fewer branches; 6-II usually with short third branch; 6-III frequently triple; siphon index about 20.0–24.0.

MATERIAL EXAMINED.—222 specimens; 61 ♀; 62 ♂; 8 pupae; 91 larvae; 1 individual larval rearing.

SYSTEMATICS.—*C. lairdi* is superficially so similar to *buxtoni* that it may be easily confused with the latter, but it can be separated in all stages except the female by inconspicuous constant differences, as noted in the diagnosis.

There appears to be as much variation—individual, ecological, and geographic—in *lairdi* as in *franclemonti,* but all the males I have examined conform to a single type which can be easily recognized from *buxtoni* as well as from *franclemonti.*

I have labeled the majority of the females of the *buxtoni* complex from the Solomons as *lairdi.* It is very probable that included among these are some females of *franclemonti,* which at present cannot be differentiated from *lairdi.*

BIONOMICS AND DISEASE RELATIONS.—

The immature stages of *lairdi* have been collected chiefly in jungle swamps. This species has been reported breeding on Guadalcanal once each along a stream and in a treehole. Both sexes have been taken occasionally in night catches and, more frequently, in day catches and resting on tree trunks. As far as I have been able to determine, females of *lairdi* do not bite man.

DISTRIBUTION (fig. **151**).—*Solomon Islands:* Bougainville; New Georgia; Banika; Guadalcanal. Not known elsewhere.

4. Culex (Lophoceraomyia) bergi Belkin, n. sp.

Figs. **152**, **161**, **162**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 946-21), Poha River, about 3 miles from coast, Guadalcanal, Solomon Islands, in stream bed pool, Apr. 11, 1945, J. N. Belkin (USNM, 64762). *Allotype:* ♀ with associated larval and pupal skins (JNB, 946-23), same data as holotype (USNM). *Paratypes:* 3 ♀, 1 ♂, 2 pupae, 2 larvae, all with same data as holotype (JNB, 946-2), 1 ♂ (JNB, 946-22) with associated larval and pupal skins.—This species is dedicated to Clifford O. Berg in recognition of his contributions to the knowledge of the mosquitoes of the South Pacific.

FEMALE.—*Wing:* 2.55 mm. *Proboscis:* 1.75 mm. *Forefemur:* 1.5 mm. *Abdomen:* about 1.9 mm. In general similar to *buxtoni* but without any indication of pale markings on abdominal tergites and differing most conspicuously in the following. *Head:* erect scales apparently lighter; palpus about 0.17 of proboscis, segment 3 shorter. *Thorax:* scales apparently narrower and lighter; fossa with numerous long, slender hairs; *ppn* with fewer but longer hairs cephalad of caudal bristles, scales apparently absent. *Legs:* light scaling of hindfemur extending completely around at least in basal 0.35, without indication of dingy dorsal line in this region. *Abdomen:* sternites apparently with darker scaling.

MALE (fig. **161**).—Essentially as in the female and differing further from *buxtoni* in the following. *Labium:* apical 0.5 or more with very long slender hairs dorsally and shorter hairs ventrolaterad on apical 0.3 or more. *Palpus:* shorter, usually exceeding proboscis by less than full length of segment 5; segment 3 with ventral hairs longer and apparently restricted to basal 0.6. *Antenna* (fig. **161**): tuft of flagellar segment 5 with 2,3 long broad acute dark scales followed laterad by 2,3 shorter broad acuminate scales and 2,3 very long linear scales; scales of flagellar segment 9 usually 3, very long, rather broad and acuminate; flagellar segment 10 with 2,3 thickened, apically curved ventral bristles.

MALE GENITALIA (fig. **161**).—As figured, diagnostic characters as in the key; in general similar to *buxtoni, franclemonti,* and *lairdi* and differing from all 3 chiefly in the following. *Segment IX:* hairs of tergite lobe longer, usually 4,5. *Sidepiece:* differentiated tergomesal hairs usually 4, in an even, slightly curved row, slender and with outwardly curved distal portion; area laterad of specialized hairs with large patch of long slender straight hairs. *Subapical Lobe:* accessory hair long and slender. *Clasper:* conspicuously broadened just before apex. *Proctiger:* mesal spicules of paraproct crown in a single row, not markedly different from lateral, intermediate area with spicules in 2 rows; apical sternal processes stronger.

PUPA (fig. **161**).—*Abdomen:* 2.4 mm. *Trumpet:* 0.7 mm. *Paddle:* 0.74 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general as in *buxtoni*. *Cephalothorax:* moderately to strongly pigmented, usually darker on mesonotum and leg cases; hair 1-C weak, usually triple; 3-C stronger, usually double or triple; 2-C very weak, usually triple; 4-C very weak, usually double; 5-C strong, usually double; 6-C weak, usually triple; 7-C strong, usually double; 8-C very strong and long, double; 9-C weak, short, double or triple. *Trumpet:* long and slender, strongly and suddenly flared on apex; moderately to strongly pigmented, darkened on tracheoid; tracheoid from about 0.1 to 0.6; a distinct slit in meatus; pinna a little over 0.2. *Metanotum:* darkened; hair 10-C moderate, long, usually double; 11-C strong, single; 12-C weak, double or triple. *Abdomen:* uniformly moderately pigmented; hairs moderately pigmented except for 5-V,VI and 9-VII,VIII which are darker; hair 1-II weak, densely dendritic; 1-III,IV usually 6-8b; 1-V usually 4b; 1-VI usually double, weak but long; 1-VII weak, double or triple; 3-I single; 3-III weak, a little shorter than tergite following; 5-IV rather strong, usually 4b; 5-V,VI strong, usually double and longer than tergite following; 6-II usually single, long but weak; 6-III-V weak, double or single; 6-VI sometimes stronger, single or double; 9-VII with 2–4 primary branches; 9-VIII usually 6-8b; hair 1-IX very distinct. *Paddle:* uniformly lightly pigmented except for bright dark midrib; marginal spicules not developed; hairs 1,2-P both present, moderate.

LARVA (fig. **162**).—*Head:* 0.65 mm. *Siphon:* 1.02 mm. *Anal Saddle:* 0.32 mm. Chaetotaxy as figured; diagnostic characters as in the key; conspicuously different from all other species in the mental plate, length of head hairs 5,6-C, and branching of siphonal hair 2-S. *Head:* uniformly moderately to rather lightly pigmented except for usual light and darkened areas; mental plate with about 25 very close-set inconspicuous long blunt teeth on each side of median tooth; hair 1-C dark, moderately long and thickened; 3-C short, not projecting beyond head capsule, apparently always directed anteromesad; 5,6-C distinctly shorter than antenna, 5-C double or single, 6-C usually double; 12,13-C both single, 13-C long; 14-C multiple. *Antenna:* about 0.7 of head length; largely concolorous with head capsule, extreme base and distal part darkened; spicules essentially as in *buxtoni. Thorax:* chaetotaxy essentially as in *buxtoni* but long hairs shorter; hairs 3,8-P usually single; 7-P usually double; 13-T heavy, usually double. *Abdomen:* chaetotaxy essentially as in *buxtoni* except for following; hair 1-III-VI usually double; 3-III-V usually single; 6-II usually with third branch stronger; 6-III-VI usually double and quite long, 6-VI sometimes single; 13-III-V short, usually single. *Segment VIII:* hair 2-VIII single. *Siphon:* index about 8.0–10.0; usually with more pronounced dorsal concavity than shown in figure; moderately to lightly pigmented, darkened on basal ring, acus, and distal part; short blunt spicules rather conspicuous on distal part; pecten teeth 12–14 or more; subventral tufts (1,1a-S) of 2 types, proximally usually 4 long heavy tufts on one side and 5 on the other, distally 1 short pair with weak branches; hair 2-S a multiple more or less palmate hair; 9-S rather long and heavy; median caudal spiracular filament short and inconspicuous. *Anal Segment:* saddle moderately pigmented, darkened on basal incomplete ring and caudolateral angle; hair 1-X long and rather heavy, usually double; 2-X usually with moderately long branch from base; gills usually longer than saddle.

MATERIAL EXAMINED.—104 specimens; 27 ♀; 45 ♂; 8 pupae; 24 larvae; 5 individual larval rearings.

SYSTEMATICS.—*C. bergi* appears to be closely related to *oweni, winkleri, laffooni,* and sp. 16, 18, and possibly 21. The larva is unique in the subgenus in having hair 2-S palmate and is also readily differentiated by the shortness of hairs 5,6-C. The male genitalia are of the type found in the *buxtoni* complex. There is a strong suggestion that the members of the *bergi* complex may have originated through hybridization between members of the *buxtoni* and *solomonis* complexes.

There is considerable individual variation in *bergi,* but all the available material conforms to a single type as diagnosed and is readily recognized from all other South Pacific species in all stages except the female.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *bergi* have been collected on Guadalcanal in rock pools and pools in blocked stream beds a considerable distance from the coast. Adults were collected on one occasion resting on moist rocky banks of a stream in the vicinity of breeding sites. Apparently females of *bergi* do not attack man.

DISTRIBUTION (fig. **152**).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

5. Culex (Lophoceraomyia) oweni Belkin, n. sp.

Figs. **152, 163, 164**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 775-201), tributary of Matanikau River, Guadalcanal, Solomon Islands, from rock pools, Dec. 9, 1944, J. N. Belkin *et al.* (USNM, 64763). *Allotype:* associated female larval and pupal skins (JNB, 775-206), adult female apparently lost, same data as holotype (USNM). *Paratypes:* 1 ♂, 4 larvae, same data as holotype (JNB, 775-2).—This species is dedicated to William B. Owen in recognition of his valuable contributions to the knowledge of the mosquitoes of Guadalcanal.

FEMALE.—*Wing:* 2.66 mm. *Proboscis:* 1.75 mm. *Forefemur:* 1.36 mm. *Abdomen:* about 1.86 mm. Not definitely associated with male, since the adult from the only available individual rearing has apparently been lost; very similar to *bergi* and differing from *buxtoni* in the same characters except the following; palpus about 0.2 of proboscis; broad decumbent scales of vertex lighter, some whitish near frons, erect scales dark; thoracic bristles and scales darker; mesonotal fossa without conspicuous hairs.

MALE (fig. **163**).—Essentially as in the female; very similar to *bergi* and differing from *buxtoni* in the same characters except for the following. *Palpus:* segment 3 with ventral hairs numerous in basal 0.4 or less and widely spaced beyond; segments 4 and 5 with more numerous but thinner hairs. *Antenna* (fig. **163**): tuft of flagellar segment 5 with about 5 linear dark scales, the 2 dorsal longer, followed usually by about 5 very long slender hairs; scales of flagellar segment 9 usually 4, very long, narrow at base, broadly lanceolate and acuminate distally.

MALE GENITALIA (fig. **163**).—As figured; diagnostic characters as in the key; in general similar to *solomonis* and differing chiefly in the following; seta *a* of subapical lobe slender and abruptly bent before middle; most distal tergal seta of distal group usually markedly flattened.

PUPA (fig. **163**).—*Abdomen:* 2.6 mm. *Trumpet:* 0.62 mm. *Paddle:* 0.75 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *bergi,* differing chiefly in the following. *Cephalothorax:* hair 1-C relatively longer, double; 5-C double or triple; 7-C single or double; 8-C shorter and weaker; 9-C relatively longer. *Trumpet:* relatively broader, not distinctly flared; pinna longer. *Metanotum:* 10-C usually single and strongly barbed, sometimes with distal fork; 11-C double; 12-C relatively longer. *Abdomen:* hair 1-III-VI with fewer branches, 1-IV usually 4,5b, 1-V usually double, 1-VI usually single; 3-I double; 5-IV stronger, similar to 5-V,VI, usually triple and distinctly longer than tergite following; 6-III-VI single or double. *Paddle:* slightly infuscated near apex of midrib.

LARVA (fig. **164**).—*Head:* 0.71 mm. *Siphon:* 1.15 mm. *Anal Saddle:* 0.31 mm. Chaetotaxy as figured; diagnostic characters as in the key; conspicuously different from all other South Pacific species in the short antenna and long head hair 3-C; in general similar to *bergi* but differing chiefly in the following. *Head:* mental plate with 13–15 teeth on each side of median tooth, the proximal 3,4 broader and more widely spaced; hair 1-C longer and straighter; 2-C usually represented by spicule; 3-C usually long, projecting well beyond anterior border of labrum; 5,6-C longer than antenna, 5-C triple, 6-C triple or double; 13-C usually 4,5b; 14-C double from base. *Antenna:* less than 0.5 of head length; usually darker than head capsule; spicules usually stronger; hair 1-A at about 0.6. *Thorax:* hair 8-P usually double; 13-T weaker, multiple. *Abdomen:* hair 1-III,IV usually triple; 6-II usually double; 6-III-VI usually triple; 13-III-V well developed, usually 3,4b. *Siphon:* index about 8.0–9.0; usually with less pronounced dorsal concavity; subventral tufts usually 5 pairs, sometimes 4 or 6 hairs on one side, most distal pair shorter but not markedly different; hair 2-S a short slender spiniform; 9-S weaker. *Anal Segment:* membrane caudad of saddle with more distinct spicules; hair 1-X weaker; gills apparently shorter.

MATERIAL EXAMINED.—110 specimens; 10 ♀; 8 ♂; 16 pupae; 76 larvae; 3 individual larval rearings.

SYSTEMATICS.—*C. oweni* appears to be closely related to *bergi, winkleri, laffooni,* and sp. 16, 18, and possibly 21. The larva is strikingly different from other South Pacific species of *Lophoceraomyia* except sp. 18 in the short antenna and long hair 3-C. The male genitalia are of the *solomonis* type but are easily differentiated by the characteristic bending of seta *a* of the subapical lobe.

This species is known definitely only from Guadalcanal, but it is possible that some of the larvae from Florida or Bougainville provisionally placed in sp. 18 may represent a race of *oweni.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *oweni* have been collected principally in rockholes and in pools in rocky stream beds usually a considerable distance from the coast. A single collection on Guadalcanal (JNB, 867) was made in a treehole along a mountain stream bed. No adults have been collected in nature.

DISTRIBUTION (fig. **152**).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

6. Culex (Lophoceraomyia) winkleri Belkin, n. sp.

Figs. **152, 165, 166**

TYPE.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 833-21), small tributary of Matanikau River, Guadalcanal, Solomon Islands, from rockholes, Jan. 19, 1945, J. N. Belkin *et al.* (USNM, 64764).—This species is dedicated to Eric C. Winkler, a member of the 20th Malaria Survey Unit on Guadalcanal.

FEMALE.—Unknown; not associated with male or immature stages, possibly represented among material identified as *bergi* or *oweni.*

MALE (fig. **165**).—*Wing:* 2.71 mm. *Proboscis:* 1.93 mm. *Forefemur:* 1.43 mm. *Abdomen:* about 2.0 mm. Very similar to *bergi* and *oweni. Palpus:* essentially as in *bergi,* hairs of segments 4 and 5 apparently longer. *Antenna* (fig. **165**): tuft of flagellar segment 5 with 2 most dorsal setae bristlelike, next 2,3 linear scales, followed by 3 very long bristles; lateral scales of segment 9 very narrow, bristlelike, narrowly lanceolate apically. *Thorax:* mesonotal fossa with a few inconspicuous short hairs. *Legs:* hindfemur pale-scaled dorsally in about basal 0.4–0.5.

MALE GENITALIA (fig. **165**).—As figured; diagnostic characters as in the key; very similar to *solomonis* and *walukasi*, apparently differing chiefly in the long hairs of IX tergite lobe.

PUPA (fig. **165**).—*Abdomen:* 2.35 mm. *Trumpet:* 0.55 mm. *Paddle:* 0.7 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *bergi* and *oweni*, differing from the former chiefly in the following. *Cephalothorax:* hair 1-C longer, double; 2-C apparently 5b; 3-C longer, triple; 7-C longer and heavier; 8-C shorter, 9-C longer. *Trumpet:* shorter and broader, not distinctly flared apically; uniformly pigmented; pinna shorter. *Metanotum:* 11-C double; 12-C with branches. *Abdomen:* hair 1-II larger; 1-III,IV shorter but with more branches; 1-V very small, triple; 3-I double; 3-II with 3,4 branches; 5-IV markedly longer than 1-IV; 6-III-VI triple or double. *Paddle:* broader, moderately pigmented.

LARVA (fig. **166**).—*Head:* 0.72 mm. *Siphon:* 1.26 mm. *Anal Saddle:* 0.32 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *bergi* and *oweni* and very similar to *laffooni;* differing from *oweni* chiefly in the following characters. *Head:* mentum with 9,10 teeth on each side of median tooth, the proximal 2,3 widely spaced; hair 1-C shorter; 3-C very short, not reaching labrum; 5,6-C long and double; 12-C single or 2–4 forked at apex. *Antenna:* longer, about 0.7–0.75 of head length; usually concolorous with head capsule except for basal dark ring. *Abdomen:* hair 1-III-VI shorter; 3-IV usually double; 6-II shorter and heavier, only slightly longer than 6-III, with small third branch; 13-III-V weaker and shorter. *Siphon:* index about 9.5–10.5; nearly straight and not as strongly narrowed distally; pecten teeth usually 10–12; 6 pairs of subventral tufts (1,1a-S), shorter and usually 5,6b. *Anal Segment:* hair 2-X usually with only 1 short basal branch in addition to main stem.

MATERIAL EXAMINED.—8 specimens; no ♀; 2 ♂; 1 pupa; 5 larvae; 1 individual larval rearing.

SYSTEMATICS.—Only the holotype of *winkleri* is definitely associated with the immature stages; only one other adult (a male) is known. The larva is very similar to *laffooni* but can be distinguished by the characters given in the key. The single known pupa appears to be distinct from the other known pupae of the *bergi* complex. The single known male of *Lophoceraomyia* sp. 21 from Guadalcanal resembles *winkleri* in having long hairs on tergite IX of the genitalia but is markedly different in antennal characters and in all probability represents a different species.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *winkleri* have been collected only twice in rock pools (JNB, 833) and rockholes (JNB, 829). Nothing is known of the bionomics and disease relations of the adults.

DISTRIBUTION (fig. **152**).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

7. Culex (Lophoceraomyia) laffooni Belkin, n. sp.

Figs. **152, 154, 167**

TYPES.—*Holotype:* ♂ with genitalia slide (590114-15), Halavo, Florida, Solomon Islands, from rock crevices along a jungle stream, about 2 miles from coast, Dec. 17, 1943, K. L. Knight, 841 (USNM, 64765). *Paratypes:* 1 ♂ with genitalia slide (590114-16), same data as holotype; 1 ♂ with genitalia slide (590225-2), Halavo, Florida, Solomon Islands, from small stream in shady area, Dec., 1943, K. L. Knight, 869 (USNM).—This species is named in honor of J. Laffoon in recognition of his valuable contributions to the knowledge of the mosquitoes of the South Pacific.

FEMALE.—*Wing:* 2.81 mm. *Proboscis:* 1.81 mm. *Forefemur:* 1.25 mm. *Abdomen:* about 1.66 mm. Not definitely associated with male, may represent a different species; very similar to *oweni* and differing chiefly in the hindfemur with dorsal dark streak extending to base.

MALE (fig. **154**).—Essentially as in the female except that holotype (but not the paratypes) has the basal 0.2 of hindfemur pale dorsally; differing from *oweni* as follows. *Palpus:* segments 4 and 5 with hairs less numerous. *Antenna* (fig. **154**): scales of flagellar segment 5 broader, followed ventrally by 2,3 long hairs; flagellar segment 9 with only 2,3 long specialized setae which are narrow, more bristlelike, and only narrowly lanceolate apically.

MALE GENITALIA (fig. **154**).—As figured; diagnostic characters as in the key; very similar to *oweni* and differing chiefly in the following; IX tergite lobe with very much longer hairs and bristles; tergomesal surface of sidepiece with 1,2 specialized setae similar to but weaker than in *bergi;* tergomesal margin with more or less regular row of poorly differentiated short hairs, more distal 1,2 stronger; seta *a* of subapical lobe heavier but similarly bent (erroneously labeled *c* in figure).

PUPA.—Unknown.

LARVA (fig. **167**).—*Head:* 0.74 mm. *Siphon:* 1.21 mm. *Anal Saddle:* 0.29 mm. Chaetotaxy as figured; diagnostic characters as in the key; only provisionally associated with male; very similar to *winkleri,* from which it differs chiefly in the following. *Head:* mental plate usually with 8 teeth on each side of median tooth; hairs 5,6-C somewhat longer; 12-C usually with 3 branches from base. *Antenna:* longer. *Abdomen:* hair 6-II somewhat longer than 6-III; 7-II usually at least 5b. *Siphon:* index about 10.0–13.0; pecten usually with 12–14 teeth; subventral tufts usually a little longer.

MATERIAL EXAMINED.—33 specimens; 3 ♀; 3 ♂; no pupae; 27 larvae; no individual rearings.

SYSTEMATICS.—The female and the larva are only provisionally associated with the male since no individual rearings are available. It is possible that one or both of these should be referred to *Lophoceraomyia* sp. 18. *C. laffooni* is very clearly marked in the male. The genitalia show a combination of characters of *bergi, oweni,* and *winkleri.* The presumed larva is very similar to *winkleri.*

BIONOMICS AND DISEASE RELATIONS.—The 2 males of *laffooni* were reared from immature stages collected "from several rock crevices along a jungle stream" (Ingram and Gould; K. L. Knight, 841). Reared from this collection were also 3 females, provisionally identified as *laffooni,* and 1 male, treated below as sp. 18. The larvae are of 2 types, provisionally identified as *laffooni* and sp. 18 (see below). Nothing is known of the bionomics and disease relations of the adults.

DISTRIBUTION (fig. **152**).—*Solomon Islands:* Florida. Not known elsewhere.

8. Culex (Lophoceraomyia) solomonis Edwards

Figs. **153**, **168**, **169**

1929. *Culex* (*Lophoceratomyia*) *fraudatrix* var. *solomonis* Edwards *in* Paine and Edwards, B. Ent. Res. 20:316. *TYPE: lectotype ♂, marked as type by Edwards, with attached genitalia mount, Manaba, Malaita, Solomon Islands, from shallow pool with rotting coconut leaves, Sept. 10, 1928, R. W. Paine; by present selection (BHNH).

C. (*L.*) *solomonis* in part of Iyengar (1955:32).

C. (*L.*) *fraudatrix solomonis* in part of Edwards (1932:197); Taylor (1934:23); Knight, Bohart, and Bohart (1944:44, 61); Stone, Knight, and Starcke (1959).

C. (*L.*) *fraudatrix* in part of Laird (1956); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.77 mm. *Proboscis:* 1.75 mm. *Forefemur:* 1.33 mm. *Abdomen:* about 2.08 mm. In general similar to *buxtoni* but without basolateral pale markings on abdominal tergites and differing most conspicuously in the following. *Head:* narrow decumbent scales more numerous, largely bronzy or dark coppery; broad decumbent scales less numerous in front, apparently not as broad, usually forming an indefinite pale orbital line; palpus about 0.15 proboscis length, segment 3 about 0.4 of segment 4. *Thorax:* mesonotal fossa usually with conspicuous hairs or bristles; *ppn* hairs and scales usually lighter. *Legs:* hindfemur usually with dingy dark line on dorsal surface to base, as in *buxtoni,* sometimes whitish on basal 0.1. *Abdomen:* tergites entirely dark-scaled or indistinctly paler laterally but without basolateral pale spots.

MALE (fig. **168**).—Essentially as in female and differing from *buxtoni* in same general characters and in the following. *Head:* decumbent scales, both broad and narrow, predominantly pale on vertex. *Labium:* apical 0.6 or more with dorsal hairs, very long distally, shorter proximally. *Palpus:* longer, usually exceeding proboscis by more than full length of segment 5; segment 3 with continuous ventral line of hairs, longer and denser at base, shorter and more widely spaced distally, apex laterally with a group of 4 or more long bristles and several short hairs; segment 4 with about 20 or more long bristles and hairs on each side; segment 5 with about 15 or more long bristles and hairs on each side, apex usually with only one differentiated terminal heavy bristle. *Antenna* (fig. **168**): tuft of flagellar segment 5 with 5–7 broad dark scales followed by 6,7 long bristles, usually the 2,3 most dorsal scales longer and rounded apically, the others distinctly acuminate; lateral scales of flagellar segment 9 usually 3,4, narrow at base, long and narrowly lanceolate distally; segment 10 with 3,4 slightly thickened curved dark bristles.

MALE GENITALIA (fig. **168**).—As figured; diagnostic characters as in the key; in general similar to *buxtoni* but differing conspicuously in the absence of specialized tergomesal hairs, the absence of a large broad leaf on the distal tergal area of the subapical lobe, and in the following. *Segment IX:* tergite lobe very poorly defined, with 2,3 short hairs and numerous spicules. *Sidepiece:* tergomesal margin with row of poorly differentiated hairs; middle of tergal surface with very short hairs. *Subapical Lobe:* most distal tergal seta adjacent to sternal foliform rather long and only slightly flattened, not at all foliform; setae in distal division other than the long sternal foliform so closely packed that it is impossible to establish accurately their number and character in any aspect, but apparently there are 5,6 setae in 2 close-set rows and all are more or less leaflike and moderately long; seta *a* of proximal group smoothly curved, not angled; accessory seta moderately long and simple.

PUPA (fig. **168**).—*Abdomen:* 2.19 mm. *Trumpet:* 0.54 mm. *Paddle:* 0.6 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *buxtoni* and differing from it chiefly in the following. *Cephalothorax:* uniformly moderately to strongly pigmented except for darker mesonotum; all hairs usually double except for 2,5-C which are usually triple. *Trumpet:* distinctly shorter; a short slit in meatus. *Metanotum:* darkened; hair 12-C usually triple. *Abdomen:* uniformly moderately pigmented, tergite VIII sometimes darker; hairs moderately to rather strongly pigmented; hair 6-I,II shorter; 6-III,IV usually triple; 6-V,VI usually double. *Paddle:* moderately to lightly pigmented, midrib dark, external buttress and apex usually more or less distinctly infuscated; both hairs stronger.

LARVA (fig. **169**).—*Head:* 0.68 mm. *Siphon:* 1.7 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *buxtoni* and differing from it chiefly in the following. *Head:* mental plate usually with 8,9 teeth on each side of median tooth; hairs usually darker; hairs 5-7,12-C shorter; 5-C sometimes triple; 7-C usually with more branches. *Antenna:* usually concolorous with head capsule except for basal dark ring and darkened distal part. *Thorax:* hairs 1,2-P shorter; 3-P usually single; 4-M usually double or triple; 2,3-T usually with fewer branches; 13-T shorter and weaker. *Abdomen:* hair 1-III-VI weaker and usually triple; 3-III-V weaker, usually double or single; 4-VI usually shorter and 4b; 6-III-VI weaker, usually all triple, rarely 1 or more individual hairs 4b; 13-III-V shorter and weaker. *Segment VIII:* hair 2-VIII single; hair 5-VIII usually 4,5b. *Siphon:* index variable, usually 14.0–18.0; moderately pigmented, usually not darkened in the middle; pecten teeth usually 12–16; subventral tufts (1,1a-S) usually 4 pairs, rarely 3 on one side, variable in length, longer in short-siphoned forms; median caudal filament of spiracular apparatus shorter. *Anal Segment:* caudolateral spicules more numerous but short and inconspicuous; hair 1-X usually double or triple; 2-X usually with only 1 short basal branch in addition to main stem; gills variable, usually longer than saddle.

MATERIAL EXAMINED.—1,088 specimens; 291 ♀; 208 ♂; 61 pupae; 528 larvae; 32 individual rearings (31 larval, 1 pupal).

SYSTEMATICS.—There is considerable uncertainty about the application of the name *solomonis* for this species. Edwards (*in* Paine and Edwards, 1929:316) in describing *solomonis* did not specify a holotype; he marked a male as the type (BMNH), however, and it is obvious that his diagnosis of the species is based on this specimen, which therefore is designated here as the lectotype. This specimen is not mentioned by Paine (*in* Paine and Edwards, 1929:308) but was reared by him from a "shallow pool with rotting coconut leaves" at Manaba, Malaita, as indicated on the label. It is possible that an error in labeling has occurred, for Paine mentions 2 males and 1 female reared from larvae and pupae collected in a treehole at Tenaru, Guadalcanal; I was able to find in the BMNH only 1 pinned female and a slide containing 1 larva, 3 pupae, and 1 male with these data. In addition, there was included under *solomonis* 1 female of *Aedes lineatus* bearing the same locality data as the presumed type of *solomonis.* Since the type specimen agrees well in antennal characters with males reared from ground pools, I have come to the conclusion that the locality and habitat label is correctly associated with the specimen and am using *solomonis* for the ground pool-breeding species. The treehole-breeding species mentioned by Paine is described below as *walukasi.* It may very well be that I am incorrect in this interpretation, but it is impossible to settle this point definitely without associated immature stages; a more or less arbitrary decision must be made. This is further complicated by the possibility that more than 1 species is included in my present interpretation of *solomonis,* as indicated below.

C. solomonis is indistinguishable in the female from the closely related *walukasi* and *becki* but is readily separated in the pupa and larva. The male genitalia of the 3 species are extremely similar; I can find no reliable characters to separate them. While the 3 species can usually be separated readily on antennal, palpal, and labial characters of the male, there appears to be considerable variation and difficulties may be encountered occasionally. There is a great deal of variation in the larva of *solomonis*, but I have made no attempt to analyze it thoroughly, chiefly because of the absence of individual rearings from all islands except Guadalcanal. As in *Culex annulirostris*, specimens from swamps have a long siphon, those from temporary pools a much shorter one, and those from streams are intermediate. There is also considerable variation in pigmentation and branching of hairs.

I have labeled as *solomonis* not only all the material referable to this species on the basis of male, larval, and pupal characters but also all questionable material from ground pools as well as all the females of *Lophoceraomyia* which are not associated with males or immature stages. It is very probable, therefore, that several species are included in this material.

BIONOMICS AND DISEASE RELATIONS.—*C. solomonis* as interpreted here is the most common species of *Lophoceraomyia* in the Solomons and utilizes the widest range of breeding habitats. The immature stages have been found in all types of ground waters, from permanent jungle swamps to stream margins and temporary pools, much as with *Culex annulirostris*. Apparently this is the most plastic and adaptable and the dominant form of *Lophoceraomyia* in the Solomons. Its immature stages have been found most commonly without other species of *Lophoceraomyia* but may be associated at times with *lairdi, franclemonti, bergi, oweni,* and *winkleri*. I have seen 1 collection of *solomonis* from tin cans and 1 from a treehole. In spite of the abundance of the immature stages, *solomonis* is only rarely collected in hand catches, either diurnal or nocturnal. Both sexes have been collected occasionally resting on tree trunks or other vegetation. No specific information on the bionomics and disease relations of the adults of *solomonis* is available.

DISTRIBUTION (fig. **153**).—*Solomon Islands:* Bougainville; Treasury; Kolombangara; New Georgia; Rendova; Guadalcanal; Florida; Malaita. Not known elsewhere.

9. Culex (Lophoceraomyia) walukasi Belkin, n. sp.

Figs. **153, 170, 171**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 737-32), Sprague swamp, Guadalcanal, Solomon Islands, from treehole, Nov. 15, 1944, J. N. Belkin and M. Cohen (USNM, 64766). *Allotype:* ♀ (JNB, 737-3), same data as holotype. *Paratypes:* 3♀, 8♂, 9 pupae, 12 larvae (JNB, 737-3), all with same data as holotype, including 6♂ (JNB, 737-31, 33, 34, 35, 36, 37) with associated larval and pupal skins.—This species is dedicated to Leo Walukas, a member of the 20th Malaria Survey Unit on Guadalcanal.

C. (*L.*) *fraudatrix solomonis* in part of Paine and Edwards (1929:308, 316); Knight, Bohart, and Bohart (1944:44, 61); Mattingly (1949*b*:223, 227); Stone, Knight, and Starcke (1959).

C. (*L.*) *solomonis* in part of Iyengar (1955:32).

C. (*L.*) *fraudatrix* in part of Laird (1956); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.08 mm. *Proboscis:* 2.06 mm. *Forefemur:* 1.67 mm. *Abdomen:* about 2.17 mm. Extremely similar to and at present indistinguishable from *solomonis;* apparently larger in size; orbital pale line sometimes more distinct; pleural bristles usually darker; abdomen apparently darker.

MALE (fig. **170**).—Very similar to *solomonis* and differing from it chiefly in the following. *Labium:* dorsal hairs usually present on apical 0.5 or less. *Palpus:* segment 3 with ventral hairs apparently sparser distally, apical lateral bristles less numerous, usually 3; bristles and hairs of segments 4 and 5 less numerous, usually less than 15 on each side on segment 4. *Antenna* (fig. **170**): scales of flagellar segment 5 broader and usually of more uniform length and shape, usually 7,9, the most dorsal 2,3 rounded and only a little longer than others, latter broader and with acute but not acuminate apex, lateral bristles usually only 2; lateral scales of flagellar segment 9 usually 4, uniform in width from base.

MALE GENITALIA (fig. **170**).—As figured; diag-

nostic characters as in the key; extremely similar to *solomonis* and indistinguishable from it at present; most distal tergal seta of subapical lobe usually somewhat longer and apparently more flattened.

PUPA (fig. **170**).—*Abdomen:* 2.55 mm. *Trumpet:* 0.54 mm. *Paddle:* 0.65 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *solomonis* but generally more strongly pigmented, anterior abdominal tergites darker, and differing conspicuously in the following. *Cephalothorax:* hair 1-C usually stronger and longer; 4-C usually triple; 6-C usually 3,4b. *Abdomen:* hair 1-III usually 4b; 1-IV usually triple; 1-V,VI usually double; 5-IV usually triple; 6-III-VI usually all double.

LARVA (fig. **171**).—*Head:* 0.74 mm. *Siphon:* 1.52 mm. *Anal Saddle:* 0.29 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *solomonis* but differing conspicuously in the long single hairs 1-III-VI and the following. *Head:* head capsule and hairs usually more strongly pigmented; hairs 5,6-C shorter; 4-C often without distinct distal branches. *Antenna:* shorter; darker and usually uniformly pigmented; spicules stronger and more conspicuous. *Thorax:* hair 7-P usually double. *Abdomen:* hair 1-III-VI long and single, usually thickened on IV,V; 6-II sometimes with a weak third branch; 6-III-VI usually stronger; 13-IV,V usually stronger, triple or double. *Segment VIII:* hair 5-VIII usually double. *Siphon:* variable in length, index usually about 12.0 to 20.0; short in specimens from artificial containers, usually long in specimens from treeholes; usually uniformly darkly pigmented, lighter in material from artificial containers; subventral tufts with same variation; median caudal filament of spiracular apparatus usually shorter. *Anal Segment:* saddle usually uniformly darkly pigmented, lighter in specimens from treeholes; caudolateral spicules sometimes more conspicuous; hair 1-X usually double; gills usually shorter than saddle.

MATERIAL EXAMINED.—690 specimens; 111♀; 98♂; 102 pupae; 379 larvae; 45 individual larval rearings.

SYSTEMATICS.—*C. walukasi* is indistiguishable in the female and in the male genitalia from *solomonis* and *becki* but is easily separated from these related species in the larva and pupa and less readily in antennal, palpal, and labial characters of the male. The larva is unique among South Pacific *Lophoceraomyia* in the single hair 1 of abdominal segments III-VI.

There is considerable variation in all stages of *walukasi*, but all the material I have examined conforms to the diagnosis given above and it appears that only 1 species is involved. Specimens from artificial containers are usually less strongly pigmented in the immature stages, have a shorter siphon in the larva, and are larger in the adult stage.

BIONOMICS AND DISEASE RELATIONS.—The natural breeding sites of *walukasi* are treeholes, but this species is commonly found in artificial containers of various types and rarely in coconut shells or husks. Occasionally rockholes may be utilized as breeding sites. Adults of both sexes have been collected resting in treeholes and buttresses of trees, but nothing is known of their bionomics and disease relations. Apparently females do not bite man.

DISTRIBUTION (fig. **153**).—*Solomon Islands:* Bougainville; New Georgia; Roviana; Banika; Florida; Guadalcanal. Not known elsewhere.

10. Culex (Lophoceraomyia) becki Belkin, n. sp.

Figs. **153, 172, 173**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 928-21), Sprague swamp, Guadalcanal, Solomon Islands, bred from crabhole, Mar. 26, 1945, J. N. Belkin and M. Cohen (USNM, 64767). *Allotype:* ♀ with associated larval and pupal skins (JNB, 928-23), same data as holotype (USNM). *Paratypes:* 1♀ with associated larval and pupal skins (JNB, 928-22), 1♂ (JNB, 928-2) with genitalia slide (590106-11), same data as holotype.—This species is dedicated to D. Elden Beck in recognition of his contributions to the knowledge of the mosquitoes of Guadalcanal.

FEMALE.—*Wing:* 2.7 mm. *Proboscis:* 1.91 mm. *Forefemur:* 1.37 mm. *Abdomen:* about 1.6 mm. Extremely similar to *solomonis*, from which it cannot be differentiated at present; apparently no pale scales on orbital line.

MALE (fig. **172**).—In general very similar to *solomonis* and *walukasi* but differing conspicuously in the following characters, which it shares with sp. 19. *Labium:* dorsal hairs apparently longer than in *solomonis*, present on apical 0.6 or more. *Palpus:* segment

3 with ventral hairs largely restricted to basal 0.6, very few distad, apex with only 1 heavy lateral bristle; segments 4 and 5 with fewer bristles and hairs than in *walukasi;* segment 4 with 1 long strong bristle near apex laterally and with about 5,6 shorter, weaker bristles on each side and several hairs ventrally; segment 5 with about 5,6 short weak bristles on each side, numerous short hairs ventrally, 1 pair of subapical poorly differentiated thickened bristles in addition to apical differentiated bristle. *Antenna* (fig. **172**): tuft of flagellar segment 5 entirely different from *solomonis* and *walukasi,* with 4,6 acuminate, narrow, nearly linear dark scales and 5,6 long dark bristles; lateral scales of flagellar segment 9 as in *walukasi,* perhaps a little broader distally.

MALE GENITALIA (fig. **172**).—As illustrated; diagnostic characters as in the key; extremely similar to *solomonis* and indistinguishable from it and *walukasi* at present; median tergal hairs of sidepiece longer; hairs along tergomesal margin thinner and fewer in number; intermediate setae of distal division of subapical lobe possibly broader.

PUPA (fig. **172**).—*Abdomen:* 2.16 mm. *Trumpet:* 0.5 mm. *Paddle:* 0.68 mm. Chaetotaxy as figured; diagnostic characters as in key; very similar to *walukasi* and intermediate in some respects between it and *solomonis;* differing from the former chiefly in the following. *Cephalothorax:* all hairs generally weaker; 2-C usually 4b; 6-C usually double; 9-C usually single. *Abdomen:* all hairs generally weaker; hair 1-III usually 6-9b; 1-IV usually 4,5b; 1-V usually triple; 5-IV usually 3,4b; 1 or more of hairs 6-III-VI sometimes triple. *Paddle:* apparently narrower; hairs weaker.

LARVA (fig. **173**).—*Head:* 0.68 mm. *Siphon:* 1.45 mm. *Anal Saddle:* 0.31 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *solomonis* and differing from it in generally lighter pigmentation of sclerites, tubercles, and hairs and the following characters. *Head:* mental plate usually with 9,10 teeth on each side of median tooth; hairs 5,6-C usually longer, 5-C usually triple, 6-C usually double, sometimes triple. *Abdomen:* hair 6-III-VI usually stronger; 1,13-V apparently longer. *Siphon:* index usually about 13.5–14.5; uniformly lightly to moderately pigmented. *Anal Segment:* hair 1-X usually double; 2-X with 1 strong and usually 1 weak branch in addition to main stem; gills usually shorter than saddle.

MATERIAL EXAMINED.—53 specimens; 9 ♀; 24 ♂; 13 pupae; 7 larvae; 3 individual larval rearings.

SYSTEMATICS.—The females and the male genitalia of *becki* are indistinguishable from the closely related *solomonis* and *walukasi* and sp. 19. The male antenna, palpus, and labium are indistinguishable at present from sp. 19. The larva is quite similar to *solomonis,* while the pupa is more like *walukasi* but in some respects is intermediate between these 2 species. It is very probable that some specimens of sp. 19 are included in the material I have identified as *becki.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *becki* are known only from crabholes, sometimes in association with *Aedes* (*Geoskusea*) *longiforceps.* Several collections of adults have been made in crabholes, but otherwise nothing is known of the bionomics of the adults or of their disease relations.

DISTRIBUTION (fig. **153**).—*Solomon Islands:* ? New Georgia; Guadalcanal. Not known elsewhere.

11. Culex (Lophoceraomyia) hurlbuti Belkin, n. sp.

Figs. **153, 174, 175**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 920-205), Tenaru area, Guadalcanal, Solomon Islands, from leaf axils of pandanaceous plant, probably *Sararanga* sp., Mar. 15, 1945, J. N. Belkin and M. Cohen (USNM, 64768). *Allotype:* ♀ with associated larval and pupal skins (JNB, 920-203), same data as holotype (USNM). *Paratypes:* 3 ♀, 7 ♂, 2 pupae, 2 larvae (JNB, 920-2), same data as holotype, including 2 ♂ (JNB, 920-201, 202) with associated larval and pupal skins.—This species is dedicated to Herbert S. Hurlbut in recognition of his numerous contributions to the knowledge of the mosquitoes of the Pacific Ocean area.

FEMALE.—*Wing:* 2.25 mm. *Proboscis:* 1.41 mm. *Forefemur:* 1.2 mm. *Abdomen:* about 1.58 mm. In general similar to *buxtoni,* differing chiefly in the following. *Head:* narrow decumbent scales dark; broad decumbent scales whitish laterally and along distinct orbital line; erect scales very sparse and narrow on vertex; palpus about 0.17 of proboscis. *Thorax:* pleural bristles fewer, dark on *apn, ppn,* and *ppl,* light on *stp,* *pra,* and *mep; ppn* usually with 3 posterior bristles and 2,3 hairs or hairlike scales cephalad; *ppl* usually with 1 strong bristle and 2,3 hairs or weak bristles; *pra* usually with 1,2 weak hairs; *stp* with about 6 bristles and 6 hairs; upper *mep* with 4,5 weak hairs, lower *mep* bristle strong. *Legs:* hindfemur completely whitish in about basal half. *Wing:* alula with 4–6 short marginal scales distally. *Abdomen:* tergites VI,VII with inconspicuous beige lateral area from base to apex; more anterior tergites sometimes indistinctly pale laterally.

MALE (fig. **174**).—Essentially as in the female except for head and abdominal markings. *Head:* vertex with some of the narrow decumbent scales pale; whitish broad decumbent scales much more numerous. *Labium:* long dorsal hairs in distal half or slightly more. *Palpus:* segment 5 usually distinctly shorter than 4; segment 3 with moderately long hairs in basal portion where they are closely spaced, shorter and more widely spaced in distal half, outer apical angle with 1 thin bristle; segment 4 usually with only 3 pairs of thin lateral bristles and 2 ventral apical hairs; segment 5 with 2,3 pairs of bristles, the middle one heavier, a few short ventral hairs usually also present. *Antenna* (fig. **174**): tuft of flagellar segment 5 with 2 moderately long, narrow, blunt-ended scales, followed laterally by 2 shorter narrow scales with acuminate apex and 2,3 very long hairlike scales or bristles; lateral scales of flagellar segment 9 usually 3 moderately long, narrow, acute scales. *Legs:* hindfemur usually more extensively pale than in female. *Abdomen:* no pale lateral markings on tergites.

MALE GENITALIA (fig. **174**).—As figured; diagnostic characters as in the key; very similar to *solomonis* and *walukasi,* differing apparently only in the following. *Subapical Lobe:* most distal tergal seta very weak, widely separated at base from the large sternal leaf; all setae of distal group apparently foliform, longer and broader than in *solomonis* and *walukasi.*

PUPA (fig. **174**).—*Abdomen:* 2.15 mm. *Trumpet:* 0.5 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *buxtoni* and differing from it chiefly in the following. *Cephalothorax:* uniformly moderately pigmented, mesonotum darker; hairs moderately to lightly pigmented, all short and weak; hair 8-C single. *Trumpet:* narrow, only slightly flared apically; moderately pigmented, a little darker on tracheoid; tracheoid to just before 0.5 but not at base; pinna about 0.25; no slit in meatus. *Metanotum:* darkened; hairs 10,12-C weak, 11-C moderately strong; 10-C single. *Abdomen:* uniformly moderately to lightly pigmented, a little darker on anterior tergites; hairs moderately pigmented; hair 1-II variable, sometimes with primary branches only, usually less than 20b; 1-III usually 7-10b; 1-IV usually double; 1-V usually single; 1-VI very weak, single or double; 5-IV,V strong, longer than tergite following, usually with at least 5 primary branches; 5-VI strong, about as long as tergite following, usually with 5 primary branches; 6-III-VI usually all single, weak; 1-IX distinct. *Paddle:* uniformly lightly pigmented, midrib brighter; hairs 1,2-P both unusually strong and long.

LARVA (fig. **175**).—*Head:* 0.55 mm. *Siphon:* 0.95 mm. *Anal Saddle:* 0.26 mm. Chaetotaxy as figured, diagnostic characters as in the key; very similar to *perryi* and sp. 22, all 3 species conspicuously different from other South Pacific *Lophoceraomyia* in having prothoracic hair 8 very small, pecten teeth with a wide base, and only 5 pairs of hairs in the ventral brush; in general similar to *buxtoni* and differing in the following. *Head:* uniformly lightly pigmented except for usual darkened areas; mental plate usually with 7 teeth on each side of median tooth, proximal 2 widely spaced; hair 1-C lightly to moderately pigmented, long and straight; 4-C relatively longer, usually not forked apically; 5,6-C relatively shorter but both at least as long as antenna, both usually double; 7-C relatively shorter; 12-C relatively longer; 14-C usually triple. *Antenna:* relatively shorter, about 0.6–0.65 of head length; concolorous with head capsule except for dark ring at base; spicules less numerous, smaller, and weaker throughout; hair 1-A with fewer branches. *Thorax:* hairs weaker and somewhat shorter; 3-P usually double; 4,7-P usually single; 8-P minute, about same size as 11-P. *Abdomen:* spiracular sensilla present but indistinct; hair 1-III-VI usually triple; 3-III,IV double or triple; 6-II heavy, triple, distinctly longer than 6-III; 6-III-VI usually double, relatively weak, 6-III distinctly shorter than 6-II, 6-VI sometimes triple; 7-I usually single; 13-III-V usually triple. *Segment VIII:* comb smaller, scales longer, those of posterior row markedly larger; hair 2-VIII single; 5-VIII double or single, long. *Siphon:* index about 9.0–11.0; uniformly lightly pigmented except for darkened basal ring and slight apical infuscation; pecten of about 12–16 teeth; all teeth except extreme basal with basal half broad and with 1 or 2 recurved denticles, distal half a slender spine with very fine fringe of spicules; usually 4 pairs of evenly spaced, long, subequal ventral tufts (1,1a-S), each usually triple or double, rarely 4b; median caudal process of spiracular apparatus short and inconspicuous. *Anal Segment:* saddle uniformly lightly pigmented; hair 1-X usually triple or double; 2-X usually with short basal branch; ventral brush with 5 pairs of hairs; gills usually longer than saddle.

MATERIAL EXAMINED.—152 specimens; 25♀; 22♂; 16 pupae; 89 larvae; 10 individual larval rearings.

SYSTEMATICS.—*C. hurlbuti, perryi,* and sp. 22 from the New Georgia group form a distinct complex which is markedly different in the larval stage from all other South Pacific species of *Lophoceraomyia* and which has not been recognized anywhere else. The male genitalia of these species are very similar to the *solomonis* complex, as are the general adult characters.

I am including under *hurlbuti* all the material I have seen of this complex from Bougainville. The larvae and pupae from these collections agree quite well with *hurlbuti* from Guadalcanal, and the males appear to be quite similar, although the scales of flagellar segment 5 are very similar to those of *perryi*. It is possible that more than 1 species is involved in this material, but it cannot be analyzed without individual rearings.

BIONOMICS AND DISEASE RELATIONS.—On Guadalcanal the immature stages of *hurlbuti* have been collected twice in the leaf axils of a pandanaceous plant (probably *Sararanga* sp.) growing in a densely shaded nipa swamp (JNB, 920, 932), and once each in a typical pandanus on the coastal plain (JNB, 767) and a smooth-leaved pandanus on the Kokumbona trail, about 8 miles from the coast (JNB, 941). On Bougainville this species has been reared from leaf axils of "an arumlike plant" which is probably a species of *Sararanga*. All the known adults have been reared; nothing is known of their bionomics or disease relations.

DISTRIBUTION (fig. **153**).—*Solomon Islands:* ? Bougainville; Guadalcanal. Not known elsewhere.

12. Culex (Lophoceraomyia) perryi Belkin, n. sp.

Figs. 153, 176, 177

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 960-12), Balasuma area, Guadalcanal, Solomon Islands, from pandanus leaf axil, Apr. 30, 1945, M. Cohen *et al.* (USNM, 64769). *Allotype:* ♀ (JNB, 960-1), same data as holotype (USNM). *Paratypes:* 1♀, 7♂, 3 pupae, 16 larvae (JNB, 960-1), same data as holotype, including 3♂ (JNB, 960-11, 13, 14) with associated larval and pupal skins.—This species is dedicated to William J. Perry in recognition of his numerous contributions to the knowledge of the mosquitoes of the South Pacific.

FEMALE.—*Wing:* 2.53 mm. *Proboscis:* 1.7 mm. *Forefemur:* 1.4 mm. *Abdomen:* about 1.45 mm. Very similar to *hurlbuti* and differing from it apparently chiefly in the following. *Thorax: ppn* usually with only 1,2 of the posterior bristles strong, the other 1,2 weak, hairs more numerous cephalad of bristles; usually 3 distinct *ppl* bristles; *pra* usually with 3 short dark bristles; upper *mep* hairs stronger. *Legs:* hindfemur apparently less extensively pale dorsally, usually in less than basal 0.5. *Abdomen:* tergites V-VII with lateral pale markings.

MALE (fig. **176**).—Essentially as in *hurlbuti* and differing apparently chiefly in the following. *Labium:* long hairs usually confined to apical 0.4. *Palpus:* sometimes exceeding proboscis by full length of segment 5; segment 3 with hairs not as distinctly spaced distally; segment 4 usually with 3,4 pairs of stronger bristles on each side and several short hairs ventrally; segment 5 with hairs longer and more bristlelike. *Antenna* (fig. **176**): lateral scales of flagellar segment 9 apparently narrower. *Legs:* hindfemur pale dorsally in about basal 0.3–0.4.

MALE GENITALIA (fig. **176**).—As figured; diagnostic characters as in the key; apparently indistinguishable from *hurlbuti.*

PUPA (fig. **176**).—*Abdomen:* 2.0 mm. *Trumpet:* 0.54 mm. *Paddle:* 0.62 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *hurlbuti* and differing chiefly in the following. *Cephalothorax:* hairs 1,3,5,7-C much stronger, usually twice as long. *Metanotum:* 10-C usually double. *Abdomen:* hair 1-III usually stronger and with more branches; 1-IV usually triple; 1-V usually double; 1-VI stronger, usually single; 5-IV usually triple; 5-V usually double and considerably longer; 5-VI usually double, sometimes secondary apical branches, as shown in figure.

LARVA (fig. **177**).—*Head:* 0.6 mm. *Siphon:* 1.07 mm. *Anal Saddle:* 0.28 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *hurlbuti* and differing chiefly in the following; pigmentation of sclerites and hairs moderate to rather strong, conspicuously darker than in *hurlbuti. Head:* hair 1-C usually shorter and darker, often blackish; 5,6-C heavier and longer, 5-C usually triple, 6-C double or triple. *Antenna:* usually darker than head capsule; spicules stronger and more conspicuous; hair 1-A with more numerous branches. *Thorax:* hairs usually stronger; 3-P usually single. *Abdomen:* spiracular sensilla more or less distinct; hair 6-II shorter and somewhat heavier, shorter or at most equal in length to 6-III; 6-III-VI heavier and longer. *Siphon:* usually longer, index about 10.0–11.5; pecten teeth usually 12–14, distal spine of individual tooth with longer and heavier spicules proximally. *Anal Segment:* spicules more distinct dorsolaterally; hair 1-X usually double; 2-X with stronger branch, usually subequal to main stem; gills usually shorter.

MATERIAL EXAMINED.—45 specimens; 4♀; 11♂; 8 pupae; 22 larvae; 4 individual larval rearings.

SYSTEMATICS.—*C. perryi* is closely related to *hurlbuti* and sp. 22 from the New Georgia group. It is possible that some of the material identified as sp. 22 may actually be *perryi.* This species is very similar to *hurlbuti* in the adult stage, but the larva and pupa are quite distinct, in spite of considerable variation.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *perryi* have been collected twice in the leaf axils of a typical pandanus growing in partial shade in the jungle in the broad coastal plain in the Balasuma-Nalimbu area of Guadalcanal (JNB, 790-2, 960-1). All the adults are reared; nothing is known of their bionomics and disease relations.

DISTRIBUTION (fig. **153**).—*Solomon Islands:* Guadalcanal. Not known elsewehere.

13. Culex (Lophoceraomyia) sp., Aoba form

Fig. **151**

I have seen only 1 larval skin and the associated male pupa of this form, collected in a large treehole near Crater Lake, Aoba Island, New Hebrides, Aug. 24, 1956, D. Bonnet, 61-4(UCLA), in association with the immature stages of *Tripteroides melanesiensis* and *Aedes aobae.* The larva of this form is not *buxtoni.* It is of the *solomonis* type but unlike *solomonis* in that the siphon has 6 subventral tufts on one side and 5 on the other. It resembles in this and other respects the larvae of sp. 15 from the Santa Cruz Islands and may possibly be conspecific with one of these forms (see below). The siphon is strongly pigmented and darkened in the middle. The pupa appears to be of the *solomonis* type also but is different in details of chaetotaxy. This form cannot be described until more material of all stages is available and comparison can be made with all stages of the Santa Cruz forms. It is of great interest that such a form occurs in the New Hebrides and that it shows the greatest similarity to the forms from the Santa Cruz Islands. Material examined: 1 pupa; 1 larva.

14. Culex (Lophoceraomyia) sp., Belep form

Fig. **151**

Culex (*Lophoceratomyia*) *fraudatrix* of Laird (1954*a*:291); Rageau (1958*a*:878; 1958*b*:6).

Laird found 3 larvae of a species of *Lophoceraomyia* in a rock pool in the bed of a small stream on Art Island, one of the Belep Islands northwest of New Caledonia. I have not seen any material of this form, but the drawings of Laird (1954*a*:289, figs. 9-12) are sufficiently detailed to indicate that it belongs to the *buxtoni* complex and is very similar to *buxtoni* itself. The identity of this form cannot be determined until all stages are studied, but it seems improbable that this form is *buxtoni.* It is possible that this form occurs also on New Caledonia proper; to date, however, all the material in wartime collections from New Caledonia identified as *Lophoceraomyia* sp. has proved to belong to species of *Neoculex.* Material examined: none.

15. Culex (Lophoceraomyia) sp., Santa Cruz forms

Fig. **151**

The material of *Lophoceraomyia* from the Santa Cruz Islands is represented by the following collections: 15 larvae, Peuo, Vanikoro, from old steam boiler, Aug. 11, 1956, D. Bonnet, 32 (USNM, UCLA); 2 females, Graciosa Bay, Santa Cruz, on schooner, A. G. Carment (BMNH); 2 larvae, Lawai, Santa Cruz, from ground well, Aug. 30, 1956, D. Bonnet, 74 (USNM, UCLA); 13 larvae, Lawai, Santa Cruz, from rain barrel, Aug. 30, 1956, D. Bonnet, 76 (USNM, UCLA); 8 larvae, Naelo, Reef Islands, from groove in trunk of fallen tree, Aug. 31, 1956, D. Bonnet, 78 (USNM, UCLA).

The females do not show a distinct pale orbital line on the vertex or basolateral tergal abdominal markings and have the hindfemur completely white-scaled in the basal 0.4. The larvae are diverse, but all are of the *solomonis* type except 1 (Bonnet, 32), which has hairs 6-IV-VI with 4 branches but hair 1-VIII single. All the larvae usually have 5 pairs of moderate to quite long subventral tufts on the siphon.

It appears that at least 2 and probably 3 species are represented in this material and that none of these is conspecific with any of the species in the Solomons, although possibly one is the same as sp. 13 from Aoba Island in the New Hebrides. These forms seem to be in some respects intermediate between the *buxtoni, solomonis,* and *bergi* complexes. Material examined: 2 ♀; 38 larvae.

16. Culex (Lophoceraomyia) sp., Solomons aroid form

Fig. 152

This form is represented by a single male (JNB, 576-2) reared from a collection made in a leaf axil of a wild aroid with a tall stem and growing in dense shade along the Matanikau River, Guadalcanal, Solomon Islands, about 3 miles south of the coast (UCLA). The genitalia appear to be indistinguishable from *bergi,* but the head scales (including the erect scales) are nearly all whitish or pale and the thoracic bristles are weaker. It seems probable that this form represents a distinct species which may be related to the *bergi* complex. Since the unique specimen is in rather poor condition, this form is not named or described in detail for the present. Material examined: 1 ♂.

17. Culex (Lophoceraomyia) sp., Solomons ground forms

Fig. 153

Several collections of *Lophoceraomyia* made in ground pools in the Solomons have the larva and male antenna very similar to *walukasi* and the pupa intermediate between *walukasi* and *solomonis.* These forms differ in small details from *walukasi* and do not seem to belong to this species, which is apparently restricted to breeding in treeholes. They may represent an ecotype of *walukasi,* may possibly be hybrids between *walukasi* and *solomonis,* or may represent a distinct species. Since only 1 individual rearing is available, this problem cannot be resolved at present. These forms are known from Bougainville, Rendova, New Georgia, Sasavele and Guadalcanal. Material examined: 107 specimens; 17 ♀; 23 ♂; 5 pupae; 62 larvae; 1 individual larval rearing (JNB, 775-208).

18. Culex (Lophoceraomyia) sp., Solomons rock pool forms

Fig. 152

Several collections of *Lophoceraomyia* made in rock pools and in rocky streams on Florida (KLK, 838, 840, 841; Bonnet, 107; USNM), Sasavele (JGF, Nov. 21, 1943, erroneously labeled as collected by JNB; USNM), and Bougainville (ABG, 393, 406; USNM) have a larva very similar to but differing in slight details from *oweni,* especially in the branching of hairs 5,6,13-C. The associated pupae are of the *bergi* complex but have not been studied in detail. A male from Halavo, Florida (KLK, 841), is very similar to *laffooni* and has the hindfemur dark to the base dorsally; its genitalia resemble *oweni,* but seta *a* of the subapical lobe is not as sharply bent and the clasper has 1,2 setae in the proximal half. A second male from the same locality (KLK, 836) lacks the genitalia but appears to belong to the same form. Two males from Bougainville (ABG, 406) were found too late to be included in this study. Since there are no individual rearings, the males and the immature stages of sp. 18 are not definitely associated; since the same is true of *laffooni*, which is represented in one of these collections (KLK, 841), there is a possibility that the immature stages of the 2 forms are not correctly associated; furthermore a race of *oweni* may also be represented in this material. This problem cannot be resolved until individual rearings are available; for the present, I am referring all these forms to sp. 18. Material examined: 113 specimens; 12 ♀; 4 ♂; 12 pupae; 85 larvae.

19. Culex (Lophoceraomyia) sp., Solomons treehole forms

Fig. 153

Several collections of *Lophoceraomyia* made in treeholes, coconut shells, and artificial containers in the Solomons are strikingly different from *walukasi* in that the larva is quite similar to *solomonis* and *becki*, the pupa intermediate between *walukasi* and *solomonis*, and the male antenna and palpus similar to *becki*. The male genitalia are of the *solomonis*-*walukasi* type. It seems to me that a distinct species is involved, but it is possible that this is an ecotype of *solomonis* or perhaps a hybrid form between *solomonis* and *walukasi*. Since only 2 individual rearings are known, the problem cannot be resolved at present. These forms are known from Bougainville, Florida, and Guadalcanal. Material examined: 53 specimens; 8 ♀; 7 ♂; 5 pupae; 33 larvae; 2 individual larval rearings (JNB, 590-21, 737-38).

20. Culex (Lophoceraomyia) sp., Bougainville pandanus form

Fig. 153

This form is represented by a single collection of immature stages from Bougainville, Solomon Islands, from pandanus leaf axils, July 10, 1944 (ABG, 424; USNM). I have not been able to find any adults reared from this collection. The 2 fourth-instar larvae and the single pupal skin are of the *solomonis* and not of the *hurlbuti* type. I have not studied this material in detail because of its poor condition, but it is quite apparent that this form is distinct from any of the described species from the Solomons. It is possible that it is conspecific with sp. 16, which is known by a single male reared from a leaf axil of an aroid on Guadalcanal. Material examined: 6 specimens; 1 pupa, 5 larvae.

21. Culex (Lophoceraomyia) sp., Guadalcanal form

Fig. 152

A single male, collected on a moist rocky bank of a stream (JNB, 1242), resembles *winkleri* in having long hairs on tergite IX of the male genitalia which are of the *solomonis* type, but the antennal characters are quite different from *winkleri*. The tuft of flagellar segment 5 has a long blunt-ended fairly broad dorsal scale followed by 3 moderately broad acuminate scales and 2,3 long ventral bristles; on segment 9 the specialized setae are thickened bristles similar to those on segment 10, possibly slightly flattened but not scalelike or lanceolate apically. There is a possibility that this is an aberrant specimen of *winkleri* or *solomonis* or a hybrid individual, but it may also represent a distinct species. Material examined: 1 ♂.

22. Culex (Lophoceraomyia) sp., New Georgia pandanus forms

Fig. 153

I am including here all the forms of *Lophoceraomyia* collected in pandanus leaf axils in the New Georgia group of the Solomon Islands, as follows: Sasavele Island (JGF, 77); Rendova Island (JGF, 93); and Segi Point, New Georgia Island, C. O. Berg (65, CU; 62, 97, USNM). At least 2 forms are represented in these collections, and neither appears to be *hurlbuti* or *perryi*. The larvae from Segi Point have features of both *hurlbuti* and *perryi* but they have not been studied in detail; no pupae or males are represented and the females are in poor condition. The Sasavele material consists of adults only; the males have the scales of flagellar segment 5 broader than *hurlbuti*, and there are small differences as well in the labium, palpus, and pleural chaetotaxy. The Rendova material is represented also by adults only; the males are similar to *perryi* in the antennal scales but differ in the labium, palpus, and pleural chaetotaxy. Material examined: 39 specimens; 16 ♀; 13 ♂; no pupae; 15 larvae; no individual rearings.

23. Culex (Lophoceraomyia) sp., Rennell form

Fig. 151

Culex (*Lophoceratomyia*) *hilli* var. *buxtoni* of Root (*in* Lambert, 1931:163).
Culex (*Lophoceraomyia*) *fraudatrix* of Laird (1956:32, 33).
Culex (*Lophoceraomyia*) sp. of Laird and Laird (1959:216).

The material of *Lophoceraomyia* I have seen from Rennell Island consists entirely of larvae, the majority collected by J. de Beaux (UCLA)—in a taro garden at Songoa (R-3), in a water hole (R-5) and a rock pool used for bathing (R-6) at Matangi, in a rock pool (R-8) and in a coconut shell (R-11) at Teabamangu, in a rock pool used for drinking at Hatangua (R-12)—and a single larva collected by E. S. Brown (4210; UCLA) at Matangi. These larvae are undoubtedly of the *buxtoni* complex and are very similar to *buxtoni* and *franclemonti* but are apparently distinct from either of these species. Since the larval material is in poor condition and males are not available, I have made no attempt to describe this form. It seems probable that it will prove to be a distinct species; however, it may possibly be a local race of either *buxtoni* or *franclemonti* or even a typical *buxtoni* spread by natives from the New Hebrides–Santa Cruz area along with *Aedes* (*S.*) *hebrideus*. Apparently the form I have seen is the same as the one reported as *fraudatrix* by Laird (1956:32, 33) and Laird and Laird (1959:216) from Rennell and Bellona in a dugout water container (231), a large pool in a coral boulder (232), a treehole (237), brackish water in a canoe (238), a large drum (247), and a spring-fed pool surrounded by rocks (248, 249). Lambert (1931:163) reports 3 ♂, 2 ♀ identified by F. M. Root as *C.* (*L.*) *hilli* var. *buxtoni*; these specimens appear to have been lost. Material examined: 25 larvae.

TRIBE AEDEOMYIINI

Genus AEDEOMYIA Theobald

1901. *Aedeomyia* Theobald, J. Trop. Med. 4:235, July 15, no included species; Monog. Culicidae 1:98 and 2:218–219, Nov. 23. TYPE SPECIES: *Aedes squamipennis* Lynch Arribalzaga, 1878, Argentina; first subsequently included species unquestionably referred to genus, selection of Brunetti (1914:54).

1902. *Aedomyia* Giles, Handbook Gnats Mosq., ed. 2, p. 478. TYPE SPECIES: automatically *Aedes squamipennis* Lynch Arribalzaga, 1878, Argentina.—Invalid emendation of *Aedeomyia* Theobald, 1901.

1923. *Lepiothauma* Enderlein, Wiener Ent. Ztg. 40:25–26. TYPE SPECIES: *L. furfurea* Enderlein, 1923, West Africa; original designation.

FEMALES.—Small, highly ornamented mosquitoes with very broad scales, superficially resembling some *Aedes*, readily distinguished by the structure of the antenna. *Head:* eyes moderately separated above antennae; frontal tuft short but prominent; decumbent scales broad, most numerous laterally and in front of vertex, continued ventrad between eyes and then forming a pair of lines to antennal rim; a few decumbent scales laterodorsad of antennal bases, a small patch of decumbent scales laterad at base of clypeus; erect scales numerous; orbital bristles strongly developed; clypeus large and prominent, roughly heptagonal, with decumbent scales; labium short, uniform in width, never swollen, flexible, dark-scaled except usually for apical, submedian, and subbasal complete or incomplete light rings, one or more of latter sometimes absent, 4 or more pairs of subbasal ventral bristles; palpus about 0.20–0.25 of proboscis, dark-scaled except for some white scales near tip, middle, and sometimes base, 3-segmented, segment 1 with several long bristles and 1,2 scales near apex, segments 2 and 3 greatly widened and with scales on dorsal surface only, segment 2 with 1 very long dorsal bristle; antennal scape very short but with prominent outstanding scales along apical rim; torus very small, with small decumbent scales, bristles rather long and confined to mesal portion; flagellum (fig. **179**) distinctly shorter than labium, all segments very thick and short, flagellar whorls poorly developed, a dense vestiture of short light hairs, flagellar segment 1 with a large tuft of scales, flagellar segment 13 with a slender small apical projection which may be a vestige of segment 14. *Thorax:* mesonotum weakly arched; scutellum trilobed; postnotum bare; paratergite bare above; *apn* lobes moderate and moderately separated; *pra* not separated by a suture from *stp;* meron large, its upper edge distinctly above base of hindcoxa; mesonotum with dense vestiture of broad decumbent scales and with outstanding tufts of scales in antealar and supraalar areas and sometimes just caudad of scutal angle and along dorsocentrals in front of prescutellar area; acrostichal bristles short but numerous, dorsocentrals well developed; scutellum with small broad scales and sometimes outstanding tufts of longer scales on lateral lobe; *apn* with a dorsal and a ventral group of numerous bristles, and with numerous small scales; *ppn* with a group of several bristles in upper caudal part, upper part densely scaled, a small patch of scales in lower middle; *ppl* with several well-developed bristles and numerous scales; *pst* with scales; antecoxal (*acx*) and postcoxal (*pcx*) membranes with scales; *sp* bare; *psp* area without bristles but with a large patch of scales; another patch of scales underneath paratergite, sometimes a few scales on its border; *stp* with usual bristles, a large area of scales in upper part extending uninterrupted to *pra,* a smaller patch of scales in lower caudal portion; *pra* with numerous bristles; *mep* with a continuous row of long bristles along anterior border, an upper group of numerous bristles, a large triangular patch of scales covering upper anterior half; metameron with a patch of scales. *Legs:* rather short; bristles well developed; forefemur short and with a few suberect scales apically; midfemur and hindfemur progressively longer, somewhat swollen, and with large suberect tufts of scales apically; hindtibia with some suberect scales in basal 0.5; femora and tibiae speckled; hindtarsal segment 1 about as long as tibia; foretarsal segment 4 markedly shorter than segment 5; tarsi with more or less distinct light rings; all claws large, equal, and simple; pulvilli not developed. *Wing:* rather short and broad; microtrichia distinct; very densely scaled, dorsal scales all large broad, asymmetrical, decumbent, and in a speckled and spotted pattern; cell R_2 longer than vein R_{2+3}; veins Rs and R_{4+5} without basal spurs, vein Rs unusually long; vein 1A long, nearly straight, ending far distad of level of fork of Cu; vein R without dorsal remigial bristles; vein Sc without bristles at base ventrally; plical area with a patch of scales at base ventrally; alula with a large patch of dorsomarginal scales; upper calypter with a continuous row of numerous long narrow scales. *Abdomen:* tergites and sternites almost completely scaled; tergite I scaled in center only; laterotergite with dorsal and lateral patches of scales; sternite I distinctly sclerotized; bristles well developed, especially on proximal segments; tip of abdomen blunt. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; segment VIII not retractile, tergite subequal to sternite, latter with a pair of long specialized bristles; tergite IX not developed; cercus very short, broad and horizontal; postgenital plate broader than long; spermatheca single, large, and with large funnel-like projection at base of duct (Edwards, 1941:65).

MALES.—Essentially as in the females. *Palpus:* same length and apparently same segmentation as in the females. *Antenna* (fig. **179**): flagellum densely long-plumose, shorter than labium; flagellar segment 1 distinctly longer than segment 2 and with a tuft of scales; flagellar segments 1-11 elongate but broad, with dense postmedian or subapical whorls of very long bristles, segments 12 and 13 subequal to each other and to segment 11, both somewhat swollen and without whorls of long bristles, apex of segment 13 as in the females. *Legs:* claws of foreleg and midleg both enlarged, 1 member of each pair with a long submedian tooth; claws of hindleg as in the females.

MALE GENITALIA.—*Segment VIII:* very long, constricted at base, swollen and rounded distally and containing retracted genitalia. *Segment IX:* poorly developed; tergite unsclerotized and without bristles; sternite short and without bristles. *Sidepiece:* small and short; with a poorly developed basal mesal lobe bearing specialized bristles; mesal surface sclerotized. *Claspette:* represented by basal mesal lobe. *Clasper:* simple; with a large broad comblike spiniform. *Phallosome:* not studied in detail; aedeagus with swollen dorsal portion which is narrowed at base and a narrow median complex ventral portion; ventral paramere very small; basal piece poorly differentiated. *Proctiger:* largely membranous; with a pair of weak ventrolateral sclerotizations; without sclerotized paraprocts or cercal setae.

PUPAE.—*Cephalothorax:* middorsal ridge moderate; all hairs present; hair 6-C short and branched; 7-C slender and single. *Trumpet:* arising from distinct tubercle; nearer middorsal line than wing base; without narrow slit in meatus; apex sharply diagonally truncate, emarginate externally; tracheoid distinct. *Abdomen:* tergite I largely sclerotized; hair 1-I stellate, its branches simple; 2-5-I in a close group distant from 1-I; 1-II-VII stellate; 2-II mesad of 1-II; 5-IV-VII thickened, long, usually with short subbasal branches and barbs distad; 6-I-VI stellate; 9-IV-VII at or very near caudolateral angle of tergite, distinctly spiniform; 9-VIII thickened, with several branches, ventral in insertion but very near caudolateral angle. *Terminal Segments:* hair 1-IX bristlelike, well developed at least in *catasticta* and *squamipennis;* hair 1-X absent. *Paddle:* very narrow at base, widened distad, and very deeply and narrowly emarginate at insertion of hair 1-P; midrib distinct at least at base; outer and inner parts subequal and both without marginal spicules; hair 1-P at least 0.5 of paddle length, single; hair 2-P not developed.

LARVAE.—*Head:* usually distinctly wider than long; labrum strongly developed, distinctly separated from frontoclypeus, and with a long membranous flap in front longer than hair 1-C; collar poorly developed; ventral portion of head capsule very short; posterior tentorial pit near caudal border; maxillary suture reaching posterior tentorial pit and continued dorsad; cephalic border of labial plate rounded; aulaeum a simple lobe with short fringes and a pair of small tubercles; mental plate very small, almost square, 2 teeth on each side of large median tooth; a large bladderlike organ ventrolaterally between mandible and maxilla; hair 1-C widely separated, not on distinct tubercle; 0-C distinct; 2-C not developed; 3-C small; 4-6-C in a group caudad of antenna; 13-C close to 11-C; 14,15-C near anterior border; hairs 16,17-C apparently not developed. *Antenna:* tremendously developed, longer than head capsule; basal part, ending with hairs 2-4-A, greatly swollen and strongly curved with concavity mesad, strongly spiculate except on inner upper part; distal part, bearing 5,6-A, narrow, short, smooth, and angled laterad; hair 1-A strongly branched, lateral in position; 2-4-A long, single; 5,6-A simple, short. *Thorax:* integument smooth or strongly and densely spiculate; spiracular sensilla not apparent; notched organ not developed; long hairs tremendously elongate; hairs 9-12-P,M,T on common tubercles; 1-3-P on common tubercle; 13-P not developed but all others present; none of the hairs plumose or palmate but larger hairs strongly barbed; 1-3-P very close together near middle line; 4-7-P with large individual tubercles; 8-P caudad of 7-P, stellate; 1-M stellate; 5-7-M on common basal plate; 8-M long, branched, on basal plate; 1,5,8,13-T stellate; 7-T long, branched. *Abdomen:* integument smooth or strongly spiculate throughout; spiracular sensilla not apparent; dorsal sensilla distinct; tergites without sclerotization; hair 1 never palmate; 6,7-I,II always long but never plumose; 6-III-VI long and with basal plate; 1,2-I-VII, 5,9,13-II-VI stellate; segment I with full complement of hairs except for hair 14. *Segment VIII:* comb scales very long, arising from a small sclerotized plate which does not include hair 0-VIII; hairs 1,2-VIII with a common basal plate. *Siphon:* well developed, with acus and long or short spicules; pecten teeth not developed; hair 1-S branched, varied in position but never at base, accessory hairs 1a-S not developed; 2-S removed from apex, accessory hairs 2a-S not developed; valves very small, rudimentary; hair 9-S a very strong, long, recurved spiniform; 8-S long, branched; hair 13-S not visible; stirrup-shaped piece not developed, trachea rudimentary. *Anal Segment:* saddle complete but poorly pigmented especially ventrad, very strongly emarginate for ventral brush; very strongly spiculate especially dorsad; acus not developed; median dorsal caudal process not apparent; dorsal brush hairs (2,3-X) single but with long dorsal barbs, not hooked apically; ventral brush with 6 pairs of long single hairs (4-X) with long dorsal barbs, not hooked apically, on a grid connected to saddle; accessory saddle hairs absent; gills well developed.

EGGS.—Unknown but probably laid in rafts.

SYSTEMATICS.—The tribe Aedeomyiini consists of the single compact pantropic genus *Aedeomyia,* which is known at present by 6 species. All the adults are very similar not only in superficial ornamentation but in structural detail as well. The immature stages, on the other hand, although conforming to a unique type, show rather striking differences.

The affinities of *Aedeomyia* cannot be definitely determined at present. Edwards (1932:64) placed it in his *Theobaldia-Mansonia* group, but it shows too many important departures from this group to be retained in tribe Culisetini; I propose to put it in a distinct tribe. *Aedeomyia* is unique among the Culicinae in the peculiar structure of the female antenna and the broad comblike spiniform of the male clasper. In the male, the largely unsclerotized proctiger which is devoid of cercal setae is found elsewhere only in the Anophelini, Uranotaeniini, and a few Aedini. The ornamentation of the alula and upper calypter and scalation of the wing is suggestive of *Ficalbia* (*Etorleptiomyia*). The pupa appears to be distinctive in the position of hairs 2-5-I and the development of the paddles. The larva is quite unlike that in any other genus in the development of the antenna. The latter is superficially similar in some respects to *Ficalbia, Mansonia,* and some *Culex,* but it differs from all these in having hair 4-A on the apex of the swollen basal part rather than on the narrowed distal part.

On the basis of morphology and distribution, *Aedeomyia* is probably a very ancient primitive but highly specialized segregate, which originated in the Old World and reached the New World prior to or very early in the Tertiary.

None of the species have been studied in detail, and it appears that additional unrecognized forms may exist. The South Pacific populations seem to belong to *catasticta,* a widespread species in the Australasian, Indomalayan, and Oriental regions.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *Aedeomyia* are found chiefly in dense swamps and in more or less permanent ground pools with a dense growth of aquatic vegetation. They have been reported less commonly from river margins. The method of respiration used by the larvae is not definitely known. The tracheal system is greatly reduced, as is the spiracular mechanism, which lacks the stirrup-shaped piece. Larvae are known to stay below the surface film for long periods of time, either resting upside down on the bottom or upright in the vegetation. Wigglesworth (*in* Hopkins, 1952:72–73) observed *africana* obtaining air with equal facility from the water surface or from the underside of the leaves of *Pistia.* It has been suggested that the tip of the siphon may be thrust into the tissues of aquatic plants to obtain air in a manner similar to *Mansonia* species (Hopkins, 1952:73) or that the swollen antennae and the eversible head bladders may be used in cuticular respiration. In *catasticta,* the recurved spinelike hair 9 of the siphon is used to anchor the larva to the vegetation in a favorable position and the antennae are also often clasped around plants. Adults of *A. africana* have been reported to be attracted to human bait (Mattingly, 1949*a*), but other species apparently do not come to man.

DISTRIBUTION (fig. **178**).—The genus is pantropic, and all but 2 species have wide distributions: *squamipennis* (Lynch Arribalzaga, 1878) from Mexico to Argentina; *catasticta* Knab, 1908 from India and the Philippines to Fiji and northern Australia; *venustipes* (Skuse, 1889), New South Wales; *africana* Neveu-Lemaire, 1906 and *furfurea* (Enderlein, 1923), equatorial Africa; *pauliani* Grjebine, 1954, Madagascar. In the South Pacific *Aedeomyia* has been found only in Fiji and the Solomons.

KEYS TO SPECIES

See keys to tribes, pp. 118–122

1. Aedeomyia catasticta Knab
Figs. **178-180**

1909. *Aedeomyia catasticta* Knab, Ent. News 20:387–388. *TYPE: lectotype ♀, Samal, Bataan, Philippines; selection of Stone and Knight, 1957*b*:196 (USNM, 12627).

Aedeomyia catasticta of Knight, Bohart, and Bohart (1944:40, 49); Stone, Knight, and Starcke (1959).

Aedomyia catasticta of Lee (1944*a*:46); Iyengar (1956:26); Laird (1956).

Aedomyia venustipes of Edwards (1932:122, in part); Taylor (1934:15); Lever (1944*a*).

FEMALE (fig. **179**).—*Wing:* 2.67 mm. *Proboscis:* 1.53 mm. *Forefemur:* 1.33 mm. *Abdomen:* about 2.08 mm. *Head:* erect scales white in front, yellowish in the middle, predominantly dark caudolaterad; decumbent scales white in the middle, predominantly dark laterad except for white ocular border and lateral patch and scattered whitish scales elsewhere; frontal tuft and frontal and facial scales white; clypeal scales white; labium with white scales in a dorsal apical patch, a narrow submedian ring, and a subbasal dorsal patch or narrow diagonal ring; palpus with a few white scales on apex of segments 3,2, and sometimes 1; antennal scape and pedicel (torus) with white scales; flagellar segment 1 with a few white scales at base and a large tuft of dark scales (fig. **179**). *Thorax:* scales dark except for variable number of scattered white scales and the following pattern, (1) tuft of white scales on anterior promontory followed by a median stripe of yellowish scales within the dorsocentral lines to about middle of mesonotum where a pair of posterior dorsocentral lines of yellow scales are separated from it by whitish scales, (2) tufts of outstanding dark scales at caudal end of dorsocentral lines, (3) similar tufts caudad of scutal angle, (4) a third more or less continuous pair of tufts of dark scales in supraalar area, the latter with a few white scales; scutellum with midlobe white-scaled except for a small tuft of dark scales apically, lateral lobe with large tuft of dark scales and few white scales at base laterad; *apn* largely white-scaled; *ppn* with upper part largely dark-scaled, lower white-scaled; remainder of scaled areas of pleuron and prosternum white-scaled. *Legs:* forecoxa and all trochanters with mixed black and white scales; midcoxa and hindcoxa white-scaled; light scales of femora, tibiae, and tarsi largely white, a few yellowish scales in the femoral tufts; hindtibia with poorly developed basal tuft of suberect scales; segment 1 of all tarsi dotted with white scales and with white apex; foretarsus with segment 2 white at base and apex, yellowish in the middle, and dark subapically, segment 3 whitish in basal half, remainder dark; midtarsus with segment 2 white at base and apex, segments 3 and 4 white at base, remainder dark; hindtarsus with segment 2 narrowly white at base and apex, segment 3 white except for narrow subapical dark ring, segment 4 similar to 3 except subapical dark ring broader, segment 5 largely white, a few dark scales ventroapically, remainder dark. *Wing:* background of dark brown or blackish scales speckled with yellowish scales and a more or less distinct pattern of pure white scales as follows, (1) a few at extreme base of C, (2) a basal spot from C to R, base of Cu and 1A, (3) a submedian spot on C, Sc and R, (4) a postmedian spot on C, Sc, R, R_{2+3} at fork, and M at fork, (5) a subapical spot on C and extreme apex of R_1, (6) a few white scales at point of separation of Rs from R_1 and on fork of Cu; 1 or more of the white spots frequently reduced or absent or occasional white scales present elsewhere. *Haltere:* light at base, dark-scaled on knob. *Abdomen:* tergite I and laterotergite light-scaled; remainder of tergites with background of dark scales, whitish scales numerous laterad and on distal segments (VI-VIII), proximal segments sometimes with more or less distinct submedian caudal spots of dark yellowish scales; sternites with numerous white scales midventrally on apex and base of segments.

MALE (fig. **179**).—Generally as in the female; vertex of head more extensively dark-scaled; labium with more extensive submedian white ring; flagellar segment 1 with tuft of white scales (fig. **179**); abdomen with longer hairs; tergites with more distinct submedian apical yellowish patches; sternites with fewer white scales.

MALE GENITALIA (fig. **179**).—As figured; diagnostic characters as in the key. *Sidepiece:* a few broad scales laterally and ventrally; basal mesal lobe with about 6 short heavy bristles in a double row. *Clasper:* comblike spiniform with about 16–18 teeth. *Phallosome:* not studied in detail, as described for genus.

PUPA (fig. **179**).—*Abdomen:* 3.37 mm. *Trumpet:* 0.52 mm. *Paddle:* 0.8 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly lightly to moderately pigmented; hairs concolorous with integument except 8-C which is darker. *Trumpet:* brightly pigmented; strongly flared apically; tracheoid to about 0.3–0.4. *Metanotum:* hair 10-C darkened. *Abdomen:* uniformly moderately to strongly pigmented; all larger hairs strongly pigmented and conspicuous; hair 2-II-VII weakly spiniform; 3-III mesad of 2-III; 9-III-VII strongly spiniform, all except 9-III placed at almost exactly the caudolateral angle on dorsal surface, 9-VII usually branched, others sometimes barbed; 9-VIII inserted midway between dorsal and ventral surface at caudolateral angle, usually 3b(2–4). *Paddle:* uniformly lightly pigmented except for darker midrib and external buttress and a cloud in area where midrib is evanescent; hair 1-P inserted in a deep narrow emargination.

LARVA (fig. **180**).—*Head:* 0.65 mm. *Siphon:* 0.65 mm. *Anal Saddle:* 0.5 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly lightly pigmented; hairs concolorous with integument except for 7-C which is darker. *Antenna:* swollen portion uniformly lightly pigmented and with moderately long fine spicules on outer dorsal, lateral, and ventral surfaces, with very long fine spicules on mesal ventral surface, and without spicules on mesal dorsal surface; distal slender part darkly pigmented and smooth; hair 5-A appearing forked at base. *Thorax:* tubercles and larger hairs moderately to strongly pigmented, smaller hairs and general integument light; integument densely short-spiculate; stellate hairs with branches of uneven lengths, larger ones attenuate apically, shorter with denser and longer barbs and frayed brush tip; 9,10,12-P very short, none of the hairs in group thickened or strongly pigmented. *Abdomen:* integument and hairs as on thorax; hair 6-I,II usually 7b, 6-III-V usually 3b, 6-VI usually 2b; 7-I,II very long and single. *Segment VIII:* comb with about 12–16 sharply pointed spinelike scales which are very lightly fringed subapically. *Siphon:* index about 3.2–3.8; uniformly moderately pigmented except for dark acus; integument with moderately long spicules, denser and longer ventroapically; hair 1-S beyond middle, longer than siphon; 2-S single, in apical 0.2; 9-S a strong spiniform, slender at base then swollen and with a recurved distal part. *Anal Segment:* saddle lightly pigmented, short-spiculate except for large dorsolateral caudal patch of very long strong spicules and a small midlateral caudal lobe with long spicules; hair 1-X usually 3,4b; gills about 0.4–0.5 of saddle length.

MATERIAL EXAMINED.—108 specimens; 20♀; 15♂; 16 pupae; 57 larvae; 6 individual larval rearings.

SYSTEMATICS.—*A. catasticta* shows a great deal of variation in the color pattern of the wings and abdominal tergites. The white spots of the wing may be greatly reduced and the proximal tergites almost completely dark except for irregular blotches of light scales laterally, thus attaining the characteristic coloration described for *venustipes* (Skuse, 1889) by Knight, Bohart, and Bohart (1944:40). I have not been able to obtain specimens of the latter for examination, but, according to Skuse's description, *venustipes* differs from *catasticta* in labial, palpal, thoracic, leg, and abdominal ornamentation.

The specimens from the South Pacific are quite similar to those from the Philippines and both are consistently different from 2 specimens from Horn Island, North Queensland, in a much narrower subapical dark ring on hindtarsal segment 3. Philippine specimens, however, appear to have more teeth in the comblike spiniform of the male clasper. I cannot find any reliable characters to differentiate the Fiji populations from those in the Solomons.

BIONOMICS AND DISEASE RELATIONS.—On Guadalcanal the immature stages of *catasticta* were found along the grassy banks of a small coastal lagoon in full sunlight. The larvae were anchored in masses of algae within the dense vegetation. The pupae were very active and the larvae difficult to collect, as they seemed to drop to the bottom, where they rested quietly and could not be seen readily. Nothing is known of the bionomics or disease relations of the adults.

DISTRIBUTION (fig. **178**).—*Solomon Islands:* Bougainville; Kolombangara; Russell; Guadalcanal. *Fiji:* Viti Levu; these populations are not introduced by air, as stated by Laird (1956), since I have seen a single specimen collected in 1938 at Nandarivatu. Also reported from *New Guinea, Northern Australia, Indonesia, Philippines, Carolines, Marianas, Malaya, Burma, India,* and *Ceylon.*

TRIBE HODGESIINI

Genus HODGESIA Theobald

1904. *Hodgesia* Theobald, J. Trop. Med. 7:17. *TYPE SPECIES: *H. sanguinae* Theobald, 1904, Entebbe, Africa; original designation.

FEMALES.—Very small mosquitoes with silvery markings and distinctive outstanding wing scales (fig. 182). *Head:* eyes narrowly separated above antennae; frontal tuft not developed; vertex with broad flat decumbent scales only; erect scales completely absent; orbital bristles few but strongly developed; clypeus small, triangular; labium normal, only slightly swollen apically, a single pair of subbasal ventral bristles; palpus shorter than clypeus, with only 2 segments; antenna distinctly longer than proboscis; all flageller segments similar, segment 1 without scales, not much more than 1.33 of segment 2, flagellar whorls sparse. *Thorax:* mesonotum moderately arched; scutellum trilobed; postnotum bare; paratergite narrow in front, broadened caudad, bare; *apn* lobes rather large and more or less approximated; *pra* not separated by a suture from *stp;* meron rather large, its upper edge above insertion of hindcoxa; mesonotum with narrow curved decumbent scales; scutellum with small decumbent broad scales; pleural scales all broad, confined to *apn, ppl,* and *stp;* metameron bare; acrostichal bristles entirely absent, dorsocentrals and supraalars few but strongly developed; *apn* with about 5 anterior and ventral bristles; *ppn* usually with 2 very strong bristles; no *sp* or *pra* bristles; *psp* rarely with a few minute hairs or a distinct bristle; *stp* rarely with 1 or more fine hairs in center or upper part; *mep* with 2 upper caudal bristles and 1 to several strong lower anterior bristles. *Legs:* normal; tibial bristles conspicuous, others small; forefemur and midfemur swollen, hindfemur slender; foretarsal segment 4 markedly longer than segment 5; claws of all legs small and simple; pulvilli absent. *Wing:* wing membrane with distinct microtrichia; uniformly dark-scaled; outstanding vein scales in distal half of wing elongate and notched at tip in characteristic fashion (fig. 182); cell R_2 about as long or longer than vein R_{2+3}; a short scaled spur at base of Rs but none at base of R_{4+5}; vein 1A sharply curved apically and ending before level of fork of Cu; no remigial bristles on base of R; vein Sc without bristles at base ventrally; plical vein strongly developed but without scales at base ventrally; alula and upper calypter both bare. *Abdomen:* tergites and sternites almost completely scaled; tergite I and laterotergite completely scaled, latter very small; sternite I not developed as a sclerite; bristles short and not numerous except on tergite I and distal segments; tip of abdomen blunt. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; cercus and postgenital plate short and broad; spermatheca single and large.

MALES.—Practically indistinguishable from females. *Palpus:* entirely similar to females. *Antenna:* entirely similar to females. *Legs:* claws of foreleg and midleg enlarged, subequal, and simple; those of hindleg as in the females.

MALE GENITALIA.—Extremely small and practically invisible in pinned specimens. *Segment VIII:* long and wide and containing retracted genitalia; tergite emarginate and with short heavy bristles near caudal border, with a narrow but long intersegmental caudal sclerotization bearing short heavy spicules. *Segment IX:* poorly developed; tergite sinuate proximally, without sclerotized lobe or bristles; sternite short and bare. *Sidepiece:* very short; without any indication of basal mesal lobe but with a more or less distinct short sternal apical process; completely sclerotized on middle of mesal surface; without scales. *Claspette:* not developed. *Clasper:* about as long as sidepiece; simple; 2 or possibly more setae subapically; in *solomonis* at least a tiny, practically invisible subapical, conical spiniform. *Phallosome:* very simple; aedeagus long and conical, broad at base and with basal ventral bridge, without teeth; neither ventral nor dorsal paramere differentiated; basal piece very large and strongly differentiated. *Proctiger:* very strongly developed; with strong basal lateral sclerotization continuous with tergite IX; paraproct strongly sclerotized and ending in a sclerotized process with 3 strong teeth; dorsal surface unsclerotized; 1–3 minute cercal setae.

PUPAE.—*Cephalothorax:* middorsal ridge poorly developed; all normal hairs present; hairs 4,5-C widely separated; 6,7-C close together and far forward; 6-C stronger than 7-C in *solomonis;* 8-C cephalad of trumpet base. *Trumpet:* arising from a moderate tubercle; widely separated, closer to wing base than middorsal line; divided almost to base, no tracheoid. *Abdomen:* hair 1-I strongly dendritic and with broad basal expansion from which branches radiate palmately; hair 9 small, removed from caudolateral angle on II-VII; 9-VIII near caudolateral angle and ventral in insertion; 2,3-I widely separated from 4,5-I which are far laterad and near 6,7,9-I. *Terminal Segments:* hair 1-IX a simple bristle, less than 0.5 of tergite IX; hair 1-X absent; female cercus poorly developed, indistinct, unsclerotized, and never projecting; male sidepiece lobes short, divergent apically. *Paddle:* part mesad of midrib distinctly wider than outer part; hair 1-P present, short; hair 2-P absent.

LARVAE.—*Head:* distinctly wider than long; labrum very long, prominent, and separated by a very distinct internal ridge from frontoclypeus; collar not distinct; side not bulging caudad of antenna; ventral surface of head capsule quite long; posterior tentorial pit nearer caudal border than middle of ventral surface; maxillary suture complete to posterior tentorial pit but not extended beyond; cephalic border of labial plate more or less truncate; aulaeum narrow, produced in front, and bearing a median tooth fringed laterally; mental plate small, narrow, and more or less triangular; maxilla with a heavy long black spiniform subapical bristle, palpus very short; mouthbrushes normal; hair 1-C not arising on process; 0-C distinct; 2-C not developed; 3-C small; 4-7-C removed caudad; 5-C near level of hair 8; 4,6,7-C more or less in line; 13-C closer to 11-C than 12-C; 14-C large and spiniform, at anterior border near maxillary suture; 15-C in anterior half; hairs 16,17-C apparently not developed. *Antenna:* about 0.75 or more of head length; simple; with spicules on shaft; hair 1-A near apex, large and multiple; 2-4-A very long and thickened, all on apex. *Thorax:* spiracular sensilla distinct; notched organ not developed; hair 13-P not developed but all others present; 9-12-P,M,T on common tubercles, 9-12-P small, displaced caudad to level of 9-12-M; 1-3-P on large common tubercle; 4-P on large tubercle; 5,6-P on common tubercle; 7-P on tubercle; 8-P short, branched; 12-P very strong; 5,6-M on separate tubercles; 8-M,7-T large, multiple, on separate tubercles; none of the hairs plumose or palmate but larger hairs barbed. *Abdomen:* spiracular and dorsal sensilla distinct; tergites without sclerotization except at base of hairs; hair 1 never palmate; 6,7-I-II long and branched, barbed but not plumose, conspicuously different from those on following segments; hairs 1-I-VI, 5-II-VI, and 13-III-V stellate; segment I with full complement of hairs except for 14. *Segment VIII:* comb scales present, not joined to sclerotized plate. *Siphon:* short and cylindrical; with distinct acus in *solomonis*, apparently without in Ethiopian species; pecten teeth always developed; hair 1-S a simple pair at base of siphon; no accessory 1a-S hairs; hair 2-S minute, apical; no accessory 2a-S hairs; ventral valve very strongly developed; hair 13-S very long, twisted near base; trachea and stirrup-shaped piece well developed. *Anal Segment:* saddle complete; without acus; no caudal marginal spicules; median dorsal caudal process strongly developed; hair 1-X on saddle; dorsal brush with both hairs (2,3-X) branched; ventral brush usually with only 4 pairs of hairs (4-X) on grid which is connected to saddle and several unpaired hairs on midventral line of saddle; no accessory saddle hairs; gills short.

EGGS.—Unknown.

SYSTEMATICS.—The genus *Hodgesia* has a unique combination of characters in the adult stage and in the larva and cannot be properly placed within any of the larger tribes. In the adult stage *Hodgesia* shows some similarities with *Uranotaenia* —for example, in the development of vein 1A and the absence of scales or hairs on the alula. The larva, on the other hand, is suggestive of *Culiseta* and *Ficalbia*. It appears that *Hodgesia* may have originated through hybridization between 2 ancient members of these 3 lines. This genus is so different from all these genera that I am placing it in the separate monotypic tribe Hodgesiini.

Hodgesia is a very compact genus, all the 9 described species conforming to one distinct type in all stages. It is very likely that there are a number of undescribed species in this genus. In the South Pacific *Hodgesia* is represented only by *solomonis*, which appears to be endemic to the Solomons.

BIONOMICS AND DISEASE RELATIONS.—The bionomics of *Hodgesia* are very poorly known. The immature stages are usually found in swamps and marshes and small pools in marshy areas, usually in water with very dense vegetation. Species of *Ficalbia* are often associated. *Hodgesia* larvae can be easily mistaken for the younger instars of *Culex* or *Culiseta;* for this reason, they may be neglected by collectors.

The blood-feeding habits of most species are not known. The African *sanguinae* has been reported to attack man, and *solomonis* is a vicious biter in the vicinity of its breeding sites. Females of *Hodgesia* are so small that they may be neglected even by collectors who are being bitten, since these tiny mosquitoes may be mistaken for ceratopogonids.

Hodgesia does not appear to be of any economic importance or to be involved in human disease transmission. Although only *sanguinae* and *solomonis* have been reported to attack man, it appears likely that other species may occasionally feed on man, but only in the neighborhood of their breeding sites.

DISTRIBUTION (fig. 181).—*Hodgesia* is confined to the Old World tropics. It is represented by 4 species in Africa, 1 in India, 2 or more in the Indomalayan area, at least 3 in New Guinea and northern Australia, and 1 species in the Solomons.

KEYS TO SPECIES

See keys to tribes, pp. 118–122

1. Hodgesia solomonis Belkin, n. sp.

Figs. **181-183**

TYPES.—*Holotype:* ♂ with genitalia slide (JNB, 676–1001), West Poha swamp, Guadalcanal, Solomon Islands, from grassy swamp, Oct. 16, 1944, J. N. Belkin and J. Laffoon (USNM, 64770). *Allotype:* ♀ (JNB, 676-1) with genitalia slide (560220-2), same data as holotype (USNM). *Paratypes:* 7 ♀, 3 ♂, 1 pupa, 62 larvae (JNB, 676-1), same data as holotype; 68 ♀ (probably including a number of ♂), 50 ♂, 73 pupae, 89 larvae (JNB, 708-2), same locality as holotype, Nov. 1, 1944, J. N. Belkin.

Hodgesia cairnsensis in part of Iyengar (1955:25); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.0 mm. *Proboscis:* 1.17 mm. *Forefemur:* 1.03 mm. *Abdomen:* about 1.08 mm. *Head:* scales dark except for a large anterior median patch of bluish silvery scales and a pair of lateral patches of pure silvery scales; labium dark; torus with a few minute hairs. *Thorax:* mesonotal integument light orange brown, with a central longitudinal dark brown stripe more distinct caudad and a dark brown spot on each side in spraalar area; median lobe of scutellum dark brown; postnotum dark brown centrally, lighter laterad; paratergite light orange brown; pleuron light orange brown, darkened in middle of *stp* and lower *mep;* mesonotal scales very dark brown; scutellar scales very dark brown and very small; *apn* and *ppl* scales pure silvery; *stp* with a large dorsal patch of pure silvery scales separated by darkened integument from large lower caudal patch of pure silvery scales; dorsocentrals very strong; usually 5 *apn* bristles; 2 *ppn* bristles; 1 large and 1 small *ppl* bristle; rarely 1 *psp* bristle; no *stp* bristles; 2 upper and usually 3 lower *mep* bristles. *Legs:* coxae and trochanters with silvery scales; femora largely light yellowish brown, forefemur and midfemur extensively dark above and apically, hindfemur darkened on extreme apex dorsally and laterally; tibiae entirely dark except for light lower surface of foretibia; tarsi entirely dark. *Haltere:* light on base and most of stem, upper part of stem and knob dark-scaled. *Abdomen:* tergites dark-scaled and with conspicuous pure silvery lateral patches or bands as follows, (1) entire lateral portion of laterotergite, (2) a small lateral patch on tergite II, (3) an extensive lateral patch on tergite III produced mesad as a complete or almost complete apical band, (4) none on IV, (5) an extensive lateral patch on V produced mesad as a complete or almost complete apical band, (6) a large lateral triangular patch on VI; sternites entirely silvery with a slight yellowish tinge.

MALE.—Entirely similar to the female; even male genitalia are difficult to see; claws hardly larger than in female.

MALE GENITALIA (fig. 182).—As figured and as described for genus; not described or figured for any other species.

PUPA (fig. 182).—*Abdomen:* 1.59 mm. *Trumpet:* 0.38 mm. *Paddle:* 0.53 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* a strongly contrasting pattern of light and dark areas, dark anteriorly and posteriorly, lighter in the middle and ventrally, some of the leg segments strongly pigmented; hairs not strongly contrasting with integument, inconspicuous. *Trumpet:* uniformly pigmented; larger division with fine spicules on inner surface and very indistinct external imbrications; smaller division with deep notch near middle, distal part only slightly swollen beyond middle, with numerous fine spicules. *Abdomen:* moderately to rather strongly uniformly pigmented, somewhat lighter caudolaterad; hairs largely concolorous with integument, inconspicuous. *Paddle:* unpigmented except for base, external margin, and midrib; rather deeply and broadly emarginate at apex; inner part distinctly wider than outer; distal 0.5 or less of inner and outer margins with scattered small sharp spicules.

LARVA (fig. **183**).—*Head:* 0.53 mm. *Siphon:* 0.25 mm. *Anal Saddle:* 0.34 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* rather uniformly and strongly pigmented except for lighter ocular areas and darker caudolateral angles; no visible integumentary sculpturing; mental plate with 4,5 distinct heavy teeth on each side of much larger median tooth; hairs largely concolorous with head capsule; hair 1-C long, straight, spiniform, very darkly pigmented; 14-C very darkly pigmented, spiniform. *Antenna:* about 0.75

of head length; darkly pigmented at base and apex, light in the center; spicules short; hairs 1,5-A lightly pigmented, all others very dark. *Thorax:* larger hairs and tubercles strongly pigmented, others lightly. *Abdomen:* larger hairs and tubercles strongly pigmented, others lightly. *Segment VIII:* comb scales usually 10–13, each with a central dark heavily sclerotized stem surrounded by thin bladelike expansion laterally and apically, and bordered by extremely fine spicules. *Siphon:* index about 1.75-2.0; short, cylindrical; uniformly strongly pigmented; imbricate sculpturing very coarse and conspicuous; pecten teeth usually 12–14, extending beyond middle of siphon, each tooth entirely similar to comb scale; hair 1-S longer than siphon, usually 6,7b. *Anal Segment:* saddle a little lighter than siphon except for dark ring at base; integumentary sculpturing coarse but not very prominent; hair 1-X short, usually 2,3b, inserted some distance from caudal margin of saddle; usually 4 single hairs midventrally on saddle.

MATERIAL EXAMINED.—869 specimens; 274 adults; 78 pupae; 517 larvae; 6 individual pupal rearings.

SYSTEMATICS.—The adults of *solomonis* show very little variation except in the extent of the silvery markings on abdominal segment V, which may form a complete or an interrupted apical band, and in the coloration of the mesonotal integument, which however always shows a more or less distinct pattern and appears to be never completely infuscated. The number of mesepimeral bristles is constant in *solomonis.* The immature stages also appear to show very little variation. Although no individual larval rearings are available for this species, it seems evident that there is only 1 species in the mass-reared material. No striking differences are apparent in the samples from populations on Bougainville and Guadalcanal.

H. solomonis is undoubtedly a member of the *quasisanguinae* complex, which is characterized by the head, pleural, and abdominal silvery ornamentation, as indicated above in the diagnosis. This complex consists of *quasisanguinae* Leicester, 1908 from Malaya, *niveocaputis* Ludlow, 1911 from the Philippines, *triangulata* Taylor, 1914 from New Guinea, and *cairnsensis* Taylor, 1908 from Australia. Edwards (1932:94) synonymized the first 3 species but retained *cairnsensis* as a distinct species, although earlier (1924:359) he had suggested that this form might perhaps be a variety of *quasisanguinae.* It now appears that this is a complex of several very similar species and that it may be necessary to resurrect 1 or more of the synonymized nominal species or to recognize new forms. *H. quasisanguinae* is known at present by a single female (BMNH) which agrees quite well with *solomonis* except that its mesonotum is uniformly dark. The *"quasisanguinea"* of authors reported from New Guinea and Australia is an entirely different species, which may be recognized immediately by the presence of small hairs on the postspiracular area. This form may be *triangulata,* but its identity cannot be established until Taylor's type is reëxamined. *H. solomonis* agrees with *cairnsensis* in the general coloration of the mesonotum but can be easily distinguished from it in the adult stage by the possession of only 2 upper and 3 lower *mep* bristles (instead of 4 and 5,6 respectively) and in differently shaped smaller division of the pupal trumpet. *H. solomonis* differs from *niveocaputis* in the mesonotal pattern of the adults.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *solomonis* are found in dense jungle swamps, most frequently in small pockets of water at the edges of the swamps. They may be associated with various species of *Uranotaenia, Culex* (*Lophoceraomyia*), *Culex* (*Culex*), and also with *Ficalbia* (*Etorleptiomyia*). The larvae are easily overlooked or mistaken for early instars of *Culex* and therefore are seldom collected. They are extremely difficult to rear under artificial conditions. Despite numerous attempts on Guadalcanal, no individual rearings from larvae were ever successful, although in mass rearings a fair percentage of larvae reached the adult stage. On the other hand, no great difficulty was experienced in obtaining adults from field-collected pupae.

On Guadalcanal females of *solomonis* were the most vicious biting mosquitoes encountered. They attacked only in the open in broad sunlight in the immediate vicinity of the breeding sites and at times were so persistent as to drive the collector out of the area within a few minutes. Their bites are extremely painful and resemble those of some species of *Culicoides.*

DISTRIBUTION (fig. 181).—*Solomon Islands:* Bougainville; Guadalcanal. Not known elsewhere.

TRIBE CULISETINI

Genus CULISETA Felt

1902. *Theobaldia* Neveu-Lemaire, Soc. de Biol., Compt. Rend. 54:1331–1332. TYPE SPECIES: *Culex annulatus* Schrank, 1776, Europe; original designation.—Preoccupied by *Theobaldia* Fischer, 1885; invalid emendation for *Theobaldius* Nevill, 1878 but available name for homonymy.

1904. *Culiseta* Felt, N.Y. State Mus., B. 79:391*c*. TYPE SPECIES: *Culex absobrinus* Felt, 1904, New York; original designation.

1915. *Climacura* Dyar and Knab *in* Howard, Dyar, and Knab, Carnegie Inst. Wash., P. 159(3):452. *TYPE SPECIES: *Culex melanurus* Coquillett, 1902, New Hampshire, U.S.A.; original designation.—As subgenus of *Culex*.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Medium-sized to large mosquitoes, easily confused with *Culex* but readily distinguished from most genera by the presence of bristles on base of vein Sc ventrally. *Head:* eyes contiguous or narrowly separated above antennae; frontal tuft not developed; vertex with all decumbent scales narrow and curved except laterad; erect scales forked and very numerous; upper orbital bristles not strongly differentiated, usually removed far from border; clypeus small, triangular; underside of head capsule with numerous hairs; labium normal, length varied, apex not markedly swollen, subbasal ventral bristles varied; palpus usually less than 0.33 of proboscis, 5-segmented, segment 5 short or minute; antenna shorter than proboscis; flagellar segment 1 not markedly longer than 2. *Thorax:* mesonotum only slightly arched; scutellum trilobed; postnotum bare; paratergite narrow, bare or with scales or hairs below; *apn* small and widely separated; *pra* not separated by a suture from *stp;* meron small, its upper edge above insertion of hindcoxa; mesonotum with narrow curved decumbent scales only; scutellum generally with scales similar to those of mesonotum, rarely broad; pleural scales varied in shape and distribution, usually widespread and some broad; *mep* always with scales; metameron bare or with scales; acrostichal bristles present but rather short; dorsocentrals and supraalars well developed; *apn* with bristles numerous and scattered, not confined to anterior and ventral margins; *ppn* with several bristles; *ppl* bristles very numerous and extending anteroventrad of forecoxal base; *sp* bristles always present, usually numerous and light in color, scales sometimes also present; *psp* without bristles but usually with 2 or more distinct patches of scales; *pra* bristles very numerous; *stp* with numerous bristles in caudal line and an upper patch or line; *mep* with extensive patch of upper bristles, a line of several anterior lower *mep* bristles and sometimes posterior as well. *Legs:* normal; bristles well developed on femora and tibiae; femora not markedly swollen; foretarsal and midtarsal segment 4 not markedly shortened, about as long as segment 5; claws of all legs of female small, subequal, and simple; pulvilli not developed; empodia strongly developed and with heavy short spicules. *Wing:* frequently with dark pattern of scales and infuscation of membrane; wing membrane with distinct microtrichia; plume scales narrow; cell R_2 longer than vein R_{2+3}; usually no distinct spur at base of Rs and R_{4+5}; vein 1A somewhat sinuous and ending distad of level of fork of Cu; short or long remigial bristles present at base of R dorsally; base of Sc ventrally always with a patch of outstanding hairs or bristles and sometimes scales as well; plical vein strongly developed, sometimes ventral area with a few scales; alula and upper calypter each with continuous marginal row of hairlike scales or hairs. *Abdomen:* tergites and sternites almost completely but often not densely scaled; tergite I largely unscaled; laterotergite without scales; bristles varied, tergite I always with numerous long bristles; tip of abdomen blunt. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; cercus and postgenital plate short and broad; 3 large equal spermathecae.

MALES.—Essentially similar to the females. *Palpus:* always at least as long as proboscis; distinctly 5-segmented, segments 4 and 5 long; with or without long hairs on distal part of segment 3 and on segments 4 and 5. *Antenna:* length as in the female; flagellum strongly plumose; flagellar segments 12 and 13 elongate, segment 12 with large basal whorl of long bristles, segment 13 with small whorl of short bristles. *Legs:* claws of foreleg and midleg enlarged, both members of a pair usually toothed.

MALE GENITALIA.—Prominent; not studied in detail. *Segment VIII:* long and wide, tergite often with median caudal lobe bearing specialized spiniforms. *Segment IX:* well developed; tergite with more or less distinct lateral lobes bearing bristles or spiniforms; sternite long and without bristles. *Sidepiece:* well developed, more or less conical; a more or less distinct basal mesal lobe, varied in length; frequently a more or less distinct ventral subapical lobe; scales usually not developed; mesal surface completely sclerotized. *Claspette:* represented by basal mesal lobe. *Clasper:* well developed; simple and tapered; with distinct simple or bifid apical spiniform. *Phallosome:* simple but varied; aedeagus long, conical or cylindrical with apical process; ventral paramere developed but not dorsal; basal piece well developed. *Proctiger:* very strongly developed; basal lateral sclerotization usually strongly developed; paraproct strongly sclerotized and ending in 1 or more teeth; dorsal surface unsclerotized; a variable but distinct group of cercal setae.

PUPAE.—Not studied in detail. *Cephalothorax:* middorsal ridge moderate; all normal hairs present; hairs 4,5-C close together; 8,9-C both caudad of trumpet. *Trumpet:* widely separated, arising closer to wing base than middorsal line; apex diagonally truncate, no slit; tracheoid not developed. *Abdomen:* hair 1-I a well-developed dendritic hair; 2,3-I and 4,5-I in well-separated groups; 9-II-VI small, removed from caudolateral angle, near lateral margin, either dorsal or ventral in origin; 9-VII branched, dorsal in position, well removed from caudolateral angle; 9-VIII branched, at caudolateral angle, ventral in insertion. *Terminal Segments:* hair 1-IX a simple bristle, less than 0.5 of tergite IX; hair 1-X represented by a minute hair or alveolus on cercus; female and male cercus more or less distinct but not projecting beyond apex of proctiger; male sidepiece lobes well developed, divergent apically. *Paddle:* varied in shape and spiculation of margin; hair 1-P well developed; hair 2-P usually absent, rarely represented as anomaly.

LARVAE.—*Head:* usually distinctly wider than long; labrum short; collar distinct, narrow; side distinctly bulging caudad of antenna; ventral surface of head capsule quite long; posterior tentorial pit closer to caudal border than to middle of ventral surface; maxillary suture complete to posterior tentorial pit but not extending beyond; cephalic border of labial plate truncate; aulaeum very broad, with very long filamentous spicules throughout; mental plate broad, triangular, with numerous teeth which are most distinct laterad at base; maxilla with subapical bristle short, palpus well developed; mouthbrushes normal, numerous, outer filamentous, inner with pectinate apex; hair 1-C simple, not arising from distinct process; 0-C distinct or not; 2-C absent; 3-C well developed; 4-6-C well caudad of antennal level; 11-C well ventrad of antenna; 12,13-C varied in development and position; 14-C near anteromesal corner; 15-C near middle; hairs 16,17-C apparently absent. *Antenna:* varied in length; simple; shaft spiculate; hair 1-A varied in position, always well developed and branched; other hairs varied in position and development. *Thorax:* spiracular sensilla distinct; notched organ not developed; hairs 9-12-P,M,T on common tubercles; 13-P not developed but all others present; 1-3-P on large common tubercle; all large hairs on more or less distinct separate basal tubercles or plates; 8-P long; 8-M,7-T long, multiple; 12-P very strong; hairs 9,10,12-P all long; none of the hairs plumose or palmate but some of the larger branched hairs barbed. *Abdomen:* spiracular and dorsal sensilla usually distinct; tergites without sclerotizations other than at base of hairs; hair 1 never palmate; hairs 6-I,II not markedly differentiated from 6-III-VI; 7-I long, markedly different from hair 7 on following segments; segment I with full complement of hairs except for hair 14. *Segment VIII:* comb scales present, in a triangular patch or a single row, no sclerotized plate. *Siphon:* varied in length; acus present; pecten teeth always developed; hair 1-S at base of siphon (except in *littleri* (Taylor, 1914), in which it is at middle), accessory hairs 1a-S present or not; 2-S on siphon, accessory hairs 2a-S present or not; 13-S minute; valves small; trachea and stirrup-shaped piece well developed. *Anal Segment:* saddle almost always complete; without acus; strongly emarginate for ventral brush; caudal marginal spicules weak; median dorsal caudal process strongly developed; hair 1-X on saddle, at or removed from margin; dorsal brush with hair 2-X usually multiple, 3-X single or with few branches and longer; ventral brush usually with 5–7 or more pairs of hairs on grid which is joined to saddle and 1 or more detached hairs midventrally on saddle; no accessory saddle hairs; gills usually narrow, pointed.

EGGS.—Varied; laid in rafts on water surface or singly on ground or on objects above the water level.

SYSTEMATICS.—The genus *Culiseta* is most readily characterized by the development of hairs on the lower surface of the wing at the base of the subcosta. This character, however, is not unique, as was formerly believed, but is found also in *Opifex* and *Mansonia* (*C.*) *tenuipalpis*. The larvae are remarkably diverse in the head chaetotaxy, length of antenna, and the details of the terminal segments and have been used to a large extent in characterizing the 7 subgenera currently recognized.

Without a review of the entire genus, it is difficult to determine the affinities of *Culiseta*. It appears to be 1 of the most (if not the most) generalized of all the genera of the subfamily and may consist of several stocks from which some of the other genera have been derived or may include forms of hybrid origin between several primitive phylads in the subfamily. At least superficial similarities of some species of *Culiseta* have been noted with some representatives of *Culex, Orthopodomyia, Ficalbia,* and even *Aedes.* For the present I am regarding *Culiseta* as constituting the monotypic tribe Culisetini.

In the South Pacific the genus is represented by the single species *tonnoiri* from New Zealand, which is undoubtedly a member of the subgenus *Climacura,* otherwise known only by the type species *melanura* (Coquillett, 1902) from the Eastern United States and by an undescribed species from Australia. It is quite possible that additional species of the genus may exist in New Zealand.

BIONOMICS AND DISEASE RELATIONS.—The bionomics of the better known species of *Culiseta* are briefly reviewed by Horsfall (1955:347–357); Dobrotworsky (1954:65, 66) adds interesting information on Australian species. The majority of species are ground pool-breeders in bogs, marshes, ponds, streams, and small ground and rock pools. Several species are sometimes found in artificial containers and rarely in treeholes. The African *fraseri* Edwards, 1914 is restricted to treeholes. Several Australian species breed underground. The majority of species of *Culiseta* are cold-adapted forms occurring in warm areas only during the colder parts of the year or at higher elevations, where the temperature is low.

Little is known of the blood-feeding habits of species of *Culiseta.* Several species attack domestic animals and at least occasionally man; the natural hosts may be birds.

In the Western United States *inornata* (Williston, 1893) has been found naturally and *incidens* (Thomson, 1868) experimentally infected with encephalitis viruses (Hammon and Reeves, 1943*a,b;* Reeves and Hammon, 1944, 1946). There is considerable recent evidence that *melanura* (Coquillett, 1902) is an animal vector of encephalitides through much of its range in the Eastern United States.

In Australia *hilli* (Edwards, 1926), *frenchii* (Theobald, 1901), and *victoriensis* (Dobrotworsky, 1954) are said to be very troublesome to man in late summer and autumn (Dobrotworsky, 1954:65).

DISTRIBUTION (fig. **184**).—*Culiseta* is dominantly Holarctic and Australian in distribution but is represented also in the Ethiopian and Oriental regions. It has not been reported from the Indomalayan, Malagasy, Papuan, or Neotropical regions. In the South Pacific it is known only from New Zealand.

KEYS TO SPECIES

See keys to tribes, pp. 118–122

1. Culiseta (Climacura) tonnoiri (Edwards)

Figs. **184, 185**

1925. *Theobaldia tonnoiri* Edwards, B. Ent. Res. 15:258–259. TYPE: holotype ♀, Waiho, Westland, New Zealand, Jan. 16, 1922, A. Tonnoir (NELSON, *fide* Gourlay, *in lit.*).

Culiseta (*Culiseta*) *tonnoiri* of Stone, Knight, and Starcke (1959).
Theobaldia (*Climacura*) *tonnoiri* of Edwards (1932:106); Taylor (1934:13).
Theobaldinella tonnoiri of Miller (1950:45); Miller and Phillipps (1952:25–26).

FEMALE.—*Wing:* 4.68 mm. *Proboscis:* 3.13 mm. *Forefemur:* 2.25 mm. *Abdomen:* about 3.0 mm. *Head:* scales of vertex all golden; labium slender, dark-scaled, with only a few subbasal ventral bristles; palpus dark, about 0.17 of proboscis length, distinctly 5-segmented, segments 1–3 short, segment 1 without bristles or scales, segments 2 and 3 with some very long bristles and a few elongate dorsal dark scales, 4 elongate and subequal to 1–3 combined and with more numerous dorsal dark scales and shorter bristles, segment 5 whitish and without hairs or scales, a little shorter than segment 1 and much narrower; antennal torus yellowish, with rather long hairs; flagellar segment 1 with 1,2 dark scales. *Thorax:* mesonotal, scutal, and pleural integument dull reddish brown, pleuron with lighter area in upper *stp* and on membranes; mesonotal scales all linear, largely golden but with large patches of dark brown scales on fossa, posterior dorsocentral area, and upper supraalar area; scutellar scales apparently all golden; pleural scaling very scanty and restricted; *apn* with golden hairs or extremely long hairlike scales; *ppn* with a few very narrow hairlike golden scales; *ppl* without scales; *psp* without scales; *stp* with a small patch of elongate but broad semierect creamy scales in upper part and another similar patch below, the 2 widely separated; *mep* with a large but restricted patch of similar scales in middle; metameron bare; bristles largely golden except for longer ones which are dark at least distad; 3–5 *sp* bristles; *stp* bristles not numerous, separated into upper and lower caudal group; only 1 strong lower *mep* bristle. *Legs:* dark brown; femora with a subapical light ring; ventral and posterior surfaces of forefemur and midfemur and ventral and anterior surfaces of hindfemur also light; tibiae lighter ventrally and apically; hindtarsal segment 1 about as long as hindtibia. *Wing:* membrane distinctly clouded over a large area from furcation of Rs proximad and extending from Sc to M, less distinctly from furcation of Cu along vein Cu_2; scales long, dense, lanceolate, dark brown in color, darker and forming distinct spots at base of cells R_2 and M_2, on distal half of R_5 and corresponding portion of M, and along vein Cu_2; cell R_2 about 5 or 6 times as long as vein R_{2+3}; "cross veins" not scaled; base of Rs apparently unscaled. *Haltere:* light at base and stem, dark-scaled on knob. *Abdomen:* tergites and sternites with purplish dark brown scales, latter absent at base of most of the segments, producing a slight banded appearance; bristles largely golden, numerous and elongate; tergite I completely without scales.

MALE and PUPA.—Unknown.

LARVA (fig. 185).—*Head:* 0.95 mm. *Siphon:* 1.96 mm. *Anal Saddle:* 0.51 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* very lightly pigmented, darker caudolaterad; no visible integumentary sculpturing; mental plate rather small, with about 9,10 teeth on each side of conspicuous median tooth; collar poorly developed; hairs strongly pigmented, larger hairs lightly barbed; hair 1-C slender, attenuate; 0-C not visible; 6-C single, with strong barbs near base; hair 13-C longer than hair 11. *Antenna:* longer than head capsule, slender, uniform in width to hair 1-A, narrowed beyond and again distad of 2,3-A; smoothly curved; spicules long and slender in basal portion; uniformly darkly pigmented except for very dark basal ring; hairs 1-3-A blackish, others concolorous with shaft; 2,3-A very long, subapical. *Thorax:* said to be whitish in life (Miller and Phillipps, 1952:26); larger hairs and tubercles darkly pigmented, smaller hairs moderately. *Abdomen:* said to be reddish or purplish in color in life (Miller and Phillipps, 1952:26); larger hairs and tubercles darkly pigmented, smaller hairs moderately. *Segment VIII:* comb of about 18–20 long, broadly spatulate black scales in a single even row. *Siphon:* index about 6.5–7.0; uniformly lightly pigmented, darkened at apex and with black basal ring and acus; dorsal and ventral valves black; sculpturing uniform and fine, consisting of short spicules in subparallel close rows; pecten teeth usually 8–10, extending usually to about 0.3 of siphon, each tooth a simple acute spine rarely with small subbasal tooth; hair 1-S very small, at extreme base, usually 3,4b; hairs 1a-S represented by a single midventral row of 4 very fine single or double hairs; 2-S a rather strong slender apically hooked stiff hair inserted at extreme apex of siphon body; hairs 2a-S represented by a subdorsal row of 6–8 very fine single or double hairs on each side. *Anal Segment:* saddle complete; uniformly lightly pigmented but darkened at base and dorsally at apex; integumentary sculpturing coarser than on siphon; no caudal marginal spicules; hair 1-X very small and fine, usually 3b; ventral brush with 6 pairs of hairs on grid and usually 3,4 short thick single or double hairs proximad of grid on saddle.

MATERIAL EXAMINED.—53 specimens; 26 ♀; 27 larvae; no males or pupae.

SYSTEMATICS.—The presumed larva of *tonnoiri* bears a remarkable resemblance to *melanura* (Coquillett, 1902), the type species of *Climacura* from the Eastern United States. Particularly significant are the following unique features shared by the 2 species: the comb in a single row and the peculiar shape of the individual comb scales; the very small basal hair 1-S on the siphon; a midventral line of accessory hairs 1a-S on the siphon; the dorsolateral irregular line of accessory hairs 2a-S on the siphon; the strongly developed apically hooked hair 2-S on the siphon; and the strong development of hair 13-C, which is larger than 11-C. The females of the 2 species also show a number of interesting similarities, notably (1) the poor development of pleural scaling, (2) the presence of only extremely narrow scales on the mesonotum, *apn*, and *ppn*, (3) the small number of spiracular bristles, and (4) the extremely short vein R_{2+3}. Therefore I consider that *tonnoiri* is related to *melanura* despite the unusual geographical relations of the 2 species. *C. tonnoiri* is strikingly distinct from *melanura* in the ornamentation of the femora and wings and the absence of very narrow hairlike scales on the lower surface of the paratergite. It appears likely that undescribed species of this subgenus exist elsewhere, since Dobrotworsky (1954:68) reports a species from Victoria, Australia, whose larva shows similarities with *melanura*.

BIONOMICS AND DISEASE RELATIONS.—Miller and Phillipps (1952:26) report *tonnoiri* larvae from "back waters of streams where there is very slow-flowing, or comparatively dead, water sheltered by a dense canopy of foliage and rich in decaying matter including leaves and other debris; among the latter, the larvae of *tonnoiri,* like those of *antipodeus,* hide when alarmed and are difficult to find, but unlike *antipodeus* they appear to develop chiefly during the summer." Nothing is known of the bionomics or disease relations of the adults of *tonnoiri.*

DISTRIBUTION (fig. **184**).—*New Zealand:* North Island (Auckland); South Island (Westland, Otago). Not known elsewhere.

TRIBE FICALBIINI

Genus FICALBIA Theobald

1903. *Ficalbia* Theobald, Monog. Culicidae 3:296–297. *TYPE SPECIES: *Uranotaenia minima* Theobald, 1901, South India; the first of 2 included species, selection of Brunetti (1914:60).

See under subgenera and, for complete synonymy, Stone, Knight, and Starcke (1959) and Mattingly and Grjebine (1958).

FEMALES.—Medium-sized to small mosquitoes, varied in appearance, easily confused with *Aedes*. *Head:* eyes contiguous or narrowly separated above antennae; frontal tuft present or absent; vertex with scaling varied, erect scales numerous or few; clypeus small, elongate, ovoid in outline in front; labium usually more or less distinctly swollen apically, usually with several subbasal bristles; palpus apparently 4-segmented, segment 4 minute, total length usually less than 0.33 of proboscis; antenna as long as or longer than proboscis, flagellar segment 1 varied in length, sometimes several times as long as segment 2. *Thorax:* mesonotum strongly arched; scutellum trilobed; postnotum bare; paratergite rather broad, bare; *apn* lobes small and widely separated; *pra* not separated by suture from *stp;* meron small, its upper edge above insertion of hindcoxa; mesonotal scales largely narrow, varied in shape and density; scutellar scales narrow or broad; pleural scaling varied; acrostichal bristles usually not developed, dorsocentrals usually strong but may be reduced and apparently absent, supraalars not numerous; *apn* with numerous bristles not confined to anterior and ventral margins; *ppn* with several bristles; *ppl* bristles varied in number but never very numerous; *sp* without bristles or scales; *psp* without bristles; several *pra* bristles; *stp* with a continuous row of bristles along caudal margin continued as upper transverse row; *mep* with extensive patch of posterior upper bristles and a line of several posterior bristles to lower margin, only rarely anterior lower *mep* bristles present. *Legs:* normal; bristles well developed on femora and particularly on tibiae; femora not markedly swollen; foretarsal and midtarsal segment 4 not markedly shortened, about as long as or longer than segment 5; claws of all legs small, subequal, and simple; pulvilli not developed. *Wing:* wing membrane with distinct microtrichia; plume scales in most instances all broad; cell R_2 varied in length, usually long and never less than 2.0 length of vein R_{2+3}; no spurs at base of Rs and R_{4+5}; vein 1A smoothly curved, ending distad of level of fork of vein Cu; no remigial bristles on base of R dorsally; base of Sc without bristles ventrally; plical area without scales at base ventrally; alula bare or with a few dorsal submarginal scales which are usually broad; upper calypter with continuous marginal row of bristlelike scales or a dorsal row of broad scales. *Haltere:* short and stubby. *Abdomen:* tergites and sternites almost completely and densely scaled; tergite I extensively scaled; laterotergite without scales; bristles normal; tip of abdomen blunt. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; cercus short and broad; postgenital plate large, projecting beyond cercus; 1 or 3 spermathecae.

MALES.—Essentially as in the females. *Labium:* usually more strongly swollen than in females. *Palpus:* varied in length from 0.17 to 1.33 of proboscis, apparently 4-segmented. *Antenna:* subequal in length to that of female; flagellum strongly plumose; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg and midleg variously enlarged and both members of a pair usually toothed. *Abdomen:* bristles not markedly stronger or more numerous than in females.

MALE GENITALIA.—Not studied in detail. *Segment VIII:* long and wide, without apparent specializations. *Segment IX:* large; tergite poorly sclerotized, with single median or a pair of lateral lobes with bristles; sternite long, without bristles. *Sidepiece:* more or less long conical or cylindrical, well developed; a small, more or less distinct basal mesal lobe with specialized apical bristles; no other lobes; mesal surface completely sclerotized. *Claspette:* represented by basal mesal lobe of sidepiece. *Clasper:* simple, slender; with simple subapical spiniform. *Phallosome:* simple but varied; aedeagus large, varied in form but without apical process; ventral paramere usually strongly developed, dorsal not developed; basal piece well developed. *Proctiger:* very strongly developed; lateral basal sclerotization prominent; paraproct strongly sclerotized and usually with only a few large apical teeth; dorsal surface unsclerotized; cercal setae few, small but distinct.

PUPAE.—Not studied in detail. *Cephalothorax:* middorsal ridge moderate; hair 3-C very strongly developed, much larger than 1,2-C; 6-C single, strongly developed; 8,9-C at same level, far caudad of trumpet base. *Trumpet:* closely approximated, arising much closer to middorsal line than to wing base and far forward on a more or less distinct tubercle; often very long; apex strongly diagonally truncate or with a deep slit; tracheoid very extensive. *Abdomen:* hair 1-I a simple hair or dendritic; hair 3-VII apparently usually absent; 9-II-VII small, removed from caudolateral angle, near lateral margin, usually slightly ventral; 9-VIII on caudal margin near lateral angle, ventral in insertion; 3-I and sometimes 2-I very strongly developed. *Terminal Segments:* hairs 1-IX,X apparently not developed; male and female cercus indistinct; female postgenital plate with projecting divergent spiculate lateral lobes; male sidepiece lobes well developed, not divergent. *Paddle:* varied in shape; often very long and narrow; usually with strong marginal serrations; hair 1-P present or absent, 2-P always absent.

LARVAE.—*Head:* distinctly wider than long; labrum short; collar narrow; side strongly bulging caudad of antenna; ventral surface of head capsule very short; posterior tentorial pit close to collar; maxillary suture usually completely absent, at most slightly indicated in front; cephalic border of labial plate truncate; aulaeum very poorly developed, with long sparse filamentous or close-set short spicules and a median triangular process; mental plate small, triangular, apparently undeveloped in *plumosa* (Theobald, 1901) (Mattingly 1957*a*:12); maxilla with subapical bristle short or long, palpus well developed; mouthbrushes numerous and filamentous, sometimes reduced but never as in Toxorhynchitini; hair 1-C usually very strongly developed, not on distinct tubercle; 0-C distinct; 2-C absent; 3-C distinct; 4-7-C at about level of antenna; 11-C very strongly developed; hairs 16,17-C apparently not developed. *Antenna:* usually at least as long as head capsule; shaft spiculate; often with a membranous ring distad of hairs 2,3-A so that part beyond is movable; hair 1-A varied in position, always well developed and branched; 2,3-A usually removed from apex, long, single or dendritic; 4-A at apex, long, single or dendritic; 6-A at apex, single; 5-A of the usual shape, apex translucent, appearing as the distal segment of antenna. *Thorax:* spiracular sensilla distinct; notched organ not developed; hairs 9-12-P,M,T on common tubercles, those of M and T very large; 13-P not developed but all others present; 7-T with a large basal tubercle, other hairs including 1-3-P without distinct or strong basal tubercles; 12-P very strongly developed; 8-P varied in development; 8-M,7-T long, multiple; none of the hairs plumose or palmate, larger hairs barbed. *Abdomen:* spiracular and dorsal sensilla distinct; tergites without sclerotizations other than those at base of hairs; hair 1 never palmate; hair 6-I,II longer and heavier but not markedly differentiated from 6-III-VI; 7-I and sometimes 7-II long, markedly different from hair 7 on following segments; segment I with full complement of hairs except for hair 14; hair 1-III-V strongly displaced laterad; hairs 2,4 mesad of hair 1 on III,IV and only hair 2 on V,VI. *Segment VIII:* comb scales always present, in a single row or a patch, no sclerotized plate. *Siphon:* varied in length and shape; attached or detached acus present; pecten absent or greatly reduced, at most with 4 teeth; hair 1-S varied in position, at base or near middle, no accessory hairs 1a-S; 2-S simple or spiniform, sometimes branched, always on siphon, no accessory hairs 2a-S; valves small or greatly reduced; hair 13-S minute to very long; stirrup-shaped piece always distinct, sometimes greatly developed; trachea well developed. *Anal Segment:* saddle complete, moderately to strongly emarginate for ventral brush; acus absent; caudal marginal spicules present or absent; median dorsal caudal process developed; hair 1-X on saddle; dorsal brush varied, hair 2-X usually long; ventral brush often with reduced number of hairs, with 2-6 pairs of hairs, grid poorly developed and with varied lateral sclerotization, not joined to saddle midventrally; no accessory saddle hairs; gills varied, usually pointed and subequal.

EGGS.—Known only for *minima* (Theobald, 1901); laid in small groups on undersurface of *Pistia* leaves, bluntly ovate and with apical dehiscence (Iyengar, 1935).

SYSTEMATICS.—*Ficalbia* as now understood forms a complex of 4 strongly marked subgenera: *Etorleptiomyia, Mimomyia, Ficalbia,* and *Ravenalites* (Mattingly, 1957*a*:7–18; Mattingly and Grjebine, 1958). Only the first 2 subgenera are represented in the South Pacific, by 2 and 1 species, respectively.

The genus as a whole is defined mainly on negative characters but appears to form a natural group. In spite of some overlap with other groups in a wide variety of characters, adults of *Ficalbia* are quite characteristic and fairly easily recognizable. The larvae and pupae are also varied and share a number of characters with other tribes. As in the majority of other groups, the immature stages are probably of greater value than the adults in determining relationships. In the larva the greatest similarities appear to be to *Mansonia* and *Culiseta,* but the larvae of *Ficalbia* are readily separated from both in the complete or almost complete absence of the maxillary suture and, except for the subgenus *Ficalbia,* by the median position of hair 1-S on the siphon. There are a number of rather striking similarities in the larva and pupa of some species of ground pool *Ficalbia* and *Mansonia* which are suggestive of phylogenetic affinity of these genera (Mattingly, 1957*a*:8–9). The relationship appears to be real, but it does not seem to be very close, since the details of some of the specializations (such as the plant-piercing siphon of the larva) are quite different in the 2 genera. Similarly the suggested affinities with *Uranotaenia, Hodgesia,* and *Orthopodomyia* (Edwards, 1932:64; Mattingly and Grjebine, 1958:284–285) are undoubtedly real. At the same time, all these genera, as well as *Mansonia* and *Culiseta,* are clearly marked and in my opinion represent early stabilized offshoots from the same general stock, while *Ficalbia* consists of a complex of several closely interrelated, less specialized, and less distinctly differentiated types, perhaps of more recent origin. Therefore, I consider that each of these genera is worthy of recognition as a separate tribe.

BIONOMICS AND DISEASE RELATIONS.—The breeding places of *Ficalbia* are varied, but the majority of species are found in ground waters with dense vegetation or in various organic containers, such as treeholes, leaf axils of plants, and *Nepenthes* pitchers. Of particular interest is the apparent obligate relationship between some ground pool-breeders and *Pistia.* Several species have a piercing siphon in the larva and a piercing trumpet in the pupa and obtain oxygen from the tissues of aquatic plants. Mattingly and Grjebine (1958:279–284) have reviewed the interesting larval adaptations in the genus.

Very little is known about adult bionomics of *Ficalbia.* Several species have been reported biting man occasionally out of doors as well as indoors, but none are serious pests. Most species appear to be nocturnal in activity and several have been noted to be attracted in small numbers to artificial lights (Mattingly and Grjebine, 1958:279). This genus is apparently of no economic importance.

DISTRIBUTION (fig. **186**).—*Ficalbia* is known only from the Old World and is largely confined to the tropics. It occurs from West Africa to the Solomons, from 15° N. to Madagascar in the west and from Okinawa to Queensland in the east. In the South Pacific it is represented only in the Solomons.

KEYS TO SUBGENERA AND SPECIES

(Keys to tribes, pp. 118–122)

ADULTS

1. Wings unicolorous, with dark scales only; scutellar scales narrow; alula bare (MIMOMYIA) . . . . 1. *gurneyi*
Wings speckled, with light and dark scales; scutellar scales broad; alula with scales (ETORLEPTIOMYIA) 2
2(1). Humeral and fossal areas of mesonotum largely light-scaled and with only a few very narrow dark bronzy scales . . . . 1. *solomonis*
Humeral and fossal areas of mesonotum largely with short broadened curved dark bronzy scales, light scales few in number . . . . 2. *bougainvillensis*

MALE GENITALIA

1. Bristle-bearing lobes of tergite IX approximated on midline; aedeagus conical apically (MIMOMYIA) . . . . 1. *gurneyi*
Bristle-bearing lobes of tergite IX widely separated; aedeagus globular apically (ETORLEPTIOMYIA) 2
2(1). Paraproct with only 2 apical spines . . . . 1. *solomonis*
Paraproct with 3 apical spines . . . . 2. *bougainvillensis*

PUPAE

1. Paddle index less than 3.0; trumpet index less than 20.0; hair 1-I multiple, more or less dendritic (MIMOMYIA) . . . . 1. *gurneyi*
Paddle index more than 4.0; trumpet index more than 20.0; hair 1-I single, small (ETORLEPTIOMYIA) 2
2(1). Inner margin of paddle with very large teeth in basal portion; caudolateral angle of tergite VIII rounded or with short spicules . . . . 1. *solomonis*
Inner margin of paddle with small spicules in basal portion; caudolateral angle of tergite VIII with a large sharp spine . . . . 2. *bougainvillensis*

LARVAE

1. Ventral brush of anal segment with 4 pairs of long hairs; narrowed distal part of antenna more than 0.5 of proximal part; siphon short, sharply narrowed apically (MIMOMYIA) . . . . 1. *gurneyi*

Ventral brush of anal segment with only 3 pairs of long hairs and with 1,2 pairs of very short hairs; narrowed distal part of antenna less than 0.25 of proximal part; siphon elongate, more or less swollen beyond middle then narrowed (ETORLEPTIOMYIA) 2

2(1). Hair 1-VIII usually single, arising from a common basal plate with 2-VIII; 1-III-VII usually double .... 1. *solomonis*

Hair 1-VIII double or triple, no common basal plate for 1,2-VIII; 1-III-VII usually with 4 or more branches .... 2. *bougainvillensis*

Subgenus ETORLEPTIOMYIA Theobald

1904. *Etorleptiomyia* Theobald, Wellcome Res. Lab., Rpt. 1:71. *TYPE SPECIES: *E. mediolineata* Theobald, 1904, Abyssinia; monobasic.

1905. *Oreillia* Ludlow, Canad. Ent. 37:101. *TYPE SPECIES: *O. luzonensis* Ludlow, 1905, Philippines; monobasic.—Spelling corrected from *O'Reillia.*

1914. *Dixomyia* Taylor, Roy. Ent. Soc. London, Trans. 1913(61):702–703. TYPE SPECIES: *D. elegans* Taylor, 1914, Queensland; monobasic.

1944. *Luzonus* Stone and Bohart, Ent. Soc. Wash., Proc. 46:212. *TYPE SPECIES: *Aedes (L.) clavirostris* Stone and Bohart, 1944, Philippines; original designation.—As subgenus of *Aedes.*

FEMALES.—*Head:* eyes well separated above antennae; this frontal space with narrow scales and a pair of longish bristles; vertex with narrow curved scales above and broad scales laterally; erect scales numerous and conspicuous, extending forward; labium distinctly swollen on apical 0.20; palpus white-tipped; torus with broad scales and very short hairs; flagellar segment 1 about 1.0–1.5 length of segment 2, with broad scales. *Thorax:* scutellar scales largely broad, a few narrow ones apically; acrostichal bristles present or absent, dorsocentrals always present; pleural scales largely broad, sometimes some narrow curved on *apn; apn, ppn, ppl, psp, stp,* and sometimes *mep* with scales; *mep* with upper bristles only, no anterior or posterior lower bristles. *Legs:* tarsi banded with yellowish scales. *Wing:* squame scales dense, very large, broad, cordiform, contrasting light and dark; cell R_2 about 3.0–4.5 length of vein R_{2+3}; alula with marginal patch of broad scales; upper calypter with fringe of narrow hairlike scales. *Abdomen:* tergites with some light markings. *Genitalia:* only 1 spermatheca.

MALES.—*Labium:* very strongly swollen in about distal half. *Palpus:* about 0.6–0.9 of proboscis length; apparently 4-segmented; apex of segment 3 (distal part of "long" segment) only slightly swollen; segment 4 very small; only short hairs present.

PUPAE.—*Trumpet:* index about 20.0–30.0; not modified for piercing. *Abdomen:* hair 1-I single, small; 1,5-VII very large and dark, usually at least triple; 9-VIII large, usually 8-11b, strongly barbed or plumose. *Paddle:* index about 4.0–10.0 or more; margins with spicules or serrations; external buttress not developed at all; hair 1-P present or absent.

LARVAE.—*Head:* hairs 5,6,7,11-C very long; 11-C usually double. *Antenna:* articulated distad of hairs 2,3-A, distal portion less than 0.5 proximal; hairs 2-4-A all long and single. *Siphon:* long, index about 5.0–8.0 or more; valves short, not modified for piercing, valve hairs short. *Anal Segment:* ventral brush with 3 pairs of long hairs and 1,2 short hairs.

SYSTEMATICS.—Only 4 species of the subgenus are recognized by Mattingly and Grjebine (1958), but it appears likely that several unrecognized forms exist in addition to the 2 described here.

The South Pacific species of *Etorleptiomyia* are both members of the *elegans* complex, which has been reported also from Thailand, Malaya, Indonesia, Philippines, New Guinea, New Britain, and Queensland. Mattingly (1957*a*:46–49) regards populations from all these localities as constituting a single species, *elegans* (Taylor, 1914). I find that typical *elegans* from Queensland is markedly different from all the others I have seen in having a large patch of broad pale scales on the middle anterior portion of the mesepimeron and much darker wings, legs, and abdomen. There are also some rather striking differences in the larvae and pupae of the various populations.

The relationship of *elegans, solomonis,* and *bougainvillensis* cannot be determined until the populations from New Guinea are thoroughly studied. The few adult specimens that I have seen from Hollandia resemble *bougainvillensis* in general coloration but differ in having few if any broad light scales on the middle lobe of the scutellum. *F. solomonis* appears to be specifically different from *bougainvillensis,* as there is no indication of any intermediates or intergrades on Bougainville, where the 2 forms are sometimes found in the same breeding site.

BIONOMICS.—*Etorleptiomyia* species are ground pool-breeders and are most commonly found in dense swamps or even at the edge of marshy areas where no free water is apparent until the surface is depressed. Living larvae have a striking purplish pink coloration.

DISTRIBUTION (fig. 186).—The distribution of

Etorleptiomyia is coextensive with that of the genus except for its absence from Madagascar. In the South Pacific the 2 known forms are restricted to the Solomons.

KEYS TO SPECIES

See keys to tribe Ficalbiini, pp. 289–290

1. Ficalbia (Etorleptiomyia) solomonis Belkin, n. sp.

Figs **187-189**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins (JNB, 681-19), Chacon swamp, Lunga area, Guadalcanal, Solomon Islands, from shallow dense swamp, Oct. 17, 1944, J. N. Belkin (USNM, 64771). *Allotype:* ♀ with associated larval and pupal skins (JNB, 681-16), same data as holotype (USNM). *Paratypes:* 7♀, 8♂, 16 pupae, 26 larvae (JNB, 681-1), same data as holotype; including 4♀ (JNB, 681-11, 14, 18, 20) and 4♀ (JNB, 681-12, 13, 15, 17) with associated larval and pupal skins.

Ficalbia (*Etorleptiomyia*) *elegans* in part of Iyengar (1955:26); Mattingly (1957*a*:49); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.67 mm. *Proboscis:* 1.83 mm. *Forefemur:* 1.5 mm. *Abdomen:* about 1.93 mm. *Head:* frontal and vertical narrow scales light, dingy white or yellowish; erect scales very dense, light in central area, whitish on apex, yellowish at base, and a patch of dark scales caudolaterad; broad lateral scales largely dingy white, interrupted by a narrow stripe of dark scales; labium dark-scaled at base to slightly beyond apex of palpus and on broad apical ring, remainder largely light yellow with scattered dark scales dorsally toward apical dark ring; palpus about 0.25 of proboscis length, dark except for conspicuous white apex, segment 4 minute, without scales; antenna distinctly longer than proboscis; torus scales largely whitish; flagellar segment 1 about 1.5 of segment 2 or slightly less, with mixed dark and light scales. *Thorax:* mesonotal, scutellar, and central postnotal integument rather uniformly dark brown; pleural integument light except for *apn*, upper part of *ppn*, *psp*, *ssp*, central part of *ppl*, and anterior and posterior spots on lower *stp* which are dark; mesonotum largely covered with very narrow long curved decumbent light yellowish or tan scales except for more or less distinctly restricted patches of similar but dark bronzy scales as follows, (1) separate anterior and posterior patches along acrostichal line, (2) an anterior humeral patch, (3) an irregular fossal patch, (4) an antealar patch, (5) a lateral dorsocentral patch, (6) a supraalar patch, and (7) most of the prescutellar area; a tuft of large elongate erect dark scales in antealar patch and another tuft of similar dark scales with some whitish ones above anteriorly in supraalar patch; dark scales in fossal area not markedly broadened but shorter than light scales, some of those in prescutellar patch larger and broader; scutellar broad scales all dark basad and light distad on all lobes but particularly on median, narrow apical scales light; acrostichals not developed; dorsocentrals strong; *apn* scales all broad and more or less outstanding, dark on upper part, white on lower; *ppn* scales all broad and decumbent, largely dark but always some white ones caudad above and below; all other pleural scales broad, whitish, and decumbent; a *ppl* patch of scales in form of semicircle below bristles; *psp* patch very small; *stp* with 3 patches, an anterior adjacent to *ppl*, an upper caudal, and a lower caudal; *mep* with at most 2,3 scales among upper *mep* bristles; *ppn* bristles in a regular curved line, usually 6–8; usually 2 strong dark *ppl* bristles and several light hairs; usually 2 of the lower *stp* bristles stronger and darker. *Legs:* forecoxa largely white-scaled, dark in middle and on inner distal corner; midcoxa entirely dark-scaled; hindcoxa with mixed light and dark scales; remaining leg segments with pale scaling largely light yellowish; forefemur extensively pale from base, predominantly dark apically in front and along midventral line; midfemur and hindfemur mainly dark, with pale speckling in front, pale behind and apically; tibiae predominantly dark, light at base and apex and more or less extensively speckled with pale scales in between dorsally and laterally and with more or less extensive pale lines ventrally; foretarsus almost entirely pale ventrally, segment 1 pale at base and apex and extensively pale-speckled in between dorsally and laterally, segment 2 with dorsal dark scaling slightly more extensive than pale, segments 3 and 4 predominantly pale, dark in center dorsally, segment 5 pale at base dorsally; midtarsus with segment 1 largely pale ventrally and with broad basal and narrow apical pale rings, dark dorsal portion extensively pale-speckled, segments 2–5 essentially as on foreleg except that ventral surface is dark in middle; hindtarsal segment 1 with broad subbasal and narrow apical light rings, central portion dark but with pale speckling which is more extensive ventrally, segments 2–4 with light dorsal patches, basal one long and usually forming a narrow ring ventrad at least on segment 2, the apical one much shorter, the extensive dark portion of segments 2–4 without speckling, segment 5 with small basal dorsal light patch. *Wing:* light scales usually whitish, almost as numerous as the dark; vein C usually extensively pale in distal half; cell R_2 about 5.0 length of vein R_{2+3}. *Haltere:* light at base and stem, dark-scaled on knob. *Abdomen:* pale scales dingy white; tergite I largely pale, dark caudolaterad; tergite II with pale basal light band widened laterally and sometimes in the middle and with a more or less distinct small sublateral median detached light patch on each side, visible dorsally; tergites III-VII with extensive lateral basal light patches usually with dorsal basal extensions on III and sometimes IV and with large detached sublateral submedian light patches; tergite VIII with large dorsolateral light patch; sternites II-IV predominantly light and with dark triangular apical median patches and diagonal sublateral dark lines; sternites V-VII predominantly dark and with progressively smaller median basal triangular light patches; sternite VIII apparently with large lateral light patches.

MALE.—Generally similar to the female. *Labium:* strongly swollen and with some strong hairs and light scales on apical 0.3 which is predominantly dark, only about basal 0.2 dark, remainder largely whitish. *Palpus:* slightly less than 0.9 of proboscis length; dark at extreme base and on the slightly swollen apical portion, whitish with dark speckling in between. *Antenna:* barely as long as proboscis; flagellar segment 1 thickened.

MALE GENITALIA (fig. **188**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite unsclerotized in the middle; tergal lobes widely separated and poorly indicated, each with 4,5 slender bristles. *Sidepiece:* dorsal and mesal bristles not markedly different; basal mesal lobe small, only its distal part sclerotized, with 3 rather heavy differentiated apical bristles and about 12–20 short bristles and long hairs. *Clasper:* spiniform with expanded dorsal lamella. *Phallosome:* aedeagus well sclerotized, moderately broad at base and with rounded broader distal part which is wrinkled or spiculate apically. *Proctiger:* lateral sclerotization distinct; paraproct broad, sinuate in outline, with 2 distinct dorsal spines, the more apical longer; 3,4 distinct cercal setae.

PUPA (fig. **188**).—*Abdomen:* 2.6 mm. *Trumpet:* 2.28 mm. *Paddle:* 0.92 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, area ventrad of trumpet insertion and base of appendage cases darker; hairs largely concolorous with integument, 3,8-C blackish; hairs 1-3,6,8-C single; 5-C small, single or 2f. *Trumpet:* index about 26.0; tracheoid to about 0.8 or more; apical portion slightly widened, diagonally truncate, and slit for about half its length; basal 0.065 without tracheoid but with some small sharp spicules on one surface; pigmentation very dark to end of tracheoid, light yellowish beyond. *Metanotum:* hairs 10,11-C single; blackish. *Abdomen:* moderately to strongly and rather uniformly pigmented, segment VIII darker; dorsal hairs largely very dark and contrasting sharply with integument, ventral hairs and 3-II lighter; caudolateral corner of segment VIII either rounded or with 1,2 very small spicules. *Terminal Segments:* female postgenital lobe sharply produced, spicules not particularly strong; male genital lobe extending to about 0.23 of paddle, apex sharply produced and divergent laterad. *Paddle:* distal half distinctly widened; very dark on basal 0.7, lighter distad, midrib slightly darker throughout; index about 6.5; marginal spicules very strong, particularly on inner margin where they are very strong even near base; hair 1-P not developed.

LARVA (fig. **189**).—*Head:* 0.74 mm. *Siphon:* 1.1 mm. *Anal Saddle:* 0.3 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly darkly pigmented except for lighter labrum; hairs concolorous with head capsule, 1-C with labrum; aulaeum with long sparse filamentous spicules; mentum with 8,9 teeth on each side of enlarged median tooth, basal more widely spaced; hair 1-C heavy and long, simple; 7-C with broad base; 12,13-C long. *Antenna:* uniformly lightly pigmented, hairs concolorous except for darker 1-A; basal part with moderate spicules, distal with smooth shaft. *Thorax:* hairs and tubercles strongly pigmented; 1-P longest hair in shoulder group; 4-P short; 5,7-P usually 2b; 8-P short, branched; 12-P very strongly developed; 6-M long, multiple. *Abdomen:* hairs and tubercles moderately to strongly pigmented; hair 7 long on segment I only; 1-III-VII usually double, 1 branch short, other greatly elongate; 13-III-V usually 2b; 3-VII usually 2b. *Segment VIII:* comb of 2 rows of scales, distal with about 6 scales; individual scale bladelike, fringed laterally, and with 1 to several stronger apical spicules; hair 5-VIII approximated to hairs 3,4; hairs 1,2-VIII on a common heavily sclerotized basal plate, 1-VIII single, heavy, long, and with distinct barbs from near middle distad. *Siphon:* index variable, usually about 5.5–6.0; usually more or less distinctly swollen near middle and with apical 0.3 or less strongly narrowed but extremely variable in shape; pigmentation extremely dark on basal ring, moderate in basal half and apex, and darkened in between; integumentary sculpturing rather distinct at base and apex only; acus small and detached; pecten poorly developed, represented by 2–5 small sharp spinules with basal spicules;

hair 1-S usually 2b, rarely single, inserted just before middle; hair 2-S a bifid spiniform, rarely with small denticle in fork; valves small, unmodified; valve hairs distinct, 9-S hooklike and thickened; stirrup-shaped piece moderate. *Anal Segment:* saddle short; strongly uniformly pigmented, a little darker at base; integumentary sculpturing distinct dorsolaterally largely dorsad of hair 1-X, sharp spicules not continued to base of saddle; caudal margin with rather sparse, fairly heavy, moderately long spicules dorsad of hair 1-X; hair 1-X arising from saddle margin, long and single; hair 4a-X usually 2b, 4b,c-X single long, 4d-X very short, single; gills slender, shorter than saddle.

MATERIAL EXAMINED.—274 specimens; 71 ♀; 62 ♂; 59 pupae; 82 larvae; 13 individual rearings (10 larval, 3 pupal).

SYSTEMATICS.—*Ficalbia solomonis* differs considerably from *elegans* (Taylor, 1914) from Queensland, which is characterized in the adult stage by the presence of an extensive patch of broad light scales on the middle anterior portion of the mesepimeron and by the reduction of the light markings on the legs and the wing. *F. solomonis* is distinct from all other known members of the *elegans* complex by the very slender scales of the mesonotum, by the much less extensive dark scaling of the anterior part of the mesonotum, and by the more extensive light scaling of the legs, wing, labium, and abdomen. The pupa of *solomonis* has the paddle with a characteristic shape and color and usually does not have the caudolateral angle of tergite VIII produced into a conspicuous acute spine. The larva is strikingly different from other members of the complex in having hair 1-VIII thickened and single and arising from a heavily sclerotized common basal plate with hair 2.

Although there is considerable variation in all stages of *solomonis* from Guadalcanal, this population is strikingly uniform in diagnostic characters and is very similar to those from New Georgia and Russell. Larvae from 2 Bougainville collections possess all the diagnostic features of *solomonis* but have the siphon somewhat shorter and more swollen than is usual in the populations from the more southern islands; a single male from one of these collections is indistinguishable from *solomonis*.

The possible relationships of *solomonis, elegans,* and *bougainvillensis* are discussed above under the subgenus.

BIONOMICS.—On Guadalcanal the immature stages of *F. solomonis* were found only in undisturbed jungle swamps with extremely dense vegetation. They were collected most commonly along the edge of swamps where there was no exposed water at all until an artificial depression was made with the foot or a dipper. The striking purplish pink larvae and the pupae with extremely elongate trumpets became visible in these depressions after the dense and fine muck settled. The only mosquito normally associated with *Ficalbia solomonis* was *Hodgesia solomonis.*

On Guadalcanal *F. solomonis* was never taken biting but was occasionally collected at lights and in night hand catches.

DISTRIBUTION (fig. 187).—*Solomon Islands:* Bougainville; New Georgia; Russell; Guadalcanal. Not known elsewhere.

2. Ficalbia (Etorleptiomyia) bougainvillensis Belkin, n. sp.

Figs. **187, 190, 191**

TYPES.—*Holotype:* ♂ (ABG, 269) with genitalia slide (580827-2), Bougainville, Solomon Islands, from pocket "in moss and mud at mouth of lake," Mar. 6, 1944, A. B. Gurney (USNM, 64772). *Allotype:* ♀ (ABG, 269), same data as holotype (USNM). *Paratypes:* 8 ♀, 3 ♂, 3 pupae, 5 larvae (ABG, 269), same data as holotype.

Ficalbia (*Etorleptiomyia*) *elegans* in part of Iyengar (1955:26); Mattingly (1957*a*:49); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.53 mm. *Proboscis:* 1.72 mm. *Forefemur:* 1.37 mm. *Abdomen:* about 1.85 mm. Very similar to *solomonis* except that the mesonotal scales are not as long and the humeral and fossal areas are covered almost entirely with much shorter, more curved dark scales; median scutellar lobe with light scales extending basad in the center; wing with only a few light scales on vein C; abdominal tergites with light scaling more restricted, sublateral pale spots much reduced.

MALE.—Similar to *solomonis* and differing from it in same characters as female; palpus apparently shorter, about 0.8 of proboscis.

MALE GENITALIA (fig. **190**).—As figured; very similar to *solomonis* but paraproct with 3 spines instead of 2.

PUPA (fig. **190**).—*Abdomen:* 2.75 mm. *Trumpet:* 2.45 mm. *Paddle:* 0.79 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *solomonis* but differing in following characters; caudolateral angle of tergite VIII always produced into a conspicuous sharp spine; paddle more uniform in width, slightly darkened at base and distad of middle, light in between and apically, inner margin with much smaller spicules near base; hair 3-VII sometimes present, as in figure.

LARVA (fig. **191**).—*Head:* 0.65 mm. *Siphon:* 1.08 mm. *Anal Saddle:* 0.28 mm. Chaetotaxy as figured; diagnostic characters as in the key; similar to *elegans* (Taylor, 1914) from Queensland; differing from *solomonis,* as described above, chiefly in the following details; distal segment of antenna darker; hair 5-C usually 5b; 5,7-P usually 3b; 1-III-VII usually with 4 or more branches; 2-I usually 2,3b; 11-I with 6 or more branches; 13-III-V,3-VII with 3 or more branches; usually fewer scales in distal row of comb; 1-VIII double or triple, without a common plate with 2-VIII; anal saddle with caudal marginal spicules more slender, longer, and more numerous; spicules elsewhere on saddle also longer, more numerous, and developed to almost base of saddle.

MATERIAL EXAMINED.—169 specimens; 20 ♀; 17 ♂; 82 pupae; 50 larvae; no individual rearings.

SYSTEMATICS.—Since there are no individual rearings of this species, the association of the stages is uncertain, although it seems probable that it is correct. The adults of *bougainvillensis* are very similar to those of *solomonis,* while the larva and pupa are very difficult to separate from those of typical *elegans* (Taylor, 1914).

The possible relationship of *bougainvillensis, elegans,* and *solomonis* are discussed above under the subgenus.

BIONOMICS.—*F. bougainvillensis* has been collected in "puddles in cleared bog" (ABG, 103A), "pockets in moss and mud in swamp at mouth of lake" (ABG, 269), "small ground pools" (ABG, 388), "small ground pools among herbage surrounding pond" (ABG, 402), "puddles along margins of cane area" (ABG, 412), and "small ground pools among herbage" (ABG, 436). In one collection (ABG, 269) a single larva of *F. solomonis* was associated with *bougainvillensis.* Preserved specimens of this species appear to have a color similar to that of *solomonis.*

Nothing has been recorded about the adult habits of *bougainvillensis.*

DISTRIBUTION (fig. **187**).—*Solomon Islands:* Bougainville. Not known elsewhere.

Subgenus MIMOMYIA Theobald

1903. *Mimomyia* Theobald, Monog. Culicidae 3:304. *TYPE SPECIES: *M. splendens* Theobald, 1903, Uganda; only species unquestionably included, selection of Brunetti (1914:65).

1907. *Ludlowia* Theobald, Monog. Culicidae 4:193–194. *TYPE SPECIES: *Mimomyia chamberlaini* Ludlow, 1904, Philippines; the first of 2 included species, selection of Brunetti (1914:64).

1908. *Radioculex* Theobald, Indian Mus., Rec. 2:295. TYPE SPECIES: *R. clavipalpus* Theobald, 1908, India; monobasic.

1908. *Conopomyia* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):113. *TYPE SPECIES: *C. metallica* Leicester, 1908, Malaya; the first of 3 new species, selection of Brunetti (1914:58).

For complete synonymy, see Stone, Knight, and Starcke (1959) and Mattingly and Grjebine (1958:261).

FEMALES.—*Head:* scaling of vertex varied; flagellar segment 1 from 1.5 to 3.0 as long as segment 2. *Thorax:* scutellar scales all narrow; *mep* without scales. *Legs:* markings varied. *Wing:* dark-scaled except sometimes at base of vein C; squame scales often very scanty; cell R_2 from about 0.6 to 1.2 of vein R_{2+3}; alula bare; upper calypter with narrow marginal scales. *Genitalia:* 1 or 3 spermathecae.

MALES.—*Labium:* slightly to moderately swollen on about distal third. *Palpus:* about 1.1 to 1.33 of proboscis.

PUPAE.—*Trumpet:* index about 9.0 to 17.0; sometimes modified for piercing. *Abdomen:* hair 1-I usually large and branched; hair 9-VIII small, single or with a few branches. *Paddle:* index 1.5 to 2.75; hair 1-P present or absent.

LARVAE.—*Antenna:* articulated distad of hairs 2,3-A, latter and 4-A single. *Siphon:* index 2.0 to 8.0; sometimes modified for piercing. *Anal Segment:* ventral brush with 4 pairs of well-developed hairs.

SYSTEMATICS.—*Mimomyia* is the most complex subgenus and includes the majority of ground pool-breeding species of *Ficalbia.* Mattingly and Grjebine (1958:266–268) recognize 5 species groups within the subgenus. The single South Pacific species falls into Group B (*Ludlowia*) as a member of the *hybrida* complex, which differs considerably from the other forms.

BIONOMICS.—Species of this subgenus have been found breeding only in ground pools, swamps, and small depressions in marshy areas, usually in dense vegetation.

DISTRIBUTION (fig. 187).—The distribution of *Mimomyia* is nearly coextensive with that of the genus except that it is not represented in Madagascar or in Okinawa.

KEYS TO SPECIES

See keys to tribe Ficalbiini, pp. 289–290

1. Ficalbia (Mimomyia) gurneyi Belkin, n. sp.

Figs. 187, 192, 193

TYPES.—*Holotype:* ♂ (ABG, 311) with genitalia slide (560220-5), Bougainville, Solomon Islands, from freshwater lagoon, Apr. 5, 1944, A. B. Gurney (USNM, 64773). *Allotype:* ♀ (ABG, 311), same data as holotype (USNM). *Paratypes:* 2♀, 1♂, 6 pupal skins (ABG, 311), same data as holotype; 2 larvae (ABG, 332), same data as holotype except collected on Apr. 18, 1944.—This species is dedicated to Ashley B. Gurney in recognition of his numerous contributions to the knowledge of the mosquitoes of the Solomons.

FEMALE.—*Wing:* 2.13 mm. *Proboscis:* 1.17 mm. *Forefemur:* 1.33 mm. *Abdomen:* about 1.33 mm. *Head:* eyes contiguous for a short distance above antennae; a pair of medium-sized bristles on upper part of frons below the large upper frontal bristles but no scales; vertex with broad decumbent light to dusky scales; erect scales dark, short, few in number, restricted to occiput; a few short bristles adjacent to frontal pair; labium distinctly swollen distally, dark-scaled, lighter ventrally in basal 0.6; palpus about 0.17–0.2 of proboscis, dark-scaled; antenna distinctly longer than proboscis, dark; torus with short hairs and small narrow dark scales; flagellar segment 1 about 1.7–2.0 of segment 2, with a few small broad decumbent dark scales. *Thorax:* mesonotum, scutellum, median part of postnotum, *apn*, and *ppn* dark brown, contrasting sharply with pale yellowish pleuron; mesonotum and scutellum with narrow dark bronzy curved appressed scales throughout except for slightly lighter similar scales around prescutellar space but not in front or above wing root; acrostichals not developed except for first pair; 3,4 very strong dorsocentrals; prescutellars and supraalars strongly developed; 1 strong anterior humeral; *apn* without scales but with a few short bristles in addition to the large bristles; *ppn* with decumbent broad dark bronzy scales in upper caudal area, scales rather elongate and without dusky appearance of those on vertex of head; *ppl, psp,* and *pra* without scales; *stp* with a narrow patch of light translucent scales in upper posterior part separated from a small patch of similar scales along lower caudal margin against caudal row of bristles; *mep* occasionally with 1,2 light scales against upper *mep* bristles; *apn* bristles very strong; *ppn* with 2 strong and usually 3 weak bristles; *ppl* with about 4 strong bristles and several weak ones; *stp* with a more or less continuous arcuate line of bristles, 2 of the lower strongly enlarged; *pra* bristles about 5,6; about 6 small light upper *mep* bristles and about 6,7 hairs in lower caudal area of *mep*. *Legs:* largely dark-scaled; femora extensively light-scaled at base and below. *Wing:* vein scales dark, lighter on distal portions of caudal border; squame scales rather numerous; cell R_2 distinctly longer than vein R_{2+3}. *Haltere:* light on base and stem, dark-scaled on knob. *Abdomen:* tergites largely dark-scaled, with very inconspicuous and small basal lateral patches of light scales on II-VII; sternites pale-scaled.

MALE.—Generally similar to the female. *Labium:* more strongly swollen. *Palpus:* about as long as proboscis; apical segment not markedly swollen and bearing rather short heavy bristles distad. *Antenna:* distinctly shorter than proboscis; basal flagellar segments shorter and broader. *Thorax: ppn* scales apparently broader.

MALE GENITALIA (fig. **192**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with caudal lobes approximated on midline and each bearing 3 or 4 very long, heavy bristles. *Sidepiece:* dorsal bristles long and strong; basal mesal lobe large, with 3 very strong, broad widened differentiated bristles, 3 smaller slender bristles, and numerous short hairs. *Clasper:* a few minute hairs distally; spiniform large, swollen beyond base, apex narrowed. *Phallosome:* aedeagus very poorly sclerotized, broad at base, conical apically. *Proctiger:* paraproct with 1 large dorsal and 1 small ventral apical tooth; cercal setae 2,3.

PUPA (fig. **192**).—*Abdomen:* 2.4 mm. *Trumpet:* 1.13 mm. *Paddle:* 0.6 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately to strongly pigmented, darker on caudal portion of mesonotum and base of appendage cases; hairs largely concolorous with integument or slightly darker, not contrasting sharply with integument; hair 1-C branched, apparently also 3-C which is broken off near base in all specimens; 5-C large, branched. *Trumpet:* index about 14.0–15.0; strongly and uniformly pigmented except apical part; tracheoid to about 0.6; distad of tracheoid trumpet is diagonally truncate on one side and slit about halfway on the other to produce 2 sharply pointed processes. *Metanotum:* darkened. *Abdomen:* uniformly strongly pigmented; hairs largely concolorous with integument or slightly darker; hair 1-I dendritic near base, about 20b; 2,3-I close together, 3-I mesad of and longer than 2-I; 1-II-VII, 5-IV-VII stellate, not greatly elongate; 9-VIII short, single. *Terminal Segments:* female postgenital lobe strongly produced, rounded, and with short sharp spicules; male genital lobe about 0.5 of paddle length. *Paddle:* slightly lighter than abdomen, midrib very dark, external buttress slightly darkened; index about 1.75–2.0; marginal spicules long, strong at base, often branched on apex; hair 1-P not developed.

LARVA (fig. **193**).—*Head:* 0.65 mm. *Siphon:* 0.63 mm. *Anal Saddle:* 0.49 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately pigmented; hairs concolorous with integument or slightly darker; aulaeum with very short, close-set spicules; mentum with about 6 teeth on each side of very broad median tooth; hair 1-C long and rather heavy, simple; 5,6,7,11-C very long; 12,13-C short. *Antenna:* basal part lightly to moderately pigmented, distal practically colorless; basal part with moderate spicules, distal smooth; distal part about 0.67 of basal; hair 1-A strongly pigmented, others very light; 4-A much shorter than 2,3-A. *Thorax:* hairs and tubercles lightly to moderately pigmented; 2-P longest hair in shoulder group; 4-P very large; 8-P long and single; 12-P very strongly developed. *Abdomen:* hairs and tubercles lightly to moderately pigmented. *Segment VIII:* comb of 6–8 spiniform scales, apex of individual scale frequently with short barbs; hair 5-VIII removed from hairs 3,4. *Siphon:* index about 3.5–4.0; very darkly pigmented, black at base; broad at base, sharply attenuate in distal half; acus present, attached; pecten completely absent; hair 1-S single, in basal half; 2-S apparently represented by a short heavy bifid spiniform; valves highly modified and fused with siphon, apparently dorsolateral valve very small and with a small spiniform (6-S) at base and a filiform bristle (7-S) apically; ventrolateral valve with a filiform bristle (8-S) at base and an elongate slender spiniform (9-S) mesad of a strongly recurved tooth; median dorsal valve produced caudad between hairs 2-S and bearing 2 alveoli (4,5-S); other valve hairs and details not studied; stirrup-shaped piece very strongly developed, extending into basal 0.25 of siphon. *Anal Segment:* saddle moderately to strongly pigmented, integumentary sculpturing not prominent; caudal margin with long sharp spicules laterally dorsad of hair 1-X; hairs strongly pigmented; gills slender, subequal, shorter than saddle.

MATERIAL EXAMINED.—15 specimens; 3 ♀; 2 ♂; 6 pupae; 4 larvae; no individual rearings.

SYSTEMATICS.—Although individual rearings of *gurneyi* are not available, it seems probable that the association of the stages is correct. Other members of the group have similar larvae and pupae, and it does not appear probable that more than 1 species would be present in the same locality.

F. gurneyi is a member of the *hybrida* complex on the basis of adult, pupal, and larval characters. Mattingly (1957*a*:38) has tentatively synonymized several nomimal species under *hybrida* (Leicester, 1908) from Malaya, including *modesta* King & Hoogstraal, 1946 from New Guinea, but I find that *gurneyi* is markedly different from *modesta* and both are distinct from typical *hybrida*. *F. gurneyi* is most easily recognized by the characteristic development of the basal mesal lobe of the male genitalia (fig. **192**). It resembles *modesta* in having a long cell R_2 and in lacking narrow scales on *ppn*, broad scales on the scutellum, and light spots at the base of tarsal segments 1; it differs from it in being smaller, having darker scales on *ppn*, practically no light scales on mesonotum, and fewer small hairs in the lower posterior portion of *mep*. The larva of *gurneyi* differs from the "*hybrida*" of Java, the only other described form, in lacking pecten teeth.

BIONOMICS.—Only 3 collections of *gurneyi* are known. Two of these (ABG, 311, 332) were made in the same freshwater lagoon; 6 pupae were found "floating on water beside small aquatic plants and 2 larvae . . . apparently detached from plant by boat paddle"; the 5 known adults were apparently reared from these pupae. The 2 larvae comprising the third collection were removed from the roots of a "swamp fern," where they were associated with *Mansonia melanesiensis* and *M. lutea*.

DISTRIBUTION (fig. **187**).—*Solomon Islands:* Bougainville. Not known elsewhere.

TRIBE MANSONIINI

Genus MANSONIA Blanchard

1891. *Taeniorhynchus* Lynch Arribalzaga, La Plata U. Nac. Mus., Rev. 1:374; 2:147.—Suppressed by International Commission on Zoological Nomenclature, Opinion 550 (1959).

1900. *Panoplites* Theobald, Rpt. Coll. Mosq. Brit. Mus., p. 5; 1901, J. Trop. Med. 4:235, Monog. Culicidae 2:173–174. *TYPE SPECIES: *Culex titillans* Walker, 1848, Brazil; selection of Blanchard (1901:1046), as type species of *Mansonia* substitute for *Panoplites* Theobald.—Preoccupied by *Panoplites* Gould, 1853.

1901. *Mansonia* Blanchard, Soc. de Biol., Compt. Rend. 53:1046. *TYPE SPECIES: *Culex titillans* Walker, 1848, Brazil.—Placed on Official List and type fixed by International Commission on Zoological Nomenclature, Opinion 550 (1959).

See under subgenera and, for complete synonymy, Stone, Knight, and Starcke (1959).

FEMALES.—Medium-sized species, varied in appearance, easily confused with *Aedes* or *Culex* species. *Head:* eyes contiguous or narrowly separated; frontal tuft present or absent; median portion of vertex with decumbent scales all narrow, broad scales laterad; erect scales narrow and numerous; orbital bristles in a more or less continuous row; clypeus prominent, longer than wide, bare; labium moderately long, flexible, not at all swollen distad, shaft bristles numerous and conspicuous, subbasal bristles usually 2 pairs; palpus never more than about 0.3 of proboscis, 5-segmented, segments 1 and 2 more or less ankylosed, segment 5 small or minute; antenna about as long as proboscis; flagellar segment 1 sometimes as much as 1.7 of segment 2, remainder subequal. *Thorax:* mesonotum moderately arched; scutellum more or less distinctly trilobed; postnotum bare; paratergite narrow and bare; *apn* small, widely separated; meron large, its upper edge well above base of hindcoxa; mesonotum and scutellum with dense vestiture of narrow decumbent scales only; pleuron with restricted patches of scales, *psp* and metameron without scales; acrostichal bristles usually very short, sometimes absent, dorsocentrals, prescutellars, supraalars and humerals strongly developed; *apn* usually with numerous bristles; *ppn* with several bristles in a curved dorsocaudal row; *ppl* bristles numerous; *sp* bristles absent; *psp* present or absent; *stp* with usual continuous row of upper and caudal bristles; *pra* bristles numerous; *mep* with upper bristles numerous and usually several anterior bristles near middle. *Legs:* moderately long; bristles moderately to well developed, particularly on femora; femora not markedly swollen; hindtarsal segment 1 distinctly shorter than hindtibia; tarsal segments 4 as long as segments 5 or longer on all legs; all claws simple and quite large; pulvilli absent. *Wing:* wing membrane with distinct microtrichia; vein scales varied; cell R_2 longer than vein R_{2+3}; no spurs at base of Rs and R_{4+5}; vein 1A rather straight, ending distad of fork of Cu; base of R without distinct dorsal remigial bristles; base of Sc ventrally usually without bristles, occasionally with 1,2 and with a large number of bristles in *tenuipalpis;* alula and upper calypter both with complete fringe of long hairlike scales. *Abdomen:* tergites and sternites almost completely scaled; scaling of tergite I varied; laterotergite without scales; bristles well developed; apex of abdomen truncate. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; varied in development in different subgenera (see below); usually 3 spermathecae, subequal or 1 greatly reduced in size.

MALES.—Essentially similar to the females. *Labium:* with false joint more or less distinct; subbasal bristles more numerous than in females. *Palpus:* about as long as or longer than proboscis; distinctly 5-segmented, distal segment sometimes reduced. *Antenna:* about as long as or shorter than proboscis; flagellum strongly plumose; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg and midleg enlarged, larger claw of each pair usually with subbasal or submedian tooth, smaller simple.

MALE GENITALIA.—Large and conspicuous. *Segment VIII:* strongly developed; sternite longer than tergite and frequently distinctly produced into a median caudal process. *Segment IX:* poorly developed; tergite largely unsclerotized, with or without distinct bristle-bearing lobes; sternite usually without bristles, distinctly emarginate on caudal margin so as to form a pair of conspicuous lateral lobes; connection between sternite and tergite very narrow or entirely through membrane at base of sidepiece. *Sidepiece:* varied in shape, usually rather short; sometimes with more or less distinct subapical lobe or lobes; bristles often strongly differentiated on dorsal surface, scales present laterally and ventrally; basal mesal lobe strongly developed into a claspette; mesal surface usually more or less membranous from claspette to insertion of clasper. *Claspette:* variously developed and bearing at least one apical spiniform. *Clasper:* variously developed, irregular in shape and usually strongly curved dorsad and mesad near base; basal portion at insertion very large; spiniform apical, subapical, or absent, never large. *Phallosome:* strongly and variously developed; aedeagus simple but varied, small to large, lateral sclerotizations often continuous dorsally, widely separated ventrally; only ventral paramere developed, varied in size; basal piece very strongly developed. *Proctiger:* basal lateral sclerotization more or less distinct; dorsal surface membranous; paraproct strongly developed, heavily sclerotized apically and with several teeth; cercal setae distinct, several in number, sometimes on small sclerotized area.

PUPAE.—*Cephalothorax:* with a very conspicuous middorsal ridge; hair 4-C apparently absent; all hairs very small; 8,9-C far behind trumpet. *Trumpet:* arising from a more or less distinct tubercle, nearer middorsal line than wing base and far forward; apex narrowed and produced into 1 more or less sharply pointed sclerotized process which is surrounded by poorly sclerotized more or less extensive "cellular" expansions; tracheoid extensive but not reaching narrowed part. *Abdomen:* hair 1-I minute, single, inserted cephalad of unsclerotized area and far laterad; 1-II widely spaced; hair 3 apparently always absent on VII and sometimes on other segments; hair 9 removed from caudolateral angle on II-VI, ventral or dorsolateral in position, variable in position on VII and VIII; hair 11 absent or represented by alveolus only on III-VII. *Terminal Segments:* hairs 1-IX,X apparently both absent; female cercus weakly developed, postgenital plate not distinct; male sidepiece lobe apparently with laterally divergent apical process. *Paddle:* variously developed; relatively broad or narrowed; external buttress present or absent; midrib more or less distinct; margins with spicules distinct at least apically; hairs 1,2-P both absent.

LARVAE.—*Head:* distinctly wider than long; labrum short and poorly differentiated, without distinct apicolateral process; collar poorly differentiated except dorsally; ventral part of head capsule moderately long; posterior tentorial pit near caudal border; maxillary suture always distinct anteriorly and always reaching posterior tentorial pit but sometimes interrupted in apical half, never extending caudolaterad of pit; cephalic border of labial plate more or less produced in the middle; aulaeum triangular, with 1 or more short heavy spicules apically and sparse filamentous spicules laterally; mental plate small, more or less triangular; maxilla with long, heavy subapical spiniform bristle, maxillary palpus very short; mouthbrushes never reduced to 10 flattened filaments on each side; hair 1-C dorsal and removed from anterior border; 0-C distinct; 2-C rarely developed, 3-C small; hairs 16,17-C apparently not developed. *Antenna:* very strongly developed, always longer than head capsule; hairs 2,3-A always removed a considerable distance from apex and dividing antenna into basal and distal parts; basal part spiculate; distal part without spicules, varied in length, articulated or ankylosed at base; hair 1-A always long, densely branched. *Thorax:* integument smooth; spiracular sensilla distinct; notched organ not developed; hairs 9-12-P,M,T on common tubercles; 1-3-P on poorly defined common tubercle; 13-P not developed, all others present; none of the hairs plumose or palmate but larger hairs strongly barbed or with brush tip; 1-3-P close together near middle line; 8-P short; 12-P very strongly developed. *Abdomen:* integument smooth; spiracular and dorsal sensilla distinct; tergites without sclerotizations; hair 1 never palmate; hairs 6-I-VI all long, subequal, and usually single; 7-I long, single, different from hair 7 on other segments; segment I with full complement of hairs except 14. *Segment VIII:* comb scales in a single row, large, and few in number; no comb plate. *Siphon:* short, triangular, with very broad base; acus apparently always represented by a narrow complete ring at base, separated from the rest of the siphon by a deep suture; pecten not developed; ventrolateral valve greatly developed, at least as long as body of siphon, with recurved spines near and at apex (possibly modified hairs); dorsolateral valve indistinct; median dorsal valve with a sawlike long process; hair 1-S near apex of siphon body; 2-S on a tubercle distad of siphon body, very strongly developed, hooked; 6-S variously developed; 8-S usually large, inserted near base dorsally on valve; other valve hairs not studied; stirrup-shaped piece represented by a single median ventral bar, no dorsal arm; trachea well developed. *Anal Segment:* saddle always complete and long, sometimes longer than entire siphon; acus not developed; caudal marginal spicules not developed; median dorsal caudal process strong; hair 1-X removed from margin of saddle; dorsal brush strong, hairs 2,3-X both long and multiple; ventral brush strongly developed, with 4,5 pairs of hairs 4-X on grid which is not connected to saddle midventrally, and often with detached hairs on midventral line of saddle; accessory saddle hairs sometimes developed; gills slender, shorter than saddle.

EGGS.—Variously developed, elongate ovoid or with branched processes; laid in loose masses on plants or submerged objects or in rafts on water surface.

SYSTEMATICS.—*Mansonia* is a complex genus, most strikingly characterized in the larval stage and, to a lesser extent, in the pupal stage. The adults appear to be quite heterogeneous and may be easily mistaken for *Culex* or *Aedes*. The closest affinities of the genus appear to be with *Ficalbia,* but *Mansonia* is so clearly marked in the larva that I consider it as forming a separate tribe.

Four subgenera are currently recognized. These fall into 2 sections, each with an Old World and a New World representative respectively: (1) *Coquillettidia* and *Rhynchotaenia,* (2) *Mansonioides* and *Mansonia. Coquillettidia* is also known by a single species in the Nearctic region. The differences between the 2 sections are quite striking in all stages; it may be advisable to recognize a separate genus for each. The place of origin of *Mansonia* is difficult to determine at present. The majority of species in both groups are found in the Old World, as are the closest apparent relatives (*Ficalbia*). However, the Neotropical representatives appear to be more generalized, at least in the adult stage.

In the South Pacific both Old World subgenera are represented, *Mansonioides* by 1 species and *Coquillettidia* by at least 5 species. All the South Pacific species except *xanthogaster* and possibly *melanesiensis* appear to be endemic.

BIONOMICS AND DISEASE RELATIONS.—The bionomics of *Mansonia* species have attracted considerable attention because of the economic importance of several species and the very interesting adaptations of the immature stages of this genus. A general summary is given in Horsfall (1955:364–383).

All the known larvae and pupae of *Mansonia* attach to aquatic plants, from whose air cells they secure oxygen for respiration. In some species this association appears to be host specific, while in others a wide variety of plants can be used. Water lettuce, *Pistia stratiotes,* is very commonly a host plant for several species of *Mansonia,* particularly those of the subgenus *Mansonioides.* The aquatic cycle is usually rather prolonged and the immature stages are usually found only in more or less permanent bodies of water. Larvae detach and reattach to host plants quite readily. Some pupae are permanently fixed while others apparently can change host plants. Prior to emergence of the adults, the pupae become detached and float to the water surface.

Females of several species of *Mansonia* are notoriously vicious and aggressive night biters and are readily attracted to artificial lights and to light traps. The period of activity of different species varies considerably, as does their seasonal prevalence. Several species of *Mansonia* have been found naturally infected with, or have been shown experimentally to be capable of transmitting, viruses of yellow fever and encephalitides as well as *Wuchereria bancrofti* and *W. malayi* (Horsfall, 1955:36–39, 366–369).

In the South Pacific none of the species appear to be involved in disease transmission, and only *melanesiensis* can be considered to be a pest locally, although several others are said to attack man readily.

DISTRIBUTION (fig. **194**).—*Mansonia* is nearly worldwide in distribution. The majority of species are tropical, but several penetrate into the colder parts of the world. The genus is represented on all the major islands. In the South Pacific *Mansonia* occurs in New Zealand, Fiji, Samoa, New Caledonia, New Hebrides, and the Solomon Islands.

KEYS TO SUBGENERA AND SPECIES

(Keys to tribes, pp. 118–122)

ADULTS

1. Postspiracular bristles present; wing speckled, vein scales all very broad, many strongly asymmetrical; labium, palpus, and legs speckled or banded (MANSONIOIDES) ...... 1. *melanesiensis*

Postspiracular bristles absent; wing uniformly dark, vein scales narrow; labium, palpus, and legs usually without conspicuous speckling or banding (COQUILLETTIDIA) ... 2

2(1). Sternopleuron with numerous scales on upper part as well as below 3

Sternopleuron with scales largely confined to lower part 4

3(2). Base of vein Sc below with large group of bristles .... 1. *tenuipalpis*

Base of vein Sc below with scales only .... 2. *iracunda*

4(2). Pleuron with distinct diagonal longitudinal blackish stripe in the middle, remainder grayish or greenish brown; anterior surface of hindfemur with basal pale scaling extending well beyond 0.5 . . . . 3. *fijiensis*

Pleuron yellowish or bright light reddish brown, sometimes darkened but never with blackish stripe; anterior surface of hindfemur with basal pale scaling usually not extending to 0.5 5

5(4). Male sidepiece without a long ventroapical, dorsally projecting lobe; female not separable . . . . 4. *lutea*

Male sidepiece with a long ventroapical lobe projecting dorsad and bearing a large clump of dark bristles; female not separable . . . . 5. *xanthogaster*

MALE GENITALIA

1. Clasper without spiniform; claspette reaching apex of sidepiece (MANSONIOIDES) . . . . 1. *melanesiensis*

Clasper with distinct spiniform; claspette short, not reaching apex of sidepiece (COQUILLETTIDIA) 2

2(1). Sternite VIII not produced into a mesal caudal lobe, evenly rounded; clasper narrowed subapically to spiniform 3

Sternite VIII produced into a conspicuous mesal caudal lobe; clasper swollen or widened at apex 4

3(2). Aedeagus long, apex produced in middle; apex of claspette with 2 spiniforms, 1 of which is slender; clasper nearly straight and moderately lobed . . . . 1. *tenuipalpis*

Aedeagus short, evenly rounded on apex, not produced; apex of claspette with 1 very heavy long spiniform and 1 long thin bristle; clasper strongly angled and lobed . . . . 2. *iracunda*

4(2). Sidepiece with a very large ventroapical lobe projecting mesad then curving dorsad and bearing a very dense cluster of dark heavy bristles apically . . . . 5. *xanthogaster*

Sidepiece without ventroapical lobe, this angle with numerous slender bristles 5

5(4). Clasper with a minute tooth in basal 0.3 of concave inner surface ventrally; apex of clasper moderately and gradually widened; upper part of mesal membrane of sidepiece with 6–10 short setae . . . . 3. *fijiensis*

Clasper without any indication of a tooth in basal 0.3; apex of clasper very strongly and abruptly swollen; upper part of mesal membrane of sidepiece with 4,5 short setae . . . . 4. *lutea*

PUPAE

(1. *tenuipalpis* and 2. *iracunda* not included)

1. Some dorsal abdominal hairs long and thickened; hairs 9-VII,VIII at caudolateral angle; apex of trumpet with a strongly sclerotized spinelike process (MANSONIOIDES) . . . . 1. *melanesiensis*

All dorsal abdominal hairs minute; hairs 9-VII,VIII removed from caudolateral angle; apex of trumpet with a less strongly sclerotized process which is not distinctly spinelike and is normally broken off (COQUILLETTIDIA) 2

2(1). Paddle index less than 3.0; inner margin of paddle distinctly convex . . . . . . 3. *fijiensis*

Paddle index 3.5 or more; inner margin of paddle nearly straight or slightly concave . . 3

3(2). Caudolateral angle of tergite VIII very strongly produced, hair 9 on this projection . . . . 4. *lutea*

Caudolateral angle of tergite VIII only slightly produced, hair 9 not on this projection . . . . 5. *xanthogaster*

LARVAE

(1. *tenuipalpis* and 2. *iracunda* not included)

1. Distal part of antenna rigid, less than 0.5 of basal; comb scales 2, long, rodlike, and with rounded apex (MANSONIOIDES) . . . . 1. *melanesiensis*

Distal part of antenna flexible, about as long as or longer than basal; comb scales 6–10, swollen at base, apex sharp and spinelike (COQUILLETTIDIA) 2

2(1). Hair 1-A inserted beyond 0.75 of basal part of antenna; hair 6-C long, usually 4b; hair 4-P long, usually 2,3b; free portion of middle comb scales very slender and with conspicuous fringe or denticles at base; hair 3-VIII double from base or, if single, with very strong brushlike barbs beyond middle; hair 13-III-V long, single or double . . . 3. *fijiensis*

Hair 1-A inserted before 0.7 of basal part of antenna; hair 6-C short, usually with more than 6 branches; hair 4-P short, usually at least 5b; free portion of middle comb scales broader and with inconspicuous fringe or denticles at base; hair 3-VIII always single and usually with inconspicuous barbs from near base to apex; hair 13-III-V short, multiple 3

3(2). Hair 3-P usually 3b . . . . 4. *lutea*

Hair 3-P usually 4,5b . . . . . . 5. *xanthogaster*

Subgenus COQUILLETTIDIA Dyar

1905. *Coquillettidia* Dyar, Ent. Soc. Wash., Proc. 7:47. *TYPE SPECIES: *Culex perturbans* Walker, 1856, North America; original designation.

FEMALES.—*Head:* eyes narrowly separated above, this space with or without scales; labium with or without light scales; apical palpal segment minute, without scales. *Thorax:* mesonotal scales all of one color or of 2 colors; scutellar scales often scanty or practically absent; acrostichal bristles apparently always in a more or less complete line, numerous in all South Pacific species; *psp* bristles always absent. *Legs:* with or without conspicuous pale markings and with or without light tarsal rings. *Wing:* dorsal scales usually all narrow and unicolorous, or rarely broad, mixed dark and light, but not markedly asymmetrical. *Abdomen:* intersegmental membrane not strongly spiculate; scaling of tergite I confined to small central area.

FEMALE GENITALIA.—*Segment VII:* largely exposed, about as long as segment VI; tergite not concave at base or apex. *Segment VIII:* largely exposed; tergite exposed, without spiniforms; sternite not projecting much beyond tergite, without lateral flaplike lobe. *Cercus:* vertical, rounded, and without upturned apical process. *Postgenital Plate:* not divided into lateral lobes, at most slightly emarginate on distal margin, usually elliptical in outline. *Spermathecae:* 3, subequal, and spherical.

MALES.—In general as in the females. *Palpus:* about as long as proboscis to distinctly longer; tip of segment 3 and all of segment 4 appearing somewhat broadened; segment 5 well developed; bristles varied in development.

MALE GENITALIA.—*Segment IX:* tergite with more or less distinct lateral lobe, always with at least a few bristles. *Sidepiece:* not markedly thickened; more or less cylindrical or conical, not hollowed out on mesal surface; mesal membrane distinct or not developed; tergomesal margin not produced mesad and without line of thickened bristles. *Claspette:* short, poorly developed; bearing 1 or more elongate apical spiniforms subequal to claspette length. *Clasper:* varied in shape, always with 1 apical or subapical spiniform. *Phallosome:* aedeagus varied in development, with or without spicules.

PUPAE.—*Cephalothorax:* all hairs unbranched. *Trumpet:* on a slight tubercle; apex produced into a poorly sclerotized narrow process which is surrounded by a "cellular" lobe on two sides, this portion usually broken off in detached pupae. *Abdomen:* hair 9-VIII dorsal, removed from caudolateral angle; all hairs very small and unbranched; 3-III-VI absent; hair 11 rarely represented by alveolus, usually absent. *Paddle:* relatively narrow.

LARVAE.—*Head:* maxillary suture usually interrupted in apical half. *Antenna:* distal part usually as long as basal, flexible, annulated, and movable at base along peculiar diagonal ventral connection to basal part; hairs 2,3-A much shorter than distal portion of antenna. *Thorax:* longer hairs, particularly single ones, greatly elongated and without strong barbs distally. *Abdomen:* longer hairs neither markedly thickened nor strongly barbed; hair 4 laterad of hair 3 on III,IV; hair 13-III-V varied in development. *Segment VIII:* comb scales usually at least 5, distal part of scale sharply pointed, basal denticles and fringes sometimes present; hairs 3,4,5-VIII always in a compact group. *Siphon:* hair 1-S usually on a distal lobe of siphon. *Anal Segment:* ventral brush with 4,5 pairs of hairs on grid, some short detached hairs sometimes also present on midventral line of saddle; accessory saddle hairs sometimes present.

EGGS.—Laid in rafts on water surface, in at least some species.

SYSTEMATICS.—*Coquillettidia* appears to be closely related to the exclusively Neotropical subgenus *Rhynchotaenia,* which in many respects is more primitive in the adult stage and appears to be intermediate between *Coquillettidia* and the subgenus *Mansonia* in the presence of postspiracular bristles.

Within the subgenus several distinct groups are evident in the better known adult stage, and there are indications that corresponding larval and pupal characters also exist. The Holarctic species, *richiardii* Ficalbi, 1899 and *perturbans* (Walker, 1856), which are sometimes considered to be conspecific, are markedly different in the presence of broad scales on the dorsal surface of wing veins. The majority of the tropical species are conspicuously yellow in coloration.

In the South Pacific *Coquillettidia* is now known by 5 species which fall into 3 groups: (1) the monotypic *tenuipalpis* group confined to New Zealand, (2) the *iracunda* group with 1 species also confined to New Zealand, and (3) the *crassipes* group of 3 species found in Samoa, Fiji, New Caledonia, New

Hebrides, and the Solomons. The characteristics and affinities of the groups are discussed below, preceding the treatment of the included species. There is a possibility that 2 additional members of the *crassipes* group occur in the South Pacific (see *xanthogaster* and *lutea*).

BIONOMICS AND DISEASE RELATIONS.—The bionomics of the Holarctic (Horsfall, 1955:376–379) and some African species (Gillett, 1946:425–437) are fairly well known, but those of the Oriental and Australian species are very poorly known.

The immature stages of the tropical species are most commonly found in very shallow water in marshes, swamps and seepages, and sometimes in grassy margins of lakes and ponds. Breeding sites are found both in the open and in forested areas. The depth of water in the breeding places may be less than an inch. Various host plants are used, particularly grasses and, in the South Pacific, species of pandanus. The fourth instar larvae are very sluggish and are found chiefly in the flocculent muck, where they are attached to the roots of the host plant. The pupae are permanently fixed to a root; the tips of the trumpets break off when the animal is detached, and it cannot reattach to a new host or obtain oxygen at the water surface.

Adults of both sexes are frequently found resting on the vegetation near the breeding sites. Several species attack man readily, others apparently never. Both nocturnal and diurnal species are known. Some *Coquillettidia* species are serious pests of man in Africa, Europe, and North America. None of these species have been shown to be vectors of human diseases, although experimentally some of them are capable of transmitting viruses and have even been found to be naturally infected (Horsfall, 1955:36–40). Neither natural nor experimental infections with filarial larvae have been reported.

In the South Pacific only *tenuipalpis, iracunda,* and *xanthogaster* have been reported as biting man, but none of these appears to be involved in any way in disease transmission.

DISTRIBUTION (fig. 194).—*Coquillettidia* is restricted to the Old World except for *perturbans* (Walker, 1856), which occurs in North America. The subgenus is extremely widespread in the Old World, being found from Europe to Madagascar in the west and from Japan to New Zealand and Samoa in the east.

KEYS TO SPECIES

See keys to tribe Mansoniini, pp. 301–302

TENUIPALPIS GROUP

FEMALE.—*Head:* interocular space very short and narrow, with 2 pairs of bristles but apparently no scales; broad decumbent scales conspicuous laterally; labium and palpus entirely dark-scaled; apical segment of palpus minute. *Thorax:* mesonotal and pleural integument dark; mesonotal scales numerous; scutellar scales distinct; *apn* and *ppn* without distinct scales but with a few small hairs; *ppl* with a few light, broadened, elongate scales above bristles; *stp* with broad light scales in a narrow continuous dorsoventral line, straight anteriorly, scales extending from lower caudal border to above upper row of *stp* bristles at base of *pra* bristles; *mep* with large patch of broad whitish scales and 2,3 anterior median *mep* bristles. *Legs:* femora with usual light scaling, no speckling; tibiae lighter below; remainder and all tarsi dark. *Wing:* entirely dark-scaled, dorsal scales narrow; base of vein Sc ventrally with large patch of bristles and a few scales. *Abdomen:* tergites largely dark-scaled and with extensive basal lateral patches of light scales; sternites largely light-scaled.

MALE.—Essentially as in the female. *Palpus:* distinctly longer than proboscis; segment 5 distinctly broader than 4 and slightly longer; bristles sparse and short; segments 4 and 5 slightly upturned. *Antenna:* almost as long as proboscis; flagellar segments 12 and 13 together distinctly longer than remainder of flagellum.

MALE GENITALIA.—*Segment VIII:* tergite with a slight median caudal lobe; sternite without any indication of median caudal lobe. *Segment IX:* sternite with 1 pair of bristles. *Sidepiece:* simple; without any indication of apicoventral angle or lobe; mesal membrane not developed between claspette and clasper insertion. *Clasper:* relatively simple; apex pointed.

PUPA, LARVA, and EGG.—Unknown.

SYSTEMATICS.—The *tenuipalpis* group is erected for *tenuipalpis* (Edwards, 1924) from New Zealand, whose systematics are discussed below.

1. Mansonia (Coquillettidia) tenuipalpis (Edwards)

Fig. **196**

1924. *Taeniorhynchus* (*Coquillettidia*) *tenuipalpis* Edwards, B. Ent. Res. 14:366–367. *TYPE: holotype ♂ with attached genitalia mount, marked as type by Edwards, Ohakune, Wellington, New Zealand, Jan., 1924, T. R. Harris (BMNH).

Mansonia (*Coquillettidia*) *tenuipalpis* of Edwards (1932:119); Taylor (1934:14); Stone, Knight, and Starcke (1959).

Mansonia tenuipalpis of Miller (1950:45); Miller and Phillipps (1952:24).

Taeniorhynchus tenuipalpis of Graham (1939:212).

FEMALE.—*Wing:* 4.83 mm. *Proboscis:* 3.0 mm. *Forefemur:* 2.33 mm. *Abdomen:* about 2.67 mm. *Head:* narrow decumbent scales pale beige, densely packed along eye margins; broad scales similarly colored, rather elongate; erect scales somewhat darker, rather short; clypeus dark brown; palpus about 0.20–0.25 of proboscis; torus scales very small and inconspicuous. *Thorax:* mesonotal integument dark brown; mesonotal and scutellar scales all golden; pleural scales dingy translucent whitish or pale beige. *Legs:* femora not speckled; hindfemur with indefinite pale area extending to near apex on anterior surface; tibiae with some very long bristles. *Wing:* cell R_2 about 1.8 of vein R_{2+3}. *Haltere:* knob with dark bronzy scales. *Abdomen:* dark scaling apparently bronzy, without strong violet or purplish tinge.

MALE.—Essentially as in the female, and with characters described for group. *Palpus:* about 1.25–1.3 of proboscis. *Antenna:* flagellar segment 13 about 1.5 of segment 12.

MALE GENITALIA (fig. **196**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe poorly defined, with 5 bristles, 2,3 additional bristles present on one side laterad of lobe; sternite with 1 pair of bristles subapically. *Claspette:* with 2 long apical spiniforms, one considerably thinner. *Clasper:* external crest very slight; mesal surface with a postmedian dorsomesal ledgelike process. *Phallosome:* aedeagus long, cylindrical, slightly widened at base and narrowed apically, dorsal surface largely unsclerotized, a subapical dorsal patch of about 16 short sharp spicules directed cephalad; ventral paramere strongly developed. *Proctiger:* apex of paraproct with 2 curved dorsal spines and 2 straighter, more ventral spines.

PUPA, LARVA, and EGG.—Unknown.

MATERIAL EXAMINED.—11 ♀; 2 ♂; no immature stages.

SYSTEMATICS.—*M. tenuipalpis* is a most interesting and peculiar species. Superficially it is not unlike *iracunda*, but, as indicated in the diagnosis of the group, it differs strikingly in a number of important characters. The presence of a large patch of bristles ventrally at the base of vein Sc (as in *Culiseta* and *Opifex*), the extension of the sternopleural scales to the prealar knob, the development of the male palpus and antenna, and the absence of a mesal membrane on the sidepiece of the male genitalia are particularly significant.

The unique features of *tenuipalpis* may require the erection of a separate subgenus or even a genus for its reception. However, the true affinities of this species cannot be properly determined until the immature stages are discovered and studied.

BIONOMICS AND DISEASE RELATIONS.—Graham (1939:212) reports "*tenuipalpis*" to be annoying to campers in the scrub and bush areas of Auckland Province, but it is not certain that the species involved was correctly identified, as no specimens appear to have been preserved.

DISTRIBUTION (fig. **196**).—*New Zealand:* North Island (Auckland, Wellington); South Island (Marlborough, Otago). Not known elsewhere.

IRACUNDA GROUP

FEMALES.—*Head:* interocular space with 1 pair of bristles and with scales; broad decumbent scales conspicuous laterally; labium and palpus usually entirely dark-scaled, rarely a few light scales on palpus; palpus with minute apical segment. *Thorax:* mesonotal scales numerous; scutellar scales distinct at least on midlobe; *apn* and *ppn* with narrow scales; *ppl* with broad whitish scales in lower caudal portion; *stp* with a large continuous patch of broad whitish scales from bristles at upper end to lower caudal margin; *mep* with a large patch of broad whitish scales in upper part; pleural bristles numerous, 3 or more anterior median *mep* bristles. *Legs:* tarsi with or without pale markings. *Wing:* entirely dark-scaled, dorsal scales narrow; base of Sc with broad scales ventrally, no bristles. *Abdomen:* tergites largely dark-scaled and with basal lateral patches of light scales.

MALES.—Essentially as in the females. *Palpus:* about as long as proboscis; segment 5 narrower than segment 4; segments 5,4 and apex of 3 with numerous long bristles.

MALE GENITALIA.—*Segment VIII:* tergite with very slight median caudal lobe; sternite not produced into median caudal lobe. *Sidepiece:* very simple, without any indication of apical lobe; mesal membrane slightly developed. *Clasper:* irregular in shape, apex pointed.

PUPAE, LARVAE, and EGGS.—Unknown.

SYSTEMATICS.—The *iracunda* group comprises 2 species: *iracunda* (Walker, 1848) from New Zealand and *linealis* (Skuse, 1889) from Australia. The affinities of the group cannot be determined until the immature stages are discovered and studied, but it appears that this group and the *tenuipalpis* and *perturbans* groups are the most generalized ones in the subgenus.

2. Mansonia (Coquillettidia) iracunda (Walker)

Fig. 196

1848. *Culex iracundus* Walker, List Dipt. Insects Brit. Mus. 1:6. *TYPE: holotype ♀ (42–55), New Zealand; identified as the type by E. A. Waterhouse (BMNH).

Mansonia (*Coquillettidia*) *iracunda* of Edwards (1932:118); Taylor (1934:14); Stone, Knight, and Starcke (1959).
Mansonia iracundus of Miller (1950:44); Miller and Phillipps (1952:23–24).
Taeniorhynchus (*Coquillettidia*) *iracundus* of Edwards (1924:366).
Taeniorhynchus iracundus of Graham (1939:212).

FEMALE.—*Wing:* 4.08 mm. *Proboscis:* 2.41 mm. *Forefemur:* 1.8 mm. *Abdomen:* about 2.7 mm. *Head:* narrow decumbent scales pale golden or beige, densely packed along eye margins; broad scales lighter, whitish; erect scales light golden, elongate in front, shorter caudad; clypeus dark brown; palpus completely dark, about 0.20 of proboscis; torus scales broad, dark, rather large and conspicuous; flagellar segment 1 slightly longer than segment 2, scale patch conspicuous. *Thorax:* mesonotal and scutellar scales very narrow, largely pale golden, a few dark bronzy similar scales on fossa and a line of such scales between dorsocentrals and supraalars at level of wing root; *apn* and *ppn* scales very narrow and pale golden; *ppl, stp,* and *mep* scales white. *Legs:* forefemur and midfemur largely dark anteriorly, with indefinite light mottling, ventral and posterior surfaces largely light; hindfemur largely pale and with apical dark ring; foretibia and midtibia pale ventrally; remainder of legs dark with purplish violet gloss except for lighter underside of tarsi. *Wing:* cell R_2 over 2.0 of vein R_{2+3}. *Abdomen:* sternites largely dark-scaled and with basal lateral light patches much as on tergites.

MALE.—Essentially as in the female and with characters described for group. *Palpus:* entirely dark-scaled, slightly longer than proboscis; segment 5 subequal to 4 and completely scaled above. *Antenna:* distinctly shorter than proboscis; flagellar segments 12 and 13 together shorter than remainder, segment 12 shorter than 13.

MALE GENITALIA (fig. 196).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe well defined but small, with 3 bristles; sternite without bristles. *Claspette:* with 1 long apical spiniform with truncate apex and 1,2 attenuate long bristles. *Clasper:* external crest very prominent and complex, with dorsal process; basal part with dorsal ledgelike process. *Phallosome:* aedeagus short, poorly sclerotized dorsally, constricted in basal half, apex rounded, 2 subapical ventral teeth on each side, conspicuous ventrolateral denticles from near base to beyond middle; ventral paramere strongly developed. *Proctiger:* paraproct with 5 sharp teeth, most dorsal strongest; 2 cercal setae.

PUPA, LARVA, and EGG.—Unknown.

MATERIAL EXAMINED.—104♀; 2♂; no immature stages.

SYSTEMATICS.—*M. iracunda* is a very distinct species whose closest relative appears to be *linealis* (Skuse, 1889) from Australia. It differs from the latter in the ornamentation of the head, thorax, abdomen, and legs.

BIONOMICS AND DISEASE RELATIONS.—It seems very unlikely that the observations on the bionomics of the immature stages attributed to *iracunda* by Graham (1939:212) actually pertain to this species. Apparently no immature stages were preserved by Graham, and it is impossible to determine the species he observed.

Graham notes that *iracunda* is found only in scrub and bush areas, that "it is a persistent night-biter and is especially troublesome around farms, where it pesters the stock."

DISTRIBUTION (fig. **196**).—*New Zealand:* North Island (Auckland, Wellington); South Island (Westland, Otago). Not known elsewhere.

CRASSIPES GROUP

FEMALES.—*Head:* interocular area very small, without scales, sometimes with 1 pair of fine hairs; narrow decumbent scales scanty; broad decumbent scales numerous laterally; erect scales very long; labium and palpus with dark scales only, with a strong purplish violet gloss; palpus about 0.25–0.3 of proboscis, with minute apical segment; torus with hairs but no scales; flagellar segment 1 about 1.0–1.5 length of segment 2, with only 1,2 scales near base. *Thorax:* integument strongly shining; mesonotal scales scanty, very narrow, golden; scutellum without any distinct scales; pleuron with scales all broad, translucent, silvery, confined to small patch on lower *stp* and a larger one on upper *mep;* rarely a few similar scales on upper *stp; apn, ppn,* and *ppl* completely without scales or *apn* with some small hairs cephalodorsad which might be interpreted as hairlike scales; pleural bristles well developed; only 1 anterior median *mep* bristle. *Legs:* femora with usual light scaling in lines, no speckling; tibiae lighter below; tarsi dark; dark-scaling of legs with strong violet purplish gloss. *Wing:* scales all of 1 color, sometimes rather light; dorsal scales narrow; base of Sc ventrally sometimes with 1,2 small hairs in addition to scales. *Abdomen:* tergites largely purple with golden markings or golden with violet markings.

MALES.—Essentially as in the females. *Palpus:* about as long as or very slightly longer than proboscis; segment 5 turned down, well developed but distinctly shorter and narrower than segment 4; bristles numerous and long on apex of segment 3 and all of segments 4 and 5. *Abdomen:* with very long and numerous hairs.

MALE GENITALIA.—*Segment VII:* sternite with some very long apical hairs. *Segment VIII:* tergite with a slight median caudal lobe; sternite with a very prominent median caudal lobe. *Sidepiece:* with a more or less prominent apicosternal angle or distinct lobe; mesal membrane well developed; dorsum with some very long hairs mesad. *Clasper:* rather narrow basally; apex more or less swollen or rounded, not sharply produced. *Phallosome:* aedeagus short, constricted near base dorsally, apex rounded and with 2 more or less distinct blunt short spicules ventrally subapically on each side, lateral border of expanded ventral portion with a series of short denticles, dorsal sclerotization distinct; ventral paramere strongly developed. *Proctiger:* paraproct with about 3 long strong dorsal teeth and several short more ventral denticles; cercal setae 4–6.

PUPAE.—*Cephalothorax:* integument not spiculate. *Trumpet:* tracheoid very extensive, nearly to end of broad part. *Abdomen:* hair 3-II present or absent; 3-III-VII absent. Other characters not apparent, as no pupa of subgenus outside the South Pacific is completely described or figured except for *perturbans.*

LARVAE.—*Antenna:* distal part slightly longer than proximal. *Thorax:* large single hairs very long and attenuate. *Segment VIII:* hairs 3-5-VIII very close together; 0,14-VIII both branched. *Anal Segment:* 3 pairs of branched accessory hairs (*x,y,z*) on saddle; no detached hairs in ventral brush.

EGGS.—Known only for *xanthogaster;* as for subgenus.

SYSTEMATICS.—At present the *crassipes* group includes typical *crassipes* (van der Wulp, 1881) from Sumatra, the 3 species treated below, several poorly known forms synonymized with *crassipes*—*brevicellulus* (Theobald, 1901), *diaeretus* Dyar, 1920, *fuscopteron* (Theobald, 1911), and *pygmaea* (Theobald, 1908)—and various undescribed forms reported as "*crassipes*" from numerous localities in the Oriental, Indomalayan, and Australasian regions.

The group appears to be very prone to speciation. The males, larvae, and pupae show good diagnostic characters, but the females of most forms are very similar and cannot be told apart at present. As no individual or progeny rearings have been made for any of the species, the associations of the sexes and stages are presumptive only. It is very likely that many undescribed species will be found upon careful comparison of the various populations.

The affinities of the group cannot be determined at present. Of the South Pacific forms, apparently *fijiensis* and *lutea* are members of the *crassipes* complex, *fijiensis* being undoubtedly the more primitive member and *lutea* the more recent derivative. *M.*

xanthogaster is probably an ancient specialized derivative of the group and is not closely related to the other forms.

BIONOMICS AND DISEASE RELATIONS.—The bionomics of the *crassipes* group are very poorly known. Adults of both sexes, particularly the males, are often abundant in and on the vegetation around marshy and swampy areas in the open or in forested areas. Females of most species seldom attack man, and therefore these species usually escape detection. The larvae and pupae are apparently found in very shallow water, and the species can survive in very restricted habitats on small islands. The group as a whole is probably of no significance in disease transmission.

DISTRIBUTION.—Members of the group have been reported from most of the Oriental, Indomalayan, and Australasian regions. In the South Pacific the group is represented in Samoa, Fiji, New Caledonia, New Hebrides, and the Solomons.

3. Mansonia (Coquillettidia) fijiensis Belkin, n. sp.

Figs. **195, 197, 198**

TYPES.—*Holotype:* ♂ with genitalia slide (590601-1), Koronivia, Viti Levu, Fiji, from bush catch, Mar. 25, 1958, G. F. Burnett (USNM, 64774). *Allotype:* ♀, same data as holotype (USNM). *Paratypes:* 7 ♀, 7 ♂, same data as holotype.

Mansonia (*Coquillettidia*) *crassipes* in part of Edwards (1932:118); Taylor (1934:14); Lee (1944*a*:38); Knight, Bohart, and Bohart (1944:24, 64); Laird (1956); Stone, Knight, and Starcke (1959).

Taeniorhynchus (*Coquillettidia*) *crassipes* in part of Iyengar (1955:26).

Mansonia (*Coquillettidia*) *brevicellulus* of Paine (1943:9, 11, 15).

Taeniorhynchus (*Coquillettidia*) *brevicellulus* in part of Edwards (1924:365–366).

Mansonia (= *Taeniorhynchus*) species of Theobald (1914:37).

FEMALE.—*Wing:* 4.25 mm. *Proboscis:* 2.5 mm. *Forefemur:* 2.5 mm. *Abdomen:* about 2.46 mm. General coloration much darker than in other species of the group; dark scaling black with deep purplish violet gloss. *Head:* integument brown to dark brown; decumbent scales golden, broad ones lighter; erect scales golden to light brown, darkened caudolaterad; clypeus dark brown to blackish. *Thorax:* mesonotal integument brown or dark brown, lighter on central stripe and laterally caudad of scutal angle, or uniformly light brown except for a very dark brown supraalar area; scutellum usually dull light brown; postnotum dark brown except laterad; pleuron conspicuously dark brown or blackish along broad diagonal band from lower part of *apn, ppn, psp,* upper *stp,* and all *mep,* remainder light or greenish in fresh specimens; upper *stp* apparently with a few scattered broad silvery scales; *mep* scale patch extensive. *Legs:* hindfemur golden-scaled to about apical 0.33 on anterior surface. *Haltere:* scales of knob light brown. *Abdomen:* tergites largely dark purplish violet and with variable basal deep golden bands expanded laterally, dark scaling always predominating; sternites largely golden-scaled, with apical median triangular patches of dark scales, larger caudad.

MALE.—Essentially as in the female but much lighter; general coloration light yellowish brown; mesonotum uniformly lighter, without darkened areas; pleuron lighter but dark diagonal band well defined.

MALE GENITALIA (fig. **197**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe small, prominent, with 4-6 bristles. *Sidepiece:* no apicosternal lobe but this area with numerous longish hairs; upper portion of mesal membrane with 8-10 short hairs. *Claspette:* with 1 long curved slender bluntly rounded dark apical spiniform and 1 much more slender subequal light blunt-ended bristle. *Clasper:* basal part rather broad; with a short sharp tooth on inner ventral margin; apex only slightly widened.

PUPA (fig. **197**).—*Abdomen:* 3.7 mm. *Trumpet:* 1.15 mm. *Paddle:* 1.1 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly moderately pigmented; hairs concolorous with integument. *Trumpet:* uniformly darkly pigmented, blacker on tracheoid; broad part with an inconspicuous distal bulb. *Abdomen:* uniformly moderately to strongly pigmented; integument with numerous short broad rounded spicules; hairs concolorous with or lighter than integument; hair 3-II present; caudolateral angle of VIII slightly produced. *Paddle:* apical emargination relatively shallow; marginal spicules moderate.

LARVA (fig. **198**).—*Head:* 0.82 mm. *Siphon* (including valves): 0.65 mm. *Anal Saddle:* 0.56 mm.

Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly lightly to moderately pigmented; maxillary suture interrupted for short distance; mental plate with 5,6 teeth on each side of enlarged median tooth; hairs darker than integument; hairs 6,7-C long, conspicuous, particularly hair 6. *Antenna:* basal part to about base of 1-A blackish, remainder light; spicules distinct; hair 1-A inserted distinctly beyond 0.7 of basal part. *Thorax:* tubercles and larger hairs moderately to rather strongly pigmented; integument without distinct spicules; hair 4-P long, usually double. *Abdomen:* tubercles and larger hairs strongly pigmented; integument without distinct spicules; hairs 3-II-V, 13-III-V strongly developed, long, usually single or double. *Segment VIII:* 7–9 scales in comb, free portion of scale very narrow and sharply pointed, base with spicules or denticles; hairs 3-5-VIII on common basal plate; 3-VIII usually double, if single then with long barbs beyond middle. *Siphon:* index (including valves) about 3.0-3.2; blackish at base and on valves, moderately to strongly pigmented elsewhere; sculpturing more prominent ventrolaterad; hair 1-S usually 4b. *Anal Segment:* saddle distinctly shorter than siphon (including valves); lightly to moderately pigmented except for black basal ring; integumentary sculpturing uniform; accessory saddle hairs long; usually 4 pairs of hairs in ventral brush (4-X).

MATERIAL EXAMINED.—28 specimens; 6 ♀; 10 ♂; 8 pupae; 4 larvae; no individual rearings.

SYSTEMATICS.—Adults of *fijiensis* vary a great deal in coloration but are always markedly darker than any other species in the *crassipes* group. The characteristic broad diagonal dark band on the pleuron is always evident and is never present, to my knowledge, in any other species. The single male from Samoa agrees well with Fiji specimens and is provisionally referred to *fijiensis,* but there is a possibility that it may represent a distinct species endemic to Samoa.

M. fijiensis appears to be one of the most primitive members of the group and the most primitive relict of the *crassipes* complex. It resembles the *crassipes* from the Indomalayan and Oriental regions much more closely than does *lutea,* the other South Pacific member of the complex.

BIONOMICS.—No specific information is available on the breeding places of *fijiensis,* although the immature stages have been collected in a swamp and a pit (Lever). Burnett (1958) found larvae attached to *Eleocharis articulata.* Adults occur in the bush and females apparently seldom if ever feed on man.

DISTRIBUTION (fig. **195**).—*Fiji:* Vanua Levu; Viti Levu; Oneata (Lau Gp.). ? *Samoa:* Upolu. Not known elsewhere.

4. Mansonia (Coquillettidia) lutea Belkin, n. sp.

Figs. **195, 199, 200**

TYPES.—*Holotype:* ♂ (JNB, 1291) with genitalia slide (560215-1), Burns Creek, Lunga area, Guadalcanal, Solomon Islands, resting on vegetation or flying in wooded area, Nov. 16, 1944, L. J. Lipovsky (USNM, 64775). *Allotype:* ♀ (JNB, 1291-1003) with genitalia slide, same data as holotype (USNM). *Paratypes:* 3 ♀, 20 ♂ (JNB, 1291), same data as holotype.

Mansonia (*Coquillettidia*) *crassipes* in part of Stone, Knight, and Starcke (1959).
Taeniorhynchus (*Coquillettidia*) *crassipes* in part of Iyengar (1955:26).
Mansonia (*Coquillettidia*) *xanthogaster* in part of Stone, Knight, and Starcke (1959).
Taeniorhynchus (*Coquillettidia*) *xanthogaster* in part of Iyengar (1955:26).

FEMALE.—*Wing:* 4.08 mm. *Proboscis:* 2.41 mm. *Forefemur:* 2.5 mm. *Abdomen:* about 3.08 mm. General coloration yellowish or bright light reddish or yellowish brown; dark scaling brown with light violet or purplish gloss. *Head:* integument yellowish or light brown; decumbent scales golden; erect scales golden to light brown, apices sometimes darker; clypeus dark brown. *Thorax:* mesonotal integument usually uniformly yellowish or bright light reddish brown, sometimes darkened on midline, supraalar areas, and prescutellar space; scutellum usually dull light brown or yellowish; postnotum a little darker than scutellum except laterad; pleuron usually uniformly yellowish or bright light reddish brown, sometimes infuscated but not in a broad diagonal band as described for *fijiensis;* upper *stp* without scales; *mep* with small scale patch. *Legs:* hindfemur golden-scaled usually only on basal 0.33 of anterior surface. *Haltere:* scales of knob very light brown. *Abdomen:* tergites with light golden scaling and dark purplish scaling not sharply marked, appearing largely light in some aspects and light purplish violet in others but basal and lateral lighter, more golden areas usually apparent; sternites largely golden-scaled, darker purplish violet scales in triangluar apical median patches.

MALE.—Essentially as in the female; integument usually uniformly light yellowish.

MALE GENITALIA (fig. **199**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe small, prominent, usually with 5–8 bristles, occasionally a bristle laterad of lobe. *Sidepiece:* no apicosternal lobe but area with numerous longish hairs; upper portion of mesal membrane with 2,3 short hairs in one group and 1,2 short hairs in a more distal group. *Claspette:* with 1 long curved slender bluntly rounded dark apical spiniform and a subequal slender attenuate hair. *Clasper:* very slender from base to near apex; latter suddenly swollen into very conspicuous crest with 2 longish external hairs and a subapical spiniform.

PUPA (fig. **199**).—*Abdomen:* 3.8 mm. *Trumpet:* tip broken off. *Paddle:* 1.35 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly lightly pigmented; hairs concolorous with integument. *Trumpet:* moderately pigmented, darker on anterior portion of tracheoid; broad part with an inconspicuous distal bulb. *Abdomen:* uniformly moderately pigmented; integument with numerous conspicuous sharp spicules; hairs concolorous with or lighter than integument; hair 3-II present, minute; caudolateral angle of VIII very strongly and sharply produced, hair 9 on this process; hair 6-VII apparently absent. *Paddle:* apical emargination deep; marginal spicules strong.

LARVA (fig. **200**).—*Head:* 0.87 mm. *Siphon* (including valves): 0.82 mm. *Anal Saddle:* 0.65 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly lightly to moderately pigmented; maxillary suture widely interrupted; mental plate with 6,7 well-developed teeth on each side of enlarged median tooth; only hairs 1,7-C darker than integument, others concolorous; hair 7-C long and conspicuous; 6-C short. *Antenna:* basal part usually uniformly moderately to strongly pigmented, somewhat lighter distad of hair 1-A; spicules sparse, very inconspicuous; hair 1-A inserted before 0.60 of basal part. *Thorax:* tubercles and larger hairs lightly to moderately pigmented; integument without distinct spicules; hair 3-P usually 3b; 4-P short, usually 4,5b. *Abdomen:* tubercles and larger hairs lightly to moderately pigmented; integument without distinct spicules; hair 3-II-V moderately developed, usually single or double; 13-III-V poorly developed, short, multiple. *Segment VIII:* usually 7 scales in comb, free portion of scale very long, pointed, base without distinct spicules; hairs 3-5-VIII not on common plate; hair 3-VIII single, barbs short, evenly distributed. *Siphon:* index (including valves) about 2.8–3.4; strongly pigmented, valves blackish; imbrications strong; hair 1-S usually 4b. *Anal Segment:* saddle distinctly shorter than siphon (including valves); lightly to moderately pigmented except for black basal ring; integumentary sculpturing more distinct dorsally; accessory saddle hairs short; usually 5 pairs of hairs in ventral brush (4-X).

MATERIAL EXAMINED.—198 specimens; 78 ♀; 111 ♂; 1 pupa; 8 larvae; no individual rearings.

SYSTEMATICS.—The association of the sexes and stages of *lutea* is only presumptive, but it appears to be correct. The larva from Guadalcanal is quite similar to those from Bougainville, and the males from all the populations conform to 1 type. However, the few females from Bougainville are slightly darker, and the single male lacks the small hairs in the upper portion of the mesal membrane of the sidepiece. It is possible therefore that 2 species are confused under *lutea.* This problem cannot be resolved until more material is studied.

M. lutea is easily separated from typical *crassipes,* with which it has been confused in the past, by the characteristic development of the male clasper. Similar if not identical forms occur in New Guinea and the Bismarck Archipelago. All of these, including *lutea,* may prove to be conspecific with *fuscopteron* (Theobald, 1911), described from a single female from the Digul River in New Guinea. Unfortunately, all the Papuan forms are known only in the female, and these are extremely similar, if not identical, in most species of the group. The *"crassipes"* of Queensland, indistinguishable in the female, has the male clasper somewhat similar to that of *lutea* but not as strongly crested and can be readily separated from *lutea* by the following additional male genitalic characters: mesal membrane of sidepiece with a group of long bristles instead of short hairs on upper part, including 1 strong distal bristle; apicosternal area of sidepiece with longer hairs; tergite lobe of segment IX with more numerous bristles; accessory apical bristle of claspette blunt-ended, not attenuate. It appears, therefore, that a strong tendency to regional speciation exists in this group and that, in all probability, at least the typical *lutea* of the southern Solomons is a species distinct from *fuscopteron.* On Bougainville there may be 2 distinct forms, paralleling *Ficalbia solomonis* and *F. bougainvillensis.*

BIONOMICS.—The single larva known from Guadalcanal was collected at the edge of a swamp in a wooded area in very shallow water at the base of a pandanus (JNB, 694). On Bougainville larvae were found attached to plant roots in a swamp (ABG, 232), and a single pupa was collected in a freshwater lagoon (ABG, 332).

Adults of *lutea* are commonly found in wooded areas around swamps, where they fly or rest on the vegetation during the daytime. Females do not bite and are less frequently collected than the males, which seem to be more active and often come to rest on the collector. On Bougainville the few adults collected were found in tents.

DISTRIBUTION (fig. **195**).—*Solomon Islands:* Bougainville; New Georgia; Roviana; Pavuvu; Guadalcanal. Not definitely known elsewhere.

5. Mansonia (Coquillettidia) xanthogaster (Edwards)

Figs. **195**, **201**, **202**

1924. *Taeniorhynchus* (*Coquillettidia*) *xanthogaster* Edwards, B. Ent. Res. 14:366. *TYPES: syntypes, ♂ and ♀, Burpengary (Bancroft) and Townsville (Hill), Queensland; Northern Territory, Australia (Hill).—Edwards proposed *xanthogaster* as new name for the species misidentified by Theobald as *Culex acer* Walker but did not specify or mark a specimen as type; *acer* Walker is apparently a synonym of *Culex quinquefasciatus*.

Mansonia (*Coquillettidia*) *xanthogaster* of Edwards (1932:119); Knight, Bohart, and Bohart (1944:24, 65, in part); Perry (1946:14; 1949*a*); Laird (1956); Stone, Knight, and Starcke (1959, in part).

Taeniorhynchus (*Coquillettidia*) *xanthogaster* in part of Iyengar (1955:26); Rageau (1958*a*:878; 1958*b*:6); Rageau and Vervent (1958:25).

Mansonia (*Coquillettidia*) *crassipes* in part of Edwards (1932:118); Taylor (1934:14); Lee (1944*a*:38); Knight, Bohart, and Bohart (1944:26, 65); Laird (1956).

Taeniorhynchus (*Coquillettidia*) *crassipes* in part of Iyengar (1955:26); Rageau (1958*a*:878; 1958*b*:7); Rageau and Vervent (1958:26).

Mansonia (*Coquillettidia*) *brevicellulus* of Laird (1956).

Taeniorhynchus (*Coquillettidia*) *brevicellulus* in part of Edwards (1924:365–366).

Taeniorhynchus acer of Theobald (1901*b*:211).

FEMALE.—*Wing:* 4.0 mm. *Proboscis:* 2.41 mm. *Forefemur:* 2.41 mm. *Abdomen:* about 2.75 mm. Indistinguishable from *lutea* except possibly in the following; golden scaling of hindfemur generally more extensive; abdominal tergites generally lighter.

MALE.—Essentially as in the female; readily separated from *lutea* by the genitalia.

MALE GENITALIA (fig. **201**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe small, prominent, usually with 4 bristles. *Sidepiece:* apicosternal angle produced into a long lobe curved mesodorsad and bearing a dense brush of short bristles apically; upper portion of mesal membrane with 2 long hairs on a more or less distinct process. *Claspette:* apically with 1 long curved, slender, dark spiniform with slightly expanded apex and 1 subequal, more slender, blunt-ended accessory bristle. *Clasper:* moderately slender proximad; distad with a moderate expanded crest bearing 2 short hairs externally and a spiniform subapically.

PUPA (fig. **201**).—*Abdomen:* 4.85 mm. *Trumpet:* 1.58 mm. *Paddle:* 1.42 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, ventral area lighter; hairs concolorous with integument. *Trumpet:* tracheoid blackish; broad part with an inconspicuous bright brown distal bulb. *Abdomen:* uniformly strongly pigmented; integument with numerous conspicuous sharp spicules; hairs concolorous with or lighter than integument; hair 3-II absent; caudolateral angle of segment VIII slightly produced into sharp point, hair 9-VIII not on this process. *Paddle:* uniformly strongly pigmented except for darker apex; apical emargination relatively shallow; marginal spicules weak but distinct.

LARVA (fig. **202**).—*Head:* 0.8 mm. *Siphon* (including valves): 0.65 mm. *Anal Saddle:* 0.55 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly lightly to moderately pigmented; maxillary suture moderately interrupted; mental plate with about 7 well developed teeth on each side of median tooth; hair 1-C very dark, others moderately pigmented; hairs 6,7-C both moderately long. *Antenna:* basal part very dark proximad, progressively lighter distad; spicules small but distinct; hair 1-A inserted proximad of

0.60 of basal part. *Thorax:* tubercles and larger hairs moderately to rather strongly pigmented; integument without distinct spicules; hair 3-P usually 4,5b; 4-P short, usually 6-8b. *Abdomen:* tubercles and larger hairs moderately to rather strongly pigmented; integument without distinct spicules; hair 3-II-V rather strongly developed, usually single or double; 13-III-V poorly developed, short, multiple. *Segment VIII:* usually 7–9 scales in comb, free portion of scale long, pointed, base without spicules; hairs 3-5-VIII not on common plate; 3-VIII usually single, with short barbs, mostly in distal half. *Siphon:* index (including valves) about 2.5–2.75; strongly pigmented, black at base and on valves; imbrications strong; hair 1-S usually 4b. *Anal Segment:* saddle distinctly shorter than siphon (including valves); moderately pigmented except for black basal ring; spicules more distinct dorsally; accessory hairs short; usually 4 pairs of hairs in ventral brush (4-X).

MATERIAL EXAMINED.—249 specimens; 84♀; 69♂; 20 pupae; 76 larvae; no individual rearings.

SYSTEMATICS.—*M. xanthogaster* is a very clearly marked species in the male genitalia, but its females cannot be differentiated from those of the other yellow species of the *crassipes* group. The larva and pupa are fairly easily distinguished from those of *lutea,* which they resemble.

The immature stages from New Caledonia, mentioned below under bionomics, appear to be slightly different from those I have seen from the New Hebrides and Queensland and may represent an unrecognized species. Since no individual rearings were made and all the males I have seen from New Caledonia are definitely *xanthogaster,* clarification of this problem cannot be made until adequate material is studied. This larva appears to be distinct in having the antenna lighter and hair 1-A somewhat nearer the middle of the basal portion. The pupa has less distinct marginal spicules on the paddle and a somewhat differently shaped paddle.

BIONOMICS.—Perry (1949*a*) reports larvae and pupae of *xanthogaster* associated exclusively with a dwarf pandanus in water from 1–3 feet in depth in heavily shaded overgrown freshwater swamps in the New Hebrides. Several larvae and 3 pupae tentatively ascribed to this species were collected in a grassy swamp in New Caledonia (A. R. Gaufin).

Adults rest primarily on vegetation in the immediate vicinity of the breeding site. Females are said to be persistent and vicious biters in early morning and during the day in the vicinity of the breeding places in the New Hebrides (Perry, 1946: 14).

DISTRIBUTION (fig. **195**).—*New Hebrides:* Espiritu Santo; Aore. *New Caledonia:* unspecified localities. *Loyalty Islands:* Ouvea. Also reported from *Australia* (Queensland, Northern Territory).

Subgenus MANSONIOIDES Theobald

1907. *Mansonioides* Theobald, Monog. Culicidae 4:498–499. *TYPE SPECIES: *M. septemguttata* Theobald, 1907, Sarawak; monobasic.

FEMALES.—*Head:* eyes narrowly separated above, this space with narrow scales; labium with some light scales; apical palpal segment minute, without scales. *Thorax:* mesonotal scales of at least 2 colors; scutellar scales always numerous; acrostichal bristles weak or absent except at extreme anterior end; *psp* bristles always present. *Legs:* with many pale markings; tarsi ringed with light scales. *Wing:* speckled dorsally with light and dark broad scales, many of which are strongly asymmetrical. *Abdomen:* intersegmental membranes very strongly spiculate.

FEMALE GENITALIA.—*Segment VII:* partially retracted; much shorter than VI, tergite strongly concave at base and apex. *Segment VIII:* retracted; tergite small and completely retracted at rest, with a row of strong spiniforms at and near apex (fig. **203**); sternite much larger, with a pair of conspicuous lateral flaplike lobes. *Cercus:* vertical, with upturned apical process. *Postgenital Plate:* small, divided almost to base into lateral lobes. *Spermathecae:* 2 large and 1 minute.

MALES.—In general as in the females. *Palpus:* distinctly longer than proboscis; segment 4 long and slender; segment 5 minute.

MALE GENITALIA.—*Segment IX:* tergite without bristles. *Sidepiece:* very thick; hollowed out and extensively membranous on mesal surface; tergomesal margin produced mesad and with a line of thickened bristles. *Claspette:* very strongly developed; apex usually reaching level of base of clasper and bearing 1 or more spiniforms. *Clasper:* irregular in shape, without spiniform but with numerous long hairs. *Phallosome:* aedeagus with continuous broad dorsal sclerotization.

PUPAE.—*Cephalothorax:* some of the hairs branched. *Trumpet:* on a very prominent tubercle; apex produced into a heavily sclerotized spine which projects free of "cellular" lobe on one side. *Abdomen:* hair 9-VIII on caudolateral angle; hairs 1 or 5 or both greatly elongated, thickened and arising from more or less distinct basal processes on some of the segments II-VII; some of the smaller hairs branched; 3-II-VI present; hair 11 apparently not developed. *Paddle:* relatively broad.

LARVAE.—*Head:* maxillary suture complete. *Antenna:* distal part less than 0.5 of basal, rigid and ankylosed at base; hairs 2,3-A longer than distal portion of antenna. *Thorax:* longer hairs relatively short, strongly barbed distally or with brushlike tips. *Abdomen:* longer hairs thickened and with conspicuous barbs; hair 4 mesad of hair 3 on III,IV; hair 13-III-V long. *Segment VIII:* comb scales reduced to 2,3, blunt and rounded apically, without fringe; hairs 4,5-VIII removed from 3-VIII. *Siphon:* hair 1-S near apex of body but not on lobe. *Anal Segment:* ventral brush with 5 pairs of hairs on grid and a line of several longish hairs midventrally on saddle; accessory hairs absent.

EGGS.—Laid in masses attached to undersurface of leaves of aquatic plants below the water surface.

SYSTEMATICS.—*Mansonioides* is very similar to the New World subgenus *Mansonia.* The adult morphology of *Mansonioides* appears to be derived in the reduction of the terminal palpal segment of the male and in the male genitalia. The larvae of the 2 subgenera are markedly dissimilar; each subgenus possesses both generalized and derived features, but those of *Mansonioides* are much more uniform in structure. Egg laying is essentially the same in *Mansonioides* and *Mansonia,* but the latter appears to be less specialized and more varied in oviposition sites.

Several species of *Mansonioides* have been reported to have very extensive ranges, particularly *uniformis.* It seems probable that these are either polytypic species or complexes of closely related species. The different populations of these species vary a great deal in habits and in vector propensity.

In the South Pacific the subgenus is represented apparently only by *melanesiensis,* which is a member of the *uniformis* complex.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *Mansonioides* species are most often associated with *Pistia stratiotes,* but some forms may utilize the roots of other aquatic plants for attachment to secure air. The larvae of this subgenus are less specialized than those of *Coquillettidia* and usually occur in deeper water. The pupae of some species may be capable of repeated reattachment to host plants, as the apex of the trumpet does not break off when the animal becomes detached. The female genitalia are highly modified for egg laying, which takes place with the abdomen under water (Iyengar, 1933).

Females of most species of *Mansonioides* are strongly anthropophilic and will bite both out of doors and in dwellings. Their biting activity is largely crepuscular and nocturnal, but daytime feeding is not uncommon in some species. The flight range is quite varied in the different species, as are the diurnal resting places. *Mansonioides* species are often serious pests of man. Some species are important vectors of *Wuchereria malayi* and, to a lesser extent, *W. bancrofti* and may also be involved in the transmission of yellow fever virus. In the South Pacific *melanesiensis* is a serious pest in some areas in the Solomons but is not known to be a disease vector.

DISTRIBUTION (fig. **194**).—*Mansonioides* is confined to the Old World. It occurs from West Africa to the Solomons, from about 15° N. to Madagascar in the west and from Japan to Queensland in the east. In the South Pacific it has been found only in the Solomons.

KEYS TO SPECIES

See keys to tribe Mansoniini, pp. 301–302

1. Mansonia (Mansonioides) melanesiensis Belkin, n. sp.

Figs. **194, 203, 204**

TYPES.—*Holotype:* ♂ with genitalia slide (JNB, 1000–1002), Doma Cove area, Guadalcanal, Solomon Islands, Oct. 21, 1943, day catch, J. N. Belkin (USNM, 64776). *Allotype:* ♀ with genitalia slide (JNB, 1000–1001), same data as holotype (USNM). *Paratypes:* 6 ♀ (JNB, 1000), same data as holotype.

Mansonia (*Mansonioides*) *uniformis* in part of Knight, Bohart, and Bohart (1944:23, 65).

Taeniorhynchus (*Mansonioides*) *uniformis* in part of Iyengar (1955:26); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 4.55 mm. *Proboscis:* 2.47 mm. *Forefemur:* 2.92 mm. *Abdomen:* about 2.83 mm. In general similar to *uniformis* (Theobald, 1901) as described by Barraud (1934:129–130). *Head:* decumbent scales whitish, erect scales brown; clypeus reddish brown; labium largely dark-scaled at base both dorsally and ventrally and on apex dorsally, largely with pale dingy yellowish white scales elsewhere ventrally and dorsally, dorsal pale area with scattered dark scales and not sharply marked off from either basal or apical darker areas, the latter often with numerous pale scales; palpus about 0.3–0.33 of proboscis, largely with light brown scales, a few scattered light scales but not in conspicuous patches and none white; antennal torus light reddish brown, scales translucent, inconspicuous; flagellar segment 1 with small patch of dark scales, length about 1.5 of segment 2. *Thorax:* mesonotum predominantly with light coppery or golden brown scales and with a pattern of pale scales, greenish white in life, turning to silvery with age; pale scales restricted to (1) conspicuous broad sublateral lines from extreme anterior end, (2) most of humeral and fossal areas over supraalar area to above wing root, (3) a small patch in middle of anterior promontory, (4) entire prescutellar area, with extensions cephalad a very short distance along and laterad of acrostichal line; scutellum with pale scales only, similar to those of mesonotum; acrostichal bristles largely absent, a single pair of short ones at extreme anterior end; a semicircular row of alveoli in front of prescutellar space between dorsocentrals; pleuron with dingy white scales; a few narrow scales on upper *apn;* numerous more yellowish narrow scales on upper caudal part of *ppn;* scales on *apn* and *ppn* sometimes greenish; *ppl* with several semierect broad scales on lower part; *stp* with a small patch of broad scales in extreme upper part and a small elongate patch of similar scales below; *mep* with a small patch of broad decumbent scales in line with upper *stp* patch; pleural bristles golden; *psp* bristles 7–10; anterior median *mep* bristles 2–4. *Legs:* anterior surface of forefemur and midfemur largely dark-scaled, extensively speckled with yellowish and some whitish scales, posterior surface largely yellowish or whitish to beyond middle, distal part with many dark scales interrupted by a transverse subapical light band or blotch; anterior surface of hindfemur with whitish scales on ventral portion to beyond middle, dorsal surface and apical portion dark, speckled with light and a light subapical band or blotch; posterior surface of hindfemur as on other legs; tibiae extensively speckled with yellowish or dingy white scales; tarsi dark, with white or dingy white markings in form of rings which are wider dorsally as follows, (1) foretarsal and midtarsal segments 1 with narrow subbasal ring or dorsal patch and a narrow submedian ring, segments 2 and 3 with basal ring which is distinctly less than 0.5 of segment dorsally, (2) hindtarsal segment 1 as on other legs, segments 2–5 with narrow basal rings, that of 2 less than 0.33 of segment length. *Wing:* pale scaling very extensive. *Haltere:* knob dark-scaled. *Abdomen:* tergites largely dark-scaled; tergite I densely scaled in the center and with only a few lighter scales at base, sparsely scaled laterad; tergite II with a more or less distinct basal yellowish-scaled band widened in middle; tergites II-VII with extensive ventrolateral patches of dingy yellowish scales; tergite II with small subapical dorsolateral white-scaled patch; tergites III,V,VI with large apical dorsolateral white-scaled patches, tergite IV with smaller patch occasionally reduced to a few scales, tergite VII with more extensive apical light scaling, sometimes forming a complete apical band; scales of sternites largely dingy yellowish.

FEMALE GENITALIA (fig. **203**).—*Segment VIII:* spiniforms of tergite essentially as in *uniformis* (Barraud, 1934:124) but those of outer row straighter, lobe of sternite more prominent and rounded.

MALE.—Essentially as in the female, differing chiefly in the following. *Labium:* largely dark-scaled in proximal part, largely light-scaled in distal. *Palpus:* about 0.25–0.3 longer than proboscis; apex of segment 3 and segment 4 with a few long hairs; dark-scaled except for light-scaled lateral patch beyond middle of segment 2 and a premedian light-scaled ring on segment 3. *Legs:* light markings of tarsi less extensive. *Abdomen:* white markings of tergites much less extensive.

MALE GENITALIA (fig. **203**).—As figured; diagnostic characters as in the key; in general similar to *uniformis*. *Sidepiece:* about 11,12 thickened bristles in sternomesal row, the proximal longer. *Claspette:* spiniform broad, with apical hook and 1,2 subapical points. *Clasper:* external crest only slightly developed, broadly rounded; apical portion gradually and evenly tapered; hairs of crest numerous and long, those of apical part shorter. *Phallosome:* aedeagus long, narrow at base, middle portion cylindrical, apex with small median process without strong spicules; ventral paramere small; basal piece very large. *Proctiger:* paraproct produced into large hook with 4,5 denticles.

PUPA (fig. **203**).—*Abdomen:* 4.21 mm. *Trumpet:* 0.95 mm. *Paddle:* 1.25 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly light yellowish; densely covered with short rounded spicules; hairs very inconspicuous, concolorous with integument. *Trumpet:* light yellowish, slightly darkened on tracheoid and much darker on sclerotized apical process, which is strongly curved; apical process about 0.35 of total length; tracheoid on outer surface from base to a little less than middle of broad part. *Abdomen:* uniformly lightly pigmented; densely covered with short rounded spicules; all large hairs moderately pigmented, others concolorous with integument; hair 9-VII thickened, at caudolateral margin; 1-II-VII and 5-III-VII thickened and long. *Paddle:* uniformly lightly pigmented; marginal spicules small and sparse, more conspicuous on external buttress and middle portion of inner margin.

LARVA (fig. **204**).—*Head:* 0.84 mm. *Siphon* (with valves): 0.78 mm. *Anal Saddle:* 0.65 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly lightly to moderately pigmented; ocular area with conspicuous broad spicules; mental plate with very large median tooth surrounded by 3 adjoining teeth and 1 distant subbasal tooth on each side; hairs concolorous with integument except for 7,13-C which are darker and more conspicuous. *Antenna:* lightly pigmented, slightly darkened at base and distad of hair 1-A; spicules short, more numerous and larger dorsolaterad; hairs 2,3-A more than 2.0 of distal part of antennal shaft. *Thorax:* tubercles and larger hairs moderately pigmented; integument without distinct spicules. *Abdomen:* tubercles and larger hairs moderately pigmented; integument without distinct spicules. *Segment VIII:* comb of 2 spines; hair 1-VIII single; 3,5-VIII double, both thickened. *Siphon:* index (including valves) about 2.5–3.0; strongly pigmented, valves black; integumentary sculpturing distinct; hair 1-S double; 6-S very fine. *Anal Segment:* saddle distinctly shorter than siphon (including valves); moderately pigmented; spicules strongly developed and uniformly distributed.

EGG.—Unknown.

MATERIAL EXAMINED.—538 specimens; 372 ♀; 32 ♂; 4 pupae; 130 larvae; no individual rearings.

SYSTEMATICS.—The association of the stages of *melanesiensis* is uncertain, since no individual or progeny rearings are available; furthermore, the immature stages are known only from Bougainville, while the holotype designated here is from Guadalcanal. However, there is no indication of the presence of more than 1 species of *Mansonioides* in the Solomons, and the adults from the 2 islands appear to be very similar. Therefore it appears likely that the larva and pupa described above are actually those of *melanesiensis*.

M. melanesiensis is a member of the *uniformis* complex, which up to the present has been considered a single highly variable and very widespread species. It is evident, however, that several quite distinct forms have been confused with typical *uniformis* (Theobald, 1901). Even the type series of the latter from South India and Malaya may include 2 species. *M. melanesiensis* differs from all other "*uniformis*" populations that I have seen as follows: (1) in the adults, the pale scaling of the labium is not sharply separated from the dark scaling of the apex, and both the light and dark areas are extensively mottled with dark and light scales respectively; the tarsal markings are much more restricted; (2) the male and female genitalia differ in details as described above; (3) in the pupa, the paddle is much broader and hair 5-III is long; (4) the larval material of forms other than *melanesiensis* available to me is too poor for detailed study, but the latter appears to be different in the shape of the mental plate and details of chaetotaxy.

I have seen several specimens of "*uniformis*" from New Guinea which appear very similar to *melanesiensis* and may prove to belong to the same taxon.

BIONOMICS AND DISEASE RELATIONS.—Several attempts to locate the immature stages of *melanesiensis* were unsuccessful on Guadalcanal, but numerous larvae and 2 pupae of presumably this species were collected attached to the roots of a "swamp fern" on Bougainville.

Females of *melanesiensis* are chiefly night biters, but they will also attack readily during the day. Males have been collected on the wing both in the daytime and at night. *M. melanesiensis* is a vicious biter but is rarely a serious pest in the Solomons. It does not seem to fly far from its breeding sites, which are not very numerous or extensive. Occasionally it may be found in numbers in native villages. A few dissections of females from native villages in Guadalcanal were negative for filarial worms (Schlosser, 1949:740). Byrd and St. Amant (1959:63) found 23.4 per cent of 385 *melanesiensis* with developing *W. bancrofti* larvae in a native labor camp on Guadalcanal; only 1.5 per cent of the mosquitoes harbored larvae older than recently ingested microfilariae, but 3 specimens contained larvae from 10 to 12 days old.

DISTRIBUTION (fig. **194**).—*Solomon Islands:* Bougainville; Guadalcanal. Not known elsewhere.

TRIBE AEDINI

FEMALES.—Extremely varied. *Head:* eyes contiguous to distinctly separated above antennae; frontal area with or without scales; decumbent scales broad or narrow; erect scales numerous or few; orbital bristles usually well developed; clypeus with or without scales; labium varied in development, rarely markedly attenuate and recurved ventrad apically; palpus with 5 segments or less, varied in length from about 0.75 to less than 0.1 of proboscis; antenna varied in length, from slightly longer to distinctly shorter than proboscis, flagellar segment 1 usually less than 1.6 of segment 2. *Thorax:* mesonotum from slightly to strongly arched; scutellum distinctly lobed; postnotum with or without bristles; paratergite varied, with or without scales; *apn* lobes varied, sometimes approximated on midline; *pra* not separated by suture from *stp;* meron varied, its upper edge above or in line with base of hindcoxa; mesonotal, scutellar, and pleural scaling varied; mesonotal and pleural bristles varied. *Legs:* varied; tarsal segment 4 on all legs distinctly longer than segment 5; claws often toothed, those of hindleg always (?) large; pulvilli not developed. *Wing:* wing membrane with distinct microtrichia; vein scales varied; cell R_2 always longer than vein R_{2+3}; vein Rs without basal spur; vein R_{4+5} right-angled at base, without spur; vein 1A usually ending distad of branching of Cu, rarely proximad; vein R with or without dorsal remigial bristles; vein Sc usually without distinct bristles below at base, rarely (*Opifex*) with conspicuous bristles; plical area sometimes with scales at base ventrally; alula with marginal or dorsal hairlike or broad scales or both; upper calypter usually with complete marginal fringe of hairlike scales, sometimes reduced or completely absent. *Abdomen:* tergites and sternites largely scaled; laterotergite with scales numerous, reduced or absent; tip of abdomen usually pointed, sometimes truncate. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; segment VIII varied, exposed or completely retracted; cercus varied; spermathecae from 1 to 3, often unequal in size.

MALES.—Essentially similar to females. *Palpus:* varied in length and segmentation. *Antenna:* varied in length and hairiness; flagellar segments 12 and 13 usually elongate. *Legs:* claws often enlarged, unequal and toothed on foreleg and midleg.

MALE GENITALIA.—*Segment VIII:* varied. *Segment IX:* tergite variously developed; sternite usually with bristles. *Sidepiece:* varied in development; with or without lobes; mesal surface with or without distinct membrane. *Claspette:* present or absent. *Clasper:* varied in development; without or with 1 or more spiniforms. *Phallosome:* aedeagus simple or complex; only ventral paramere present. *Proctiger:* basal lateral sclerotization usually more or less developed; paraproct varied, usually with single apical dorsal spine; cercal setae present or absent.

PUPAE.—*Cephalothorax:* middorsal ridge moderate except in *Opifex;* all hairs present, variously developed. *Trumpet:* not placed on distinct tubercle; widely spaced, nearer wing base than middorsal line; usually relatively short and without distinct tracheoid; distal portion usually not markedly flared. *Abdomen:* hair 1-I usually strongly developed and dendritic, sometimes reduced to single hair; all normal hairs usually present; hair 9-II-V small, removed from caudolateral angle of tergite, ventrolateral, dorsolateral, or ventral in position; 9-VI removed from caudolateral angle, varied, small or large, ventral to dorsal in position; 9-VII usually large, dorsal and distinctly removed cephalad, rarely similar to 9-II-V; 9-VIII usually large, ventral in insertion, at or very near caudolateral angle. *Terminal Segments:* hair 1-IX apparently absent or indistinctly developed, never (?) in form of simple bristle; 1-X absent but reported as an anomaly in *Aedes* (*O.*) *monticola* Belkin & McDonald, 1957; cercal lobe of female more or less prominent, sometimes strongly projecting. *Paddle:* variously developed; usually relatively broad; external buttress more or less developed; midrib usually long and dividing paddle into more or less equally broad inner and outer portions; margins varied, sometimes with long filamentous spicules; only hair 1-P developed.

LARVAE.—*Head:* usually distinctly wider than long; labrum usually short and poorly differentiated dorsally, very strongly developed in *Aedes* (*Mucidus*) and *P.* (*Psorophora*); collar varied, usually well developed; ventral part of head capsule moderately long; posterior tentorial pit near caudal border; maxillary suture always (?) complete, sometimes extending caudolaterad of pit; cephalic border of labial plate more or less truncate or slightly produced; aulaeum usually with filamentous spicules; mental plate usually well developed, more or less triangular; chaetotaxy varied, complete except that hair 2-C apparently always absent; 3-C small, dorsal in position; hairs 16,17-C apparently not developed. *Antenna:* varied in length; simple; with or without spicules; chaetotaxy varied. *Thorax:* integument varied; spiracular sensilla distinct; notched organ not developed; hairs 9-12-P,M,T on common tubercles; 1-3-P usually on poorly defined basal plate; hair 13-P rarely developed, all others present; none of the hairs plumose or palmate but larger hairs often strongly barbed. *Abdomen:* integument varied; spiracular and dorsal sensilla distinct; tergites without sclerotizations other than those at base of larger hairs; hair 1 never palmate; hair 6-I-II and 7-I usually large; 6-III-VI varied in development; segment I with hair 11 present or absent, hair 14 absent. *Segment VIII:* comb always present, varied, rarely with small common sclerotized plate at base of scales. *Siphon:* varied in length; acus present or absent; pecten usually well developed, sometimes reduced or absent; hair 1-S usually beyond middle of siphon, never at base; no accessory 1-S hairs; usually only 1 hair 2-S, rarely accessory hairs developed; valves short; trachea usually well developed. *Anal Segment:* saddle varied, usually well developed but incomplete, sometimes complete or greatly reduced; acus sometimes developed; chaetotaxy varied, accessory hairs not developed; ventral brush usually represented by at least 4 pairs of hairs.

EGG.—Resistant, with thickened chorion; usually laid out of water or above water surface, never in boat-shaped masses on water; may survive for years.

SYSTEMATICS.—The Aedini as here defined comprise the *Aedes* group of Edwards (1932:64–65). The tribe appears to be a natural group, but some of its members show affinities with all the other tribes except the Anophelini. These annectent forms may have been derived through hybridization at the time of the early differentiation of the Culicinae. The Aedini differentiated undoubtedly in the Old World and specifically in the Indomalayan area, where the majority of the annectent types are preserved to this day.

The internal classification of the Aedini is in need of thorough revision. Currently 10 genera are recognized in this group: *Aedes, Armigeres, Ayurakitia, Eretmapodites, Haemagogus, Heizmannia, Opifex, Psorophora, Udaya,* and *Zeugnomyia* (fig. **205**). All the genera are small except for *Aedes.* In the South Pacific, only *Aedes, Armigeres,* and *Opifex* are represented, the latter 2 by a single species each and *Aedes* by 71 species grouped in 12 (13) subgenera. For a discussion of the relationships of the genera and subgenera in the South Pacific, see under *Aedes.*

BIONOMICS AND DISEASE RELATIONS.—As far as is known, all members of the Aedini deposit their eggs out of water and these withstand and may require varying periods of drying. Hatching normally takes place when the conditioned eggs are submerged following a rain or a flooding of the habitat through some other means. Some species utilize general ground habitats, such as temporary ground pools, puddles, hoofmarks, wallows, and margins of swampy or marshy areas. Others are specialized breeders in rockholes, crabholes, treeholes, leaf axils and flower bracts of plants, and *Nepenthes* pitchers; several species in this group utilize artificial containers for breeding.

The females of many species attack man readily and are among the worst mosquito pests of man. Blood-feeding habits vary a great deal as to the time and place of attack; both diurnal and nocturnal feeders are known. Some of the ground pool-breeders are reported to have extensive flight ranges.

The tribe is of great importance in transmission of diseases of man and animals. Several species have been incriminated as vectors of pathogenic viruses, protozoans, and helminths.

DISTRIBUTION (fig. **205**).—The Aedini are worldwide in distribution but are better represented in the Old World and the Nearctic region, where they form the dominant element of the mosquito fauna. In the South Pacific the tribe occurs throughout the area; indigenous forms are known from all the major island groups except the Marquesas, the low-lying coral atolls, and isolated eastern and southern islands.

KEYS TO GENERA AND SUBGENERA

(Keys to tribes, pp. 118–122)

ADULTS

(*Mansonia* (*Mansonioides*) included; undet. subgenus of *Aedes* not included)

1. Scales of vein Cu large, broad *and* conspicuously asymmetrical (1. *melanesiensis*) .... MANSONIA (MANSONIOIDES), p. 313

Scales of vein Cu varied, *if* large and broad then not asymmetrical 2

2(1). Head with decumbent scales largely broad *and* erect scales few and confined to occiput 3

Head with decumbent scales largely narrow *and/or* erect scales numerous, extending usually to orbital bristles 7

3(2). Mesepimeron with 1 or more strong lower bristle(s) in the middle or near anterior border 4

Mesepimeron without lower bristles or with several lower hairs posteriorly only 5

4(3). Clypeus with scales (1. *breinli*) . . . . ARMIGERES, p. 481

Clypeus without scales (1. *chionodes*) . . . . CHRISTOPHERSIOMYIA, p. 433

5(3). Mesonotum with silvery scales in lines or patches; tarsi with conspicuous pale markings . . . . STEGOMYIA, p. 436

Mesonotum entirely dark-scaled or with yellowish or golden scales, never with silvery markings; tarsi dark-scaled 6

6(5). Scutellum with broad scales (1. *dasyorrhus*) . . . . LORRAINEA, p. 430

Scutellum with narrow scales . . . . VERRALLINA, p. 412

7(2). Decumbent scales of vertex largely broad 8

Decumbent scales of vertex largely narrow 10

8(7). Subcosta with a patch of bristles below at base (1. *fuscus*) . . . . OPIFEX, p. 322

Subcosta without a patch of bristles below at base 9

9(8). Mesepimeron with hairs caudally on middle portion; metameron with short hairs . . . . GEOSKUSEA, p. 332

Mesepimeron without hairs caudally on middle portion; metameron without hairs (*mediovittatus* and *kochi* groups) . . . . in part FINLAYA, p. 340

10(7). Lower *mep* bristle or bristles present . . . 11

Lower *mep* bristles absent 13

11(10). Wing membrane conspicuously clouded on crossveins *r-m*, *m-cu*, and base of Rs . . . . MUCIDUS, p. 401

Wing membrane uniformly clear or uniformly infuscated 12

12(11). Erect scales of vertex long, bristlelike (1. *australis*) . . . . HALAEDES, p. 328

Erect scales of vertex short, scalelike (5. *mcdonaldi*, sp. 6) . . . . in part OCHLEROTATUS, p. 387

13(10). Pleural scaling restricted to *ppn* and *stp* (1. *suvae*) . . . . LEVUA, p. 399

Pleural scaling not restricted to *ppn* and *stp* 14

14(13). Area below prealar (*pra*) bristles with more or less extensive patch of appressed scales 15

Area below prealar (*pra*) bristles without patch of appressed scales 16

15(14). *Female* cercus short and broad; segments 4 and 5 of *male* palpus slender, without dense vestiture of long hairs or bristles . . . . in part FINLAYA, p. 340

Female cercus long and slender; segments 4 and 5 of *male* palpus thickened, with dense vestiture of long hairs or bristles . . . . in part OCHLEROTATUS, p. 387

16(14). Scutellum with broad silvery scales *or* paratergite with scales . . . . AEDIMORPHUS, p. 423

Scutellum with narrow pale scales *and* paratergite without scales (1. *imprimens*) . . . . EDWARDSAEDES, p. 408

MALE GENITALIA

(undetermined subgenus of *Aedes* not included)

1. Proctiger without any cercal setae 2

Proctiger with at least 1 pair of cercal setae 8

2(1). Clasper with a comblike row of spiniforms (1. *breinli*) . . . . ARMIGERES, p. 481

Clasper without a comblike row of spiniforms 3

3(2). Aedeagus with several apical or subapical teeth on each side 4

Aedeagus without teeth 5

4(3). Clasper irregular in shape, spiniform or spiniforms arising from a distinct lobe . . . . AEDIMORPHUS, p. 423

Clasper more regular in form, spiniform not arising from a distinct lobe . . . . STEGOMYIA, p. 436

5(3). Clasper with scales (1. *dasyorrhus*) . . . . LORRAINEA, p. 430

Clasper without scales 6

6(5). Clasper with conspicuous apical spiniform (1. *chionodes*) . . . . CHRISTOPHERSIOMYIA, p. 433

Clasper without spiniform 7

7(6). Aedeagus with apical portion sagittate (1. *imprimens*) . . . . . EDWARDSAEDES, p. 408

Aedeagus with apical portion simple, not sagittate . . . . VERRALLINA, p. 412

8(1). Cercal setae of proctiger of 2 types, short distally, long proximally; sidepiece distally with short hairs only (1. *fuscus*) . . . . OPIFEX, p. 322

Cercal setae of proctiger all of same size; sidepiece distally with some long bristles . . 9

9(8). Claspette not developed at all . . . . GEOSKUSEA, p. 332

Claspette present 10

10(9). Claspette short, rounded, with numerous apical hairs (1. *australis*) . . HALAEDES, p. 328

Claspette with a stem and a single apical spiniform or flattened appendage 11

11(10). Spiniform of clasper short, spinelike, bifid (1. *suvae*) . . . . LEVUA, p. 399

Spiniform of clasper elongate, simple or bifid, never spinelike 12

12(11). Basal tergomesal area of sidepiece differentiated but not produced into projecting lobe . . . . FINLAYA, p. 340

Basal tergomesal area of sidepiece produced into projecting lobe 13

13(12). Basal tergomesal lobe of sidepiece without thickened long bristles dorsally near base . . . . OCHLEROTATUS, p. 387

Basal tergomesal lobe of sidepiece with 1 to several thickened differentiated bristles dorsally near base, markedly different from others . . . . MUCIDUS, p. 401

PUPAE

(*Christophersiomyia* and undet. subgenus of *Aedes* not included)

1. Hair 9-VII ventral in position, simple, short, similar to 9-II-V; middorsal ridge of cephalothorax very prominent; trumpet about as broad as long (1. *fuscus*) . . . . OPIFEX, p. 322

Hair 9-VII dorsal in position, markedly different from 9-II-V; middorsal ridge of cephalothorax normal; trumpet length at least 1.5 maximum width 2

2(1). Paddle distinctly wider than segment VIII (1. *australis*) . . . . HALAEDES, p. 328

Paddle distinctly narrower than segment VIII 3

3(2). Hair 1-II single *and* very close to midline; trumpet very long, distinctly tracheoid in at least basal 0.15 . . . . MUCIDUS, p. 401

Hair 1-II branched *or* if single then removed from midline; trumpet relatively short, at most with indistinct tracheoid at base . . 4

4(3). Paddle margins with long fringe of filamentous spicules 5

Paddle margins with short or indistinct spicules 7

5(4). Hair 4-VIII short, multiple; 2-II about 3.0 as far from hair 1 as hair 3-II (1. *breinli*) . . . . ARMIGERES, p. 481

Hair 4-VIII long, single or double; 2-II at most 1.5 as far from hair 1 as hair 3-II 6

6(5). Hair 2-III at or near caudal border of tergite (1. *dasyorrhus*) . . . . . LORRAINEA, p. 430

Hair 2-III far cephalad of caudal border of tergite (*edwardsi* and *scutellaris* groups) . . . . in part STEGOMYIA, p. 436

7(4). Hair 1-C at least twice as long as hairs 2,3-C; 2-II distinctly mesad of hair 3-II (*kochi* group) . . . . in part FINLAYA, p. 340

Hair 1-C of the same order of magnitude as hairs 2,3-C, smaller or at most 1.5 as long 8

8(7). Hair 10-C laterad of 11-C (1. *imprimens*) . . . . EDWARDSAEDES, p. 408

Hair 10-C mesad or at same level as 11-C 9

9(8). Hairs 2,3-I widely separated 10

Hairs 2,3-I approximated 11

10(9). Hairs 2-III-V in basal 0.7 of tergites . . . . VERRALLINA, p. 412

Hairs 2-III-V in distal 0.1 of tergites (5. *mcdonaldi*) . . in part OCHLEROTATUS, p. 387

11(9). Hair 2-VI distinctly laterad of hair 1-VI (1, *aegypti;* 2. *albolineatus*) . . . . in part STEGOMYIA, p. 436

Hair 2-VI mesad or at level of hair 1-VI 12

12(11). Paddle hair more than 0.35 of paddle length 13

Paddle hair usually less than 0.3 of paddle length 14

13(12). Hair 2-V cephalad of hair 3-V (1. *suvae*) . . . . LEVUA, p. 399

Hair 2-V caudad of hair 3-V . . . . GEOSKUSEA, p. 332

14(12). Hair 1-IV usually double; female cercus only slightly projecting beyond lobe (2. *notoscriptus;* 3. *albilabris;* 6. *argyronotum*) . . . . in part FINLAYA, p. 340

Hair 1-IV usually at least 4b; female cercus strongly projecting beyond lobe 15

15(14). Hair 9-VII shorter than hair 6-VII (1. *alboscutellatus*) . . . . in part AEDIMORPHUS, p. 423

Hair 9-VII longer than hair 6-VII 16

16(15). Hair 1-VI of the same order of magnitude as hair 5-VI (2. *nocturnus*) . . . . in part AEDIMORPHUS, p. 423

Hair 1-VI much smaller than hair 5-VI (1. *antipodeus;* 2. *edgari;* 3. *vigilax*) . . . . in part OCHLEROTATUS, p. 387

LARVAE

1. Abdominal segment I with hair 12 developed 2

Abdominal segment I with hair 12 absent 8

2(1). Metathoracic pleural group (9-12-T) very small, longest hair less than 0.5 of long hairs in mesothoracic pleural group (1. *fuscus*) . . . . OPIFEX, p. 322

Metathoracic pleural group (9-12-T) at most moderately reduced, longest hair more than 0.5 of long hairs in mesothoracic pleural group 3

3(2). Metathoracic pleural group (9-12-T) and hair 7-T very close to large mesothoracic hairs, all appearing as a single group (1. *australis*) .... HALAEDES, p. 328

Metathoracic pleural group (9-12-T) distinctly removed from large mesothoracic hairs 4

4(3). Ventral brush with 5 or 6 pairs of hairs all on grid or boss or in a group, no detached proximal hairs 5

Ventral brush with 7 or more pairs of hairs and usually with 2 or more detached hairs proximad or with hairs extending along most of ventral surface of anal segment 6

5(4). Hairs 5,6-C both very long *and* both caudad of level of antennae .... GEOSKUSEA, p. 332

Hairs 5,6-C never both very long *and* caudad of level of antennae .... FINLAYA, p. 340

6(4). Labrum very long and wide, produced in front of head; mouthbrush filaments reduced in number, borne in compact group on side; hairs 2,3-X both single .. MUCIDUS, p. 401

Labrum normal, not produced in front; mouthbrush filaments more numerous, attached over wide area; hair 2-X always branched, 3-X single 7

7(6). Anal saddle large, complete or incomplete, always extending on sides; hair 1-X on or adjacent to saddle .... OCHLEROTATUS, p. 387

Anal saddle restricted to dorsal surface; hair 1-X distinctly removed from saddle (1. *suvae*) .... LEVUA, p. 399

8(1). Pecten not developed (1. *breinli*) .... ARMIGERES, p. 481

Pecten developed, several teeth on each side of siphon 9

9(8). Ventral brush with 4 or 5 pairs of hairs, all free or all on a grid or boss 10

Ventral brush usually with 6 or more pairs of hairs on a grid; rarely with 5 pairs of hairs on grid, then with 2 or more detached hairs proximad 12

10(9). Comb an extensive patch of several rows of small fringed spatulate scales; saddle small; hair 1-X at its caudolateral angle (1. *dasyorrhus*) .... LORRAINEA, p. 430

Comb in a single or partially double row of relatively large scales; saddle complete or incomplete, always large, hair 1-X on or near its caudolateral margin 11

11(10). Antenna distinctly spiculate; hairs 4-6-C caudad of level of antennal base (1. *chionodes*) .... CHRISTOPHERSIOMYIA, p. 433

Antenna without spicules; hairs 4-6-C usually cephalad or at level of antennal base .... STEGOMYIA, p. 436

12(9). Hairs 2,3-X both short and multiple; meso- and metathoracic pleural groups with very large tubercles which bear also hairs 13-M and 8-T (1. *imprimens*) .... EDWARDSAEDES, p. 408

Hair 3-X always long and single, 2-X varied; meso- and metathoracic pleural groups with moderate tubercles which do not bear hairs 13-M and 8-T 13

13(12). Hairs 5,6-C approximated, 6-C about 2.0 as far removed from 7-C as from 5-C .... AEDIMORPHUS, p. 423

Hairs 5,6-C widely separated, 6-C removed from 7-C less than 1.5 its distance from 5-C 14

14(13). Comb scales spinelike; hair 8-C short, multiple (sp. 1) .... AEDES, subgenus undetermined, p. 422

Comb scales fringed apically; hair 8-C long, usually single ...... VERRALLINA, p. 412

Genus OPIFEX Hutton

1902. *Opifex* Hutton, New Zeal. Inst., Trans. Proc. 34:188. TYPE SPECIES: *O. fuscus* Hutton, 1902, New Zealand; monobasic.

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Opifex fuscus Hutton

Figs. **206-208**

1902. *Opifex fuscus* Hutton, New Zeal. Inst., Trans. Proc. 34:188–189. TYPE: ♂ (?), Wellington, New Zealand, G. V. Hudson (WELL).

Opifex fuscus of Edwards (1921*a*:73–74; 1924:367; 1932: 127–128); Miller (1922, 1950:45); Kirk (1923); Taylor (1934:15); Graham (1939:213); Lee (1944*a*:47); Miller and Phillipps (1952:11); Marks (1958); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 4.9 mm. *Proboscis:* 2.25 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 3.0 mm. A large, stocky, gray-pruinose dark mosquito with scanty scaling and uniformly slightly infuscated wing membrane. *Head:* eyes widely separated above antennae; all scales broad, small, decumbent, whitish, widely scattered but uniformly distributed caudad of the very numerous orbital bristles; no erect scales anywhere, instead numerous curved attenuate hairs; numerous hairs and a few scales on frons to lower level of eyes; clypeus bare, pollinose; labium largely dark-scaled above and in apical 0.2 below, most of ventral surface with dingy white scales, scattered pale scales at base above; labella long, slender; palpus about 0.28 of proboscis, segments 1 and 2 ankylosed, segment 3 moderate and cylindrical, segment 4 long and club-shaped, within head of club an invaginated sense organ which may be developed from segment 5, a few whitish scales on segments 2 and 3, segment 4 with a few whitish and dark scales dorsally and mesally; antenna about 0.9 of proboscis; scape very strongly developed, almost as long as torus (pedicel) on outer side; torus poorly developed, not strongly swollen, with numerous long hairs but no scales; flagellar segments thick, cylindrical, whorls poorly developed, bristles short; flagellar segment 1 about 1.5 of segment 2. *Thorax:* mesonotal integument very dark, almost black, with gray pruinosity most strongly developed in prescutellar space, extremely sparse vestiture of mixed short narrow dark bronzy, golden, or sometimes whitish scales, broad whitish scales on shoulders and posterior portion of prescutellar space; acrostichals very short, in 2 complete widely separated rows; dorsocentrals short; fossal area with numerous short bristles; scutellum with median lobe strongly swollen and smoothly rounded above and with a pair of short bristles on disc, all lobes with broad whitish scales; paratergite broad, bare; pleuron with very conspicuous gray pruinosity; pleural scales all broad and whitish, sparse but covering extensive areas on *apn*, upper half of *ppn, ppl, psp,* posterior half of *stp*, upper anterior two-thirds or more of *mep;* pleural bristles numerous, present only on *apn, ppn, ppl, psp, stp, pra,* and *mep*, dark and light, some small hairs also present, particularly on *ppn; ppn* bristles extending in an upper arc from well cephalad of middle of sclerite to level of lower end of spiracle; anterior *mep* bristles numerous, extending to lower third, about 5,6 heavy dark ones and numerous light ones cephalad. *Legs:* coxae and trochanters with whitish scales, hairs unusually numerous apically; anterior surfaces of femora largely dark-scaled but sprinkled with whitish scales, extensively on hindleg, ventral or posterior surfaces largely with whitish scales, apices with a few pale scales; tibiae largely dark-scaled, whitish scales on apex and scattered elsewhere, particularly on anterior surface of hindfemur; tarsi largely dark-scaled, a variable number of white scales at base and shaft of segments 1 and sometimes other segments as well, plantar surfaces of segments 1–4 with a pair of conspicuous apical spiniforms; claws equal, quite large on all legs, all with very long, bristlelike basal process. *Wing:* wing membrane uniformly lightly infuscated; vein Sc ending before furcation of Rs; dorsal scaling scanty, scales dark except for a few white ones on Sc and remigium; squame scales small; plume scales on Rs, R_{2+3}, R_2, and R_3 long and narrow; remigium (base of R) with numerous short hairs; base of Sc below with numerous long hairs; a small patch of scales below on base of plical area; alula and upper calypter with complete marginal fringe of very long hairs or hairlike scales. *Haltere:* with whitish scales. *Abdomen:* scaling very sparse but widespread; tergite I with scattered whitish scales, hairs rather short but numerous, particularly laterally; laterotergite small, without scales or hairs; tergites II-VII dark-scaled in middle, with white-scaled basolateral triangular areas very extensive on II and III, almost meeting on basal middorsal line, small on distal segments; short hairs very numerous on distal tergites; sternite I represented by distinct sclerotization; sternites II-VII largely with scattered whitish scales; on distal segments pale scales confined to middle, outer portions with scattered dark scales; segment VIII without scales. *Genitalia:* segment VIII exposed, tergite short, sternite much larger, strongly compressed and very hairy; segment IX well developed, tergite with pair of lateral lobes; cercus long and broad; postgenital plate long, triangular; spermathecae 3, one distinctly larger.

MALE.—Essentially as in the female. *Palpus:* about 0.8 of proboscis; segment 2 rather distinctly separated from 1, short, swollen; segment 3 elongate, ankylosed with 2; segment 4 longer than 3, clubbed apically and pendant, apex apparently as in female; scaling extremely sparse, apparently only a few broad dark scales. *Antenna:* as in the female except for remarkable modifications of flagellar segments 1–4; flagellar segment 1 thickened but more or less cylindrical; segments 2 and 3 thickened and with basal swelling from which arises a strong spine or spiniform bristle directed dorsomesad; segment 4 very strongly swollen at base dorsally and with extremely long spine or spiniform bristle directed dorsad, spine 2–3 times as long as on segments 2 and 3. *Thorax:* narrow scaling of mesonotum largely whitish. *Legs:* scaling apparently reduced or largely absent on ventral surface; forefemur shortened and thickened, with numerous hairs; midfemur and hindfemur normal in size but with numerous fine hairs on lower surface at base; foretibia shortened, greatly swollen and with numerous heavy and fine short hairs; midtibia and hindtibia of normal length but strongly swollen distally, particularly hindtibia, both with numerous hairs, strong above, fine and longer below toward apex; plantar surface of all tarsi (and apex of tibiae) without scales but with densely packed fine hairs (probably hydrofuge pile), apical plantar bristles not developed, segments 4 and 5 of foretarsus shortened; claws of foreleg tremendously enlarged, equal, simple, longer than tarsal segments 3–5 combined; claws of midleg and hindleg normal, subequal, simple. *Abdomen:* scaling even more scanty than in female.

MALE GENITALIA (fig. **207**).—As figured; diagnostic characters as in the key. *Segment VIII:* markedly shortened, only slightly retracted. *Segment IX:* well developed, long; tergite with strong basal lateral sclerotization, caudal border nearly straight, without lobes but with a pair of patches bearing numerous thickened hairs; sternite long, with a triangular apical sclerite, distinctly separated from the basal sclerite, no hairs, an unpigmented spot in distal sclerite. *Sidepiece:* short and heavy, very strongly sclerotized and extremely darkly pigmented, with a strong external angle at about basal 0.4; no scales; dorsal, lateral, and ventral surfaces densely covered with short hairs and dense long pile of fine spicules; several rather short bristles near base on dorsal surface; no distinct basal tergomesal lobe, area not differentiated; a prominent apical tergal lobe projecting over insertion of clasper; mesal surface with extensive membrane from base to apex where clasper is inserted. *Claspette:* a long simple sclerotized plaque on sternal mesal surface, with short hairs distally. *Clasper:* short, strongly swollen and with small rounded process at base; distal part with numerous short setae; spiniform large, heavy, subapical, or possibly very deeply inserted. *Phallosome:* aedeagus long, simple. *Proctiger:* basolateral sclerotization well developed; paraproct with long simple dorsal spine; cercal sclerite strongly developed, setae numerous, short distally, long proximally.

PUPA (fig. **207**).—*Abdomen:* 4.04 mm. *Trumpet:* 0.62 mm. *Paddle:* 1.3 mm. Chaetotaxy as figured; diagnostic characters as in the key; only whole pupae examined; pigmentation apparently rather light bright yellowish, darker dorsally on cephalothorax. *Cephalothorax:* middorsal ridge very strongly developed. *Trumpet:* short, extremely broad distally, without slit; pigmentation moderate yellowish brown, darkened apically; tracheoid not developed. *Abdomen:* hair 1-I (float hair) a simple hair with a few branches; 9-III-VI ventral in position; 9-VII small, single, similar to 9 on preceding segments, inserted on ventral surface near caudolateral margin; 5-VI short, single or with a few branches; female cercus prominent. *Paddle:* extremely large and broad; thickened at base; pigmentation very light except for darkened base, midrib, and external buttress; marginal spicules extremely small; hair 1-P short.

LARVA (fig. **208**).—*Head:* 0.98 mm. *Siphon:* 1.07 mm. *Anal Saddle:* 0.43 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, darkened caudally, lighter on ocular areas; hairs moderately to strongly pigmented; mental plate as figured; inner mouthbrushes strongly pectinate apically; hairs 4,6-C far forward; 7-C very small; 12,13-C single, near anterior border. *Antenna:*

short, rather even in width; pigmentation dark, lighter at base and apically; a few minute inconspicuous spicules, chiefly ventrolaterally beyond middle; hair 1-A minute, slender, spiniform. *Thorax:* integument without distinct spiculation; spiracular sensilla strongly developed; hairs and tubercles strongly pigmented; prothoracic and metathoracic pleural groups (9–12) very small, all hairs usually single, sometimes 1 branched; metathoracic pleural group in normal caudal position; shoulder hairs (1-3-P) without basal tubercle; 5-M a large multiple tuft. *Abdomen:* integument without distinct spiculation; spiracular sensilla very strongly developed; hairs strongly pigmented; 6-I-VI large, multiple; 2-I-VII spiniform. *Segment VIII:* comb in a triangular patch of usually 80 or more scales, very small proximally, progressively larger distally, scales in middle of posterior row with several strong apical spicules or denticles; hair 1-VIII small; 2-VIII large, multiple; 4-VIII multiple. *Siphon:* index about 2.0; somewhat swollen in middle, not markedly narrowed apically; acus not developed; pigmentation light to moderate, basal ring black, apex darkened; pecten of a few slender, simple spines, widely separated; hair 1-S a large multiple tuft, inserted beyond middle; valves short, broad; hair 6-S very long, barbed; trachea greatly swollen within siphon. *Anal Segment:* saddle incomplete, very small; moderately to lightly pigmented, black at base and darkened apically; with small indistinct spicules, no marginal spicules; hair 1-X on edge of saddle; ventral brush of 8,9 pairs of multiple hairs all on grid and all located on a distinct boss; gills minute, rounded.

MATERIAL EXAMINED.—262 specimens; 40 ♀; 63 ♂; 30 pupae; 129 larvae; no individual rearings.

SYSTEMATICS.—This remarkable mosquito was described by Hutton as a tipulid related to *Erioptera.* Although Miller (1922) described it in some detail, *fuscus* has never been thoroughly studied and some of its most remarkable features have not been described, most of the attention being centered on the unusual secondary sexual characters of the male. Superficially *Opifex* resembles some species of *Aedes,* but it is so distinct from it in all stages that it is unquestionably worthy of recognition as a separate genus. In the adults, the most distinctive characters are the very short vein Sc, which has a patch of long hairs at the base ventrally as in *Culiseta,* and the structure of the palpus; in the male, flagellar segments 12 and 13 of the antenna are not elongated; in the pupa, hair 9-VII is ventral in position and single as on the preceding segments; in the larva, hairs 12,13-C are anterior, the metathoracic pleural group is in normal position but very small, and all its hairs are single. Many of the features of *Opifex* represent the most primitive condition found in the tribe Aedini and are annectent with the other tribes.

The secondary sexual characters of the male of *fuscus* are truly amazing and unique in the family. Of particular interest is the hydrofuge pile of the plantar surface of the tarsi, which probably enables the male to skim over the water and to secure a firm footing on the water surface in the act of copulation with the female, which is still in the pupal skin. The function of the other specializations of the legs and those of the antenna are not definitely known; it has been suggested that the tremendously enlarged claws of the foreleg as well as the proboscis are used in combat with other males.

BIONOMICS AND DISEASE RELATIONS.—The only published results of original observations on the bionomics and behavior of *fuscus* are those of Kirk (1923) and Miller (1922:126). The immature stages are said to be found along the coast "in rock pools a little above the high-water mark. These pools contain brackish water, in which there is generally an abundant growth of Enteromorpha" (Kirk, 1923:400); the eggs are attached singly to the sides of the rock pool below the water surface (Miller and Phillipps, 1952:11). The peculiar sexual behavior of the males has been described in rather fanciful terms by Kirk (1923:400–403); more detailed observations are needed to clarify the function of the many adaptive secondary sexual characters. Females are said to attack man at night (Graham, 1939:213) and to produce a most painful bite (Miller and Phillipps, 1952:11).

DISTRIBUTION (fig. **206**).—*New Zealand:* North Island (Auckland, Wellington); South Island (Nelson, Marlborough, Otago). *Kermadec Islands* (see discussion in General Considerations). Not known elsewhere.

Genus AEDES Meigen

1818. *Aedes* Meigen, System. Beschr. Europ. Zweifl. Insekten 1:13. TYPE SPECIES: *Aedes cinereus* Meigen, 1818, Europe; monobasic.

See also under subgenera and, for complete synonymy, Stone, Knight, and Starcke (1959).

FEMALES.—With all the varied development of the tribe except for the following; postnotal and *sp* bristles absent; *psp* bristles nearly always present; *apn, ppn, ppl, stp, pra,* and *mep* bristles present; *apn* lobes usually widely separated; upper edge of meron usually above base of hindcoxa; vein Sc without bristles below at base.

MALES.—As in the female; palpus varied in length; antenna varied in length and hairiness.

MALE GENITALIA.—With all the varied development of the tribe except for the following; cercal bristles of proctiger all of 1 type and short or absent.

PUPAE.—With all the varied development of the tribe except for the following: hair 9-VII dorsal in position, enlarged, markedly different from hairs 9-II-V.

LARVAE.—With all the varied development of the tribe except for the following; metathoracic pleural group well developed; pecten teeth always present, at least 1 on each side of siphon.

EGGS.—As in tribe.

SYSTEMATICS.—*Aedes* currently includes well over 750 described species and subspecies, which are placed in some 23 subgenera (Mattingly, 1958*b*:4; Stone, Knight, and Starcke, 1959). The genus has been studied from a world standpoint only once (Edwards, 1932:129–178), and its internal classification is in great need of revision. The characters used by Edwards (1932:129–178; 1941:106–223) for the definition of the subgenera are often very superficial and unsatisfactory. For an understanding of the *Aedes* complex, it is essential that a thorough study be made of the annectent forms in the Indomalayan area and the American Mediterranean region. The recent studies of Mattingly (1957*b*, 1958*b*, 1959) indicate the complexity of the problem and suggest caution in proposing a reclassification of the genus or its dismemberment at present.

In the South Pacific, *Aedes* is the dominant mosquito genus both in the number of species and in the variety of types. I recognize 12 subgenera in this area; 3 of these (*Halaedes, Edwardsaedes,* and *Lorrainea*) are new; for a fourth, formerly considered to be the nominate subgenus, I am resurrecting Theobald's *Verrallina.* An additional subgenus may be represented in the western Solomons; since it is known by a single larval collection, it cannot be placed at present and remains undetermined.

The described subgenera, as well as the other 2 genera of the tribe Aedini represented in the South Pacific, appear to fall into 2 sections on the basis of characters in the male genitalia and in the larva. Each section can be further subdivided, principally on other male genitalic and on larval characters but general adult features are also useful.

Section A.—*Male genitalia:* proctiger always with cercal setae; aedeagus simple. *Larva:* abdominal segment I with hair 12 developed.

Subsection 1.—*Male genitalia:* proctiger with 2 types of cercal setae, long and short; claspette long, simple, with short undifferentiated setae. *Larva:* metathoracic pleural group reduced but normal in position.—*Opifex.*

Subsection 2.—*Male genitalia:* proctiger with cercal setae all short; claspette short, rounded, with numerous apical setae. *Larva:* metathoracic pleural group only slightly reduced in size, removed cephalad toward mesothoracic hairs.—*Aedes,* subgenus *Halaedes.*

Subsection 3.—*Male genitalia:* proctiger with cercal setae all short; claspette not developed. *Larva:* metathoracic pleural group normal in position and size; ventral brush reduced to 6 pairs of hairs, without detached proximal hairs.—*Aedes,* subgenus *Geoskusea.*

Subsection 4.—*Male genitalia:* proctiger with cercal setae all short; claspette with more or less elongate stem and a single enlarged apical seta or appendage. *Larva:* metathoracic pleural group normal in position and size; ventral brush varied.

a. *Male genitalia:* basal tergomesal area not produced into lobe. *Female:* cercus short and broad; segment VIII only slightly retracted. *Larva:* ventral brush reduced to 5 pairs of hairs, no detached proximal hairs.—*Aedes,* subgenus *Finlaya.*

b. *Male genitalia:* basal tergomesal area usually produced into distinct lobe. *Female:* cercus long and slender; segment VIII completely or largely retracted. *Larva:* ventral brush with at least 7 pairs of hairs and with 2 or more detached proximal hairs.—*Aedes,* subgenera *Mucidus, Ochlerotatus,* and *Levua.*

Section B.—*Male genitalia:* proctiger without cercal setae; aedeagus simple or complex. *Larva:* abdominal segment I with hair 12 not developed.

Subsection 1.—*Male genitalia:* clasper without spiniform; aedeagus relatively simple. *Larva:* pecten present; ventral brush with 6 or more pairs of hairs or with detached proximal hairs; comb in single row.

a. *Adults:* vertex of head with decumbent scales largely narrow, erect scales numerous. *Larva:* hairs 2,3-X both short and multiple.—*Aedes,* subgenus *Edwardsaedes.*

b. *Adults:* vertex of head with decumbent scales largely broad, erect scales confined to occiput. *Larva:* hair 3-X long, single.—*Aedes,* subgenus *Verrallina.*

Subsection 2.—*Male genitalia:* clasper with 1 simple spiniform; aedeagus relatively simple, without conspicuous teeth. *Larva:* pecten present; ventral brush with 4,5 pairs of hairs.

a. *Male genitalia:* clasper with scales. *Larva:* ventral brush with 5 pairs of hairs; comb of several rows of small scales.—*Aedes,* subgenus *Lorrainea.*

b. *Male genitalia:* clasper without scales. *Larva:* ventral brush with 4 pairs of hairs; comb in a single row of relatively large scales.—*Aedes,* subgenus *Christophersiomyia.*

Subsection 3.—*Male genitalia:* clasper with 1 or more spiniforms but not in a comblike row; aedeagus with conspicuous teeth. *Larva:* pecten present; ventral brush varied; comb varied.

a. *Adults:* vertex of head with decumbent scales largely broad, erect scales confined to occiput. *Larva:* ventral brush with 4,5 pairs of hairs and no detached proximal hairs.—*Aedes,* subgenus *Stegomyia.*

b. *Adults:* vertex of head with decumbent scales largely narrow; erect scales numerous. *Larva:* ventral brush with 6 or more pairs of hairs or with detached proximal hairs.—*Aedes,* subgenus *Aedimorphus.*

Subsection 4.—*Male genitalia:* clasper with comblike row of spiniforms. *Larva:* pecten not developed.—*Armigeres.*

Although the groupings indicated above appear to be natural ones, it is quite probable that the characters I have used will not hold outside the South Pacific area. For instance, hair 12 on abdominal segment I of the larva may be secondarily lost in Section A as in *purpureipes* Aitken, 1941, *muelleri* Dyar, 1920, and *monticola* Belkin & McDonald, 1957 from the New World. With more detailed study of the larvae, more reliable characters may be discovered.

Many of the subgenera of *Aedes* appear to be heterogeneous complexes of superficially similar forms, and it is very probable that they will have to be subdivided into smaller natural groups. Many of the present discrepancies have arisen from placing too much reliance on adult characters, such as general ornamentation, length of male palpus, character of claws, and secondary development in the male genitalia. The adults show many good characters, but these need to be studied in much greater detail than has been done in the past in order to distinguish between true affinities and parallel development in unrelated forms, particularly in the scalation and chaetotaxy. The female genitalia have not been studied in sufficient detail to evaluate their usefulness in showing affinities. In the male I find that the phallosome and the proctiger complex, and to a lesser extent the basal mesal derivatives of the sidepiece (claspette and homologs) and the clasper, are the most reliable group characters, while the various other developments of the sidepiece (lobes, hairs, scales) are largely of diagnostic specific value only. I have not been able to find reliable subgeneric characters in the pupal stage; I have not studied this stage very thoroughly, however, and it is possible that good characters exist. It appears at present that the pupal chaetotaxy at least is fairly uniform throughout the genus and that parallel adaptive changes occur in unrelated groups. The larval stage promises to be of great value in establishing affinities, but unfortunately it is usually described in most superficial terms. The great variety of larval types in several subgenera has been noted repeatedly, but this has been interpreted in general as indicative of adaptive specializations and not of the existence of diverse stocks within the groups. While the larva may show many adaptive features, it appears to be very conservative in others; because of this, it is of value both in the diagnosis of species and in determining affinities.

A striking feature of the *Aedes* fauna of the South Pacific is the preponderance of breeders in small water containers. Few of the islands have suitable habitats for general ground pool-breeders. The small container-breeders appear to have a limited flight range, and this feature has undoubtedly contributed to the development and preservation of numerous species in the area. The indigenous species of *Aedes* in the South Pacific belong largely to the most primitive subgenera and the most primitive groups within subgenera; in other words, the fauna is composed of relict groups and relict species.

BIONOMICS AND DISEASE RELATIONS.—*Aedes* species breed exclusively in temporary or fluctuating collections of water on the ground, in plants and plant parts, and in artificial containers and utilize the entire range of habitats known for the tribe. Females of many species attack man readily, some during the day, others at night.

The genus is of great economic importance since it includes vectors of yellow fever, dengue, encephalitides, and filariasis and, in addition, many species of pest mosquitoes. In the South Pacific, members of the *scutellaris* group, the *kochi* group, and *vigilax* are vectors of nonperiodic filariasis. Several other species are more or less serious pests at least locally, notably *australis, notoscriptus, antipodeus, longiforceps, nocturnus, imprimens, lineatus,* and *carmenti.*

DISTRIBUTION (fig. **205, 206**).—*Aedes* is worldwide in distribution but is poorly represented in the Neotropical region. The majority of the described subgenera occur in the Indomalayan, Oriental, and Australasian regions. In the South Pacific 71 species in 12 and possibly 13 subgenera are found; one or more indigenous species of the genus are represented in all the major subdivisions of the area except the Marquesas.

KEYS TO SUBGENERA

See keys to tribe Aedini, pp. 318–321

Subgenus HALAEDES Belkin, n. subg.

TYPE SPECIES.—*Culex australis* Erichson, 1842, Tasmania. INCLUDED SPECIES.—*A.* (*H.*) *australis* and the following nominal species here considered to be synonyms of *australis:* **A.* (*Ochlerotatus*) *ashworthi* Edwards, 1921, Western Australia; *Caenocephalus concolor* Taylor, 1914, New South Wales; **Culex crucians* Walker, 1856, Tasmania; **Culicada tasmaniensis* Strickland, 1911, Tasmania.

1914. *Caenocephalus* Taylor, Roy. Ent. Soc. London, Trans. 1913(61):700. TYPE SPECIES: *C. concolor* Taylor, 1914, New South Wales; monobasic.—Preoccupied by *Caenocephalus* v. der Wulp, 1898.

Aedes (*Pseudoskusea*) in part of Edwards (1932:157); Stone, Knight, and Starcke (1959); and authors.

FEMALE.—*Head:* eyes distinctly separated above antennae; decumbent scales of vertex largely narrow; erect scales numerous, bristlelike in front; palpus about 0.2 of proboscis, distinctly 5-segmented, segment 5 small; antenna shorter than proboscis. *Thorax:* mesonotal scales narrow; acrostichals and dorsocentrals present; scutellum with narrow scales; paratergite with scales; pleural scaling extensive, scales all broad; pleural bristles numerous, a line of anterior median bristles on *mep. Legs:* tarsi dark-scaled; all claws with subbasal tooth. *Wing:* remigium with conspicuous bristles; alula with extensive marginal fringe. *Abdomen:* tergite I largely bare; laterotergite with small scale patch. *Genitalia:* segment VIII partially retracted; cercus short and broad.

MALE.—Essentially as in the female. *Palpus:* slightly shorter than proboscis; segments 4 and 5 long, widened; bristles numerous from middle of segment 3. *Antenna:* distinctly shorter; flagellar segments 12 and 13 elongate; flagellar bristles long but not numerous, chiefly dorsal and ventral. *Abdomen:* lateral hairs numerous but short.

MALE GENITALIA.—*Segment VIII:* narrowed at base. *Segment IX:* tergite long, poorly sclerotized, with small bristle-bearing lateral lobe; sternite well developed, with median patch of hairs. *Sidepiece:* elongate, simple; mesal membrane from base to apex. *Claspette:* present; short, rounded, bearing numerous specialized setae. *Clasper:* long, slender, widened in basal 0.6; spiniform apical, slender. *Phallosome:* aedeagus simple; ventral paramere long. *Proctiger:* strongly developed; basolateral sclerotization long; tergal area with 2 membranous lobes; paraproct with strong apical spine; cercal setae present.

PUPA.—*Cephalothorax:* hair 8-C caudad of level of trumpet base. *Trumpet:* short, broad; tracheoid developed at base. *Abdomen:* segment VIII very short; hairs 2,3-I approximated; 1-II short, removed from caudal margin; 1-III-VII short; 2-III-V only slightly mesad of hair 1; 2-VI-VII laterad of hair 1; 9-VI small, similar to 9-II-V, slightly dorsal; 4-VIII removed mesad. *Terminal Segments:* female cercus only slightly projecting. *Paddle:* very large, wider than segment VIII; margins without distinct spicules.

LARVA.—*Head:* broad; inner mouthbrushes filamentous; hair 4-C between level of hairs 5 and 6; 12,13-C approximated. *Antenna:* short, simple; without strong spicules; hair 1-A near middle. *Thorax:* hair 13-P not developed; 5-M poorly developed; 9-12-T removed cephalad and dorsad close to mesonotal hairs. *Abdomen:* hair 12-I present; 6-I-V strongly developed, branched; 6-VI short, multiple; 7-I strongly developed; 2-III-VI near hair 1. *Segment VIII:* comb a very large patch of small fringed scales; hair 2-VIII larger than 1-VIII; 4-VIII branched, near hair 3. *Siphon:* rather swollen; acus absent; pecten teeth closely spaced except those at base; hair 1-S large, multiple; valves small; trachea strongly swollen. *Anal Segment:* saddle incomplete, very small; submarginal spicules distinct; hair 1-X small, separate from saddle; 2-X multiple; 3-X single; ventral brush of 7 pairs of hairs, all on grid; gills represented by slight lobes.

SYSTEMATICS.—*A. australis* is so markedly different in the male and female from **multiplex* (Theobald 1903), the type species of *Pseudoskusea,* with which it has been associated in the past, that I believe it should be placed in a distinct subgenus. Since Taylor's *Caenocephalus* is preoccupied, I am proposing the subgenus *Halaedes* for *australis.*

The male genitalia of *Halaedes* have a distinct small claspette of a very generalized type, found elsewhere in the genus only in some species currently placed in *Aedimorphus.* The immature stages of *Halaedes* show several features in common with *Opifex.* I believe that *Halaedes* is an old relict line of *Aedes* which has been preserved in a highly specialized habitat.

DISTRIBUTION (fig. 209).—The subgenus is known only from the southern part of the Australian region and enters the South Pacific only in Lord Howe and Norfolk Islands.

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Aedes (Halaedes) australis (Erichson)

Figs. 209-211

1842. *Culex australis* Erichson, Arch. f. Naturgesch. 8(1):270. TYPE: lectotype ♂, Tasmania (Terr. Van Diem.), Schayer; selection of Mattingly and Marks, 1955:163 (BERLIN, 5986).

1856. *Culex crucians* Walker, Insecta Saundersiana Diptera 1:432. *TYPES: syntypes, ♀, Tasmania (Van Diemen's Land) (BMNH).—Synonymy with *australis* by Mattingly and Marks (1955:163).

1911. *Culicada tasmaniensis* Strickland, Entomologist 44:181. *TYPE: lectotype ♂ with genitalia mount, Tasmania, Nov. 21, 1910, Bancroft, 85; present selection (BMNH).—Synonymy with *crucians* by Edwards (1924:387).

1914. *Caenocephalus concolor* Taylor, Roy. Ent. Soc. London, Trans. 1913(61):700–701. TYPES: syntypes, ♂, ♀, Cronulla, New South Wales, from salt-water rock pool, Nov. 13, 1911, Mrs. J. B. Cleland (SYDN).—Synonymy with *australis* by Mattingly and Marks (1955:163).

1921. *Aedes* (*Ochlerotatus*) *ashworthi* Edwards, B. Ent. Res. 12:75–76. *TYPE: holotype ♂, Yallingup, Western Australia, Sept., 1914, J. H. Ashworth (BMNH).—NEW SYNONYMY.

Aedes (*Pseudoskusea*) *australis* of Mattingly and Marks (1955:163–166); Stone, Knight, and Starcke (1959).

Aedes (*Pseudoskusea*) *concolor* of Edwards (1924:387; 1926:113; 1932:158); Taylor (1934:19); Woodhill (1936); Woodhill and Pasfield (1941:208); Lee (1944*a*:75); Knight, Bohart, and Bohart (1944:26, 51).

Aedes (*Pseudoskusea*) *crucians* of Edwards (1924:387; 1932:158); Taylor (1934:19).

Aedes (*Pseudoskusea*) *ashworthi* of Edwards (1932:158); Taylor (1934:19); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 5.5 mm. *Proboscis:* 3.4 mm. *Forefemur:* 2.4 mm. *Abdomen:* about 3.33 mm. *Head:* eyes distinctly separated, a short frontal tuft of narrow pale scales as on vertex; decumbent scales of vertex all narrow except at sides, largely whitish or slightly yellowish, a more or less extensive patch or some scattered dark bronzy scales submedially toward orbital border; erect scales numerous, all dark, those in front long and very slender, bristlelike but with truncate apex, the occipital shorter and broader; sides with broad decumbent scales above, some intermediate with those on vertex, largely whitish or yellowish, a few scattered dark ones, scaling extending to lower surface; labium largely dark-scaled, ventral surface with scattered pale scales or indistinctly paler in basal 0.6 or more; palpus distinctly 5-segmented, segment 5 small but conspicuous, scaling all dark; antenna distinctly shorter than proboscis; torus with very conspicuous unusually long hairs and small broad scales; flagellum with short whorl bristles and uniform pile of very short hairs; flagellar segment 1 conspicuously different, without pile but with longer hairs, scales present, inconspicuous. *Thorax:* integument brown; mesonotal scales all narrow, moderately long, curved, largely bronzy but with scattered golden to white scales along usual lines and areas but not forming a pattern, most numerous in supraalar area and around prescutellar space; acrostichals and dorsocentrals numerous but rather short, all anterior bristles short;

scutellum with somewhat longer narrow pale scales on all lobes, midlobe with a few dark ones laterally; paratergite with a few pale and some dark broad scales mixed, chiefly in middle of lower surface; pleural scales all broad, both dingy white pale scales and iridescent dark as follows, (1) *apn* with both light and dark scales, (2) *ppn, ppl,* and *psp* scales all dark and numerous, (3) *ssp* scales few, all light, extending from *psp* scale patch against *stp* and lower *ppn,* (4) *stp* with large continuous scale patch in posterior half, scales largely dark except above, and a few below and in front, (5) *pra* scales largely light and below bristles, (6) *mep* scale patch very extensive, occupying most of the central area, scales largely light; *ppn* bristles usually about 4,5, *psp* and *pra* very numerous, anterior *mep* (lower) usually 4,5, strong. *Legs:* forecoxa largely dark-scaled; midcoxa largely dark-scaled, with pale scales in middle; hindcoxa largely pale-scaled in front; remainder of legs dark-scaled except as follows, usual indistinct paler areas at base and on lower and posterior surfaces of femora, apex of femora and tibiae with paler scales; all claws with subbasal tooth. *Wing:* dorsal scales all dark; plume scales linear; remigium with 3,4 long thin hairs; alula with extensive fringe of narrow and broad scales. *Haltere:* knob dark-scaled above, light-scaled below. *Abdomen:* tergite I without scales, rarely with a few scattered scales; laterotergite with small lateral patch of dingy white scales; tergites II-VII largely dark-scaled, with large dorsocentral basal patches of light scales, narrowed laterad and with only slightly and indefinitely indicated dorsal transverse basal pale bands; sternites II-III largely with dingy pale scales, dark-scaled on apical caudal angles. *Genitalia:* segment VIII partially retractile; cercus short and broad.

MALE.—Essentially as in the female. *Head:* all narrow scales of vertex light. *Palpus:* about 0.8–0.9 proboscis; segments 4 and 5 widened, usually curled up in dry specimens. *Legs:* femoral and tibial apical light areas more distinct; claws of foreleg and midleg enlarged, anterior member of pair with basal and submedian teeth, posterior with submedian only; claws of hindleg small, subequal, both with basal tooth. *Abdomen:* tergites II-VII with distinct transverse basal light bands, broader on proximal segments.

MALE GENITALIA (fig. **210**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe small, not prominent, with about 8 hairs; sternite apparently with slight lateral longitudinal apodeme, a group of 10 or more hairs in the middle. *Sidepiece:* moderately long and slender; no distinct basal tergomesal or apicotergal lobe developed, claspette small; broad scales and bristles on lateral and ventral surfaces; dorsal surface with short thin hairs from near base to apex, a few longer hairs apically; basal tergomesal area with extensive patch of lanceolate curved striated scales with long narrow base. *Claspette:* called basal lobe by Mattingly and Marks (1955:165) but evidently homologous with claspette of *Ochlerotatus, Mucidus, Finlaya, Stegomyia,* and so on; a short rounded sternal structure bearing numerous flattened curved hairs (or narrow scales) apparently without distinct striations. *Clasper:* moderately long, slender; widened in basal half; distal portion narrowed, usually with 2 slender subapical setae; spiniform rather short, moderately heavy, deeply inserted on apex. *Phallosome:* aedeagus short, rather broad, rounded apically, simple. *Proctiger:* paraproct with a single heavy apical spine; cercal setae usually 2 pairs.

PUPA (fig. **210**).—*Abdomen:* 3.98 mm. *Trumpet:* 0.54 mm. *Paddle:* 1.24 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately unevenly pigmented, darkened on numerous areas dorsally as well as ventrally. *Trumpet:* short and broad; rather strongly pigmented, base lighter. *Abdomen:* moderately unevenly pigmented, darkened in various areas on anterior tergites and intersegmental areas; float hair (1-I) with very thin numerous branches; majority of other branched hairs with very thin branches. *Paddle:* unusually large and broad; lightly pigmented except for darkened midrib, base, and external buttress; marginal spicules indistinct; hair 1-P very thin.

LARVA (fig. **211**).—*Head:* 1.02 mm. *Siphon:* 1.09 mm. *Anal Saddle:* 0.34 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Head:* strongly pigmented, darkened caudad; integumentary spicules very small, in close-set transverse rows; mental plate as figured; inner mouthbrushes simple; hair 1-C slender, short; 4-C short, thin, branched, nearer 6-C than 5-C. *Antenna:* rather short, slender, slightly swollen before middle; uniformly moderately pigmented; spicules not apparent but several minute ones usually present. *Thorax:* integument without distinct spicules; hairs 9-12-T placed far forward and dorsad. *Abdomen:* integument without distinct spicules; hair 6-VI a small multiple tuft. *Segment VIII:* comb scales very small and numerous, in a large patch; individual comb scales short, widened and bearing long spicules in a row apically. *Siphon:* short, index about 2.0–2.5; characteristically shaped as in figure; moderately to lightly pigmented, base and apex darkened; acus not developed; pecten of 2 types of teeth, those at base short and widely spaced, followed by 12–15 long teeth whose bases are contiguous; hair 1-S a considerable distance beyond pecten; trachea greatly expanded in siphon, black in color. *Anal Segment:* saddle very small, restricted to dorsoapical portion; marginal spicules small; hair 1-X not on saddle; ventral brush of 7 pairs of hairs, sometimes with additional unpaired hair, all on grid; gills slightly indicated.

MATERIAL EXAMINED.—12 specimens; 6 ♀; 3 ♂; 3 pupae; 3 larvae; no individual rearings.

SYSTEMATICS.—*A. australis* shows marked variation in size and apparently in the shape of the male palpus. These morphological variations, I suspect, may be owing to a large extent to the extreme environmental variations in the larval habitat. The small form, *concolor*, has been synonymized with *australis* (*crucians, tasmaniensis*) by Mattingly and Marks (1955:163–166), and I consider that *ashworthi* from Western Australia is probably also conspecific with *australis.*

Although the only specimens I have seen from the South Pacific are all females, these are so similar to *australis* from Australia that I am confident they belong to this species. The descriptions above of the other stages are based on material from Queensland.

BIONOMICS AND DISEASE RELATIONS.—*A. australis* breeds only in salt or brackish rock pools at or slightly above high-tide mark (Woodhill and Pasfield, 1941:208). Woodhill (1936) summarized the bionomics of *australis* and carried out extensive laboratory experiments. Larvae are extremely tolerant of salt; with gradual increase in salinity, adults have been produced from larvae reared in sea water with a salinity of 180 gms. per liter; larvae lived for 5 days in sea water containing 200 gms. per liter and withstood abrupt changes in the salinity of sea water from 10 to 105 gms. per liter and from 105 to 10 gms. per liter. Inseminated females readily laid fertile eggs without a blood meal when fed on fruit juices and reared as larvae on food rich in proteins and carbohydrates.

A. australis is considered to be an important pest in restricted localities. Females attack man readily. Heydon (*in* Woodhill, 1936:633) found *australis* to be a favorable host for the larva of *Dirofilaria* of dogs.

DISTRIBUTION (fig. **209**).—*Lord Howe Island. Norfolk Island.* Also widely distributed in *Australia* (New South Wales, Tasmania, Western Australia).

Subgenus GEOSKUSEA Edwards

1929. *Geoskusea* Edwards, B. Ent. Res. 20:341–342. *TYPE SPECIES: *Aedes fimbripes* Edwards, 1924, New Britain; original designation.—As subgenus of *Aedes*.

FEMALES.—*Head:* eyes touching above antennae, no frontal scales; decumbent scales of vertex all broad; erect scales numerous; palpus about 0.125–0.15 of proboscis, 5-segmented, segment 5 minute; antenna about as long as proboscis. *Thorax:* mesonotal scales all narrow; acrostichals and dorsocentrals very strongly developed; scutellum with narrow or broad scales or both; paratergite without scales or hairs; pleural scaling restricted; pleural bristles numerous; *mep* with hairs posteriorly near middle; metameron with short hairs. *Legs:* tarsi dark-scaled; claws without strong teeth but base usually with spicules. *Wing:* remigium with short hairs; alula with extensive marginal fringe of long hairs or hairlike scales. *Abdomen:* tergite I extensively scaled; laterotergite without scales. *Genitalia:* segment VIII large, without scales, largely retractile; cercus long, rather slender, without scales; 3 spermathecae, 1 enlarged.

MALES.—Essentially as in the females. *Palpus:* from 0.2 to 0.67 of proboscis. *Antenna:* distinctly shorter than proboscis; flagellar whorls long; flagellar segments 12 and 13 greatly elongate, together subequal to rest of flagellum. *Abdomen:* lateral hairs sparse, short.

MALE GENITALIA.—*Segment VIII:* reduced, narrowed at base; tergite with long median sclerotized lobe extending into caudal membrane. *Segment IX:* strongly developed but narrow; tergite poorly sclerotized, reduced at base, strongly developed caudally, with a pair of more or less distinct lobes bearing hairs and sometimes spiniforms; sternite very strongly developed, usually produced basad in the middle, with hairs. *Sidepiece:* elongate; with or without median tergomesal hairy lobe; no basal or apical lobes; no distinct mesal membrane. *Claspette:* not developed. *Clasper:* simple, elongate; spiniform apical, slender and long. *Phallosome:* aedeagus small, simple, poorly sclerotized; paramere well developed; basal piece small. *Proctiger:* small; basolateral sclerotization distinct; paraproct with simple short dorsal spine; cercal setae usually 2,3 pairs.

PUPAE.—*Cephalothorax:* hair 8-C at level of trumpet bases. *Trumpet:* moderately long; tracheoid at base. *Abdomen:* hairs 2,3-I approximated; 9-VI small, similar to 9-II-V. *Terminal Segments:* female cercus very prominent; male lobe very long. *Paddle:* marginal spicules indistinct or small; hair 1-P very long, single.

LARVAE.—*Head:* inner mouthbrushes filamentous; hairs 5,6-C very long, single to triple; 4-C very small, cephalad of 6-C; 4-7-C all caudad of antennal bases; 8-C long, single; 12,13-C widely separated. *Antenna:* long; spiculate. *Thorax:* 13-P not developed. *Abdomen:* hair 12-I present; 6-I,II, 7-I strongly developed; 6-III-VI moderate. *Segment VIII:* comb a very large patch of small fringed scales; hairs 2,4-VIII long, single. *Siphon:* moderate in length; acus present; joined by long stem; pecten long, teeth evenly spaced; hair 1-S beyond pecten; valves small; trachea well developed. *Anal Segment:* saddle small to very small, incomplete; marginal spicules inconspicuous, short and broad; hair 1-X not on saddle; 2-X multiple; 3-X single; ventral brush of 6 pairs of hairs, all on grid; gills short.

SYSTEMATICS.—*Geoskusea* is a clearly marked subgenus whose affinities are not evident. It shares a number of adult characters with *Levua* and *Rhinoskusea,* but this does not necessarily indicate close relationship. On the other hand, the resemblance with *Levua* is supported by the very similar pupae. These subgenera, as well as several others inhabiting crabholes, appear to be relict annectent types possibly produced through hybridization.

The subgenus has attracted very little attention in the past; including the forms described here, only 9 named species and 1 unnamed form are recognized at present. However, *Geoskusea* and other crabhole subgenera may prove to be very useful indicators of former land masses in the Indomalayan and Australasian regions. It is very probable that many unrecognized forms exist. Species in these subgenera have very restricted habitats, do not disperse widely, and may have been able to survive major geological upheavals in the past.

The five known South Pacific forms of *Geoskusea* fall into three groups: (1) the *fimbripes* group, represented by *becki* in the New Georgia group in the Solomons, (2) the *daggyi* group, represented by the nominate species in the New Hebrides and *perryi* on Guadalcanal and possibly the Russell group in the Solomons, and (3) the *longiforceps* group, represented by the nominate form throughout the Solomons and a probably distinct undescribed form restricted to Bougainville (sp. 5). In spite of the fact that these forms are very poorly known at present, their apparent relationships and distributions give us a clue to a former closer connection between the areas of the New Hebrides and the Solomons and indicate that the Solomons have had a complex geological history. There is a suggestion of the hybrid origin of at least 1 of the forms, the undescribed Bougainville form. With further study of the South Pacific species of *Geoskusea,* it may be possible to reconstruct the geological history of the area more clearly than with any other group of mosquitoes.

BIONOMICS AND DISEASE RELATIONS.—All species of *Geoskusea* whose immature stages are known utilize, for breeding and for resting, holes made by land crabs near the coast. When the crabholes are flooded, larvae and pupae may move out of the holes but usually remain in their immediate vicinity. The females of some species attack man readily, chiefly at night. All species seem to be very localized and are very seldom encountered without special search. Nothing is known of their disease relations.

DISTRIBUTION (fig. 212).—*Geoskusea* has been reported from Indonesia (*tonsus* Edwards, 1924; *kabaenensis* Brug, 1939), the Philippines (*baisasi* Knight & Hull, 1951), New Guinea and the Bismarcks (*fimbripes* Edwards, 1924), ? northern Australia (? *daliensis* [Taylor, 1916]), and from the Solomons and the New Hebrides in the South Pacific.

KEYS TO SPECIES

(Keys to tribe Aedini, pp. 318–321)

ADULTS

1. Scales of midlobe of scutellum all narrow . . . . . 4. *longiforceps*
Scales of midlobe of scutellum broad, at least at base 2
2(1). Midfemur without a postmedian patch of short thin hairs on lower anterior surface 3
Midfemur with a postmedian patch of short thin hairs on lower anterior surface . . . 4
3(2). Male sidepiece without median lobe . . . . . 5. Bougainville form
Male sidepiece with median lobe . . . . . 2. *daggyi*
4(2). Male hindtibia with only moderately long narrow outstanding scales on posterior surface; only midfemur with thin hairs . . . . . 3. *perryi*
Male hindtibia with very long thin hairs ventrad of longer scales on posterior surface; both forefemur and midfemur with thin hairs . . . . . 1. *becki*

MALE GENITALIA

1. Sidepiece without median lobe . . . . . 4. *longiforceps;* 5. Bougainville form
Sidepiece with a hairy median lobe 2
2(1). Median lobe of sidepiece only slightly projecting, with very long hairs proximally . . . . . 1. *becki*
Median lobe of sidepiece strongly projecting, with short hairs proximally 3
3(2). Outer dorsal margin of median lobe of sidepiece with long regular row of long differentiated setae . . . . . 2. *daggyi*
Outer dorsal margin of median lobe of sidepiece with long differentiated setae confined to apex . . . . . 3. *perryi*

PUPAE

(1. *becki,* 3. *perryi,* and sp. 5 not included)

1. Caudal border of tergite VII with long spinelike spicules; hair 9-VIII at least 4b . . . . . 2. *daggyi*
Caudal border of tergite VII without spinelike spicules; hair 9-VIII usually 2b (1–3) . . . . . 4. *longiforceps*

LARVAE

(1. *becki,* 3. *perryi,* and sp. 5 not included)

1. Hair 6-III double or triple, strongly developed; 6-I,II usually 3,4b . . . . . 2. *daggyi*
Hair 6-III usually single, poorly developed; 6-I-II usually single or double . . . . . 4. *longiforceps*

1. Aedes (Geoskusea) becki Belkin, n. sp.

Figs. 213, 214

TYPES.—*Holotype:* ♂ (JGF, 30) with genitalia slide (580828-5), Roviana, Solomon Islands, from crabhole in flooded swamp area, Jan. 1–10, 1944, J. G. Franclemont (USNM, 64777). *Paratypes:* 2 ♂ (JGF, 30) with genitalia slides (580828-4, 6), same data as holotype.—This species is dedicated to D. Elden Beck in recognition of his contributions to the knowledge of the mosquitoes of Guadalcanal.

FEMALE.—*Wing:* 2.5 mm. *Proboscis:* 2.1 mm. *Forefemur:* 1.55 mm. *Abdomen:* about 2.3 mm. Not definitely associated with male; in general very similar to *longiforceps*, from which it differs chiefly in the following characters. *Head:* almost entirely dark-scaled above, lateral light area very restricted above, no paler scales along orbital line; labium with more conspicuous and longer hairs; palpus more slender, slightly more than 0.15 of proboscis; antenna about as long as proboscis; torus with longer hairs. *Thorax:* acrostichals in 2 disdinct rows; midlobe of scutellum largely with small broad dark scales, a few narrow distally; pleural scaling darker; *ppn* with a few small broad dark scales and more numerous small dark hairs; *ppl* usually with a few small broad pale golden scales; *stp* scales less conspicuous, pale golden in color; *mep* scales pale golden; posterior *mep* hairs longer and more numerous. *Legs:* anterior surface of midfemur with large postmedian patch of short thin hairs extending ventrad to posterior surface; forefemur with similar but smaller hairs, chiefly on lower posterior margin; claws apparently without basal spicules. *Abdomen:* tergites without distinct basolateral pale spots; sternites with pale golden scales.

MALE.—Essentially as in the female. *Labium:* with very conspicuous hairs. *Palpus:* about 0.23 of proboscis. *Antenna:* about 0.75–0.80 of proboscis. *Legs:* thin hairs on forefemur and midfemur longer, more conspicuous and extensive than in female; upper posterior margin of forefemur with only a few widely spaced thin bristles in a single row; hindtibia with 15 or more very long strong bristles along entire upper anterior surface, with usual outstanding scales but longer than in *longiforceps* on upper posterior surface, about 20 very long thin bristles or hairs in distal 0.6 or more of lower posterior surface; anterior claw of foreleg with small basal and large submedian tooth, posterior with basal only; other claws apparently simple.

MALE GENITALIA (fig. 214).—As figured; diagnostic characters as in the key; very similar to *fimbripes*, apparently differing in distinctly shorter and wider sidepiece with more prominent median lobe. *Segment VIII:* tergite as in *longiforceps*. *Segment IX:* tergite much shorter than in *longiforceps*, lobes connected by very narrow transverse bar, closer together and less prominent, each with 2,3 short bristles. *Sidepiece:* relatively short and broad; length less than 3.0 width below lobe, outer outline sigmoid; dorsal surface without bristles to almost level of distal part of lobe; distal part of dorsal surface with long bristles; ventral surface with bristles and hairs throughout; scales very numerous laterally and ventrally on basal portion, less numerous on distal portion; a large tergomesal median lobe, produced into a conspicuous narrow process distally, with very dense covering of very long, apically curved hairs from base to apex on tergal portion and with a smaller sternal field extending from apex to about halfway basad. *Clasper:* moderately long, more or less cylindrical and without strong dorsoventral expansion; spiniform rather short and heavy. *Phallosome:* aedeagus small, simple, poorly sclerotized. *Proctiger:* paraproct with simple dorsal spine; cercal setae usually 2,3 pairs.

PUPA and LARVA.—Unknown.

MATERIAL EXAMINED.—3 ♀; 3 ♂; no immature stages.

SYSTEMATICS.—*A. becki* appears to be very similar to *fimbripes* Edwards, 1924 from New Britain but differs in the shorter sidepiece, which bears hairs basad of the lobe on the ventral surface and a more strongly developed median lobe in the male genitalia, in darker scaling of the head and abdomen and the presence of an extensive patch of slender hairs on the anterior and lower surface of the forefemur and midfemur in both sexes, and apparently in details of the bristling of the male hindtibia.

The sexes of *becki* are not definitely associated since there are no individual rearings. Therefore the females are not designated as allotype and paratypes. However, it is very likely that they are correctly associated, since the general morphology and coloration are similar to the males.

BIONOMICS AND DISEASE RELATIONS.—*A. becki* adults were either collected in crabholes or reared from immature stages found in crabholes. Nothing is known of the habits of the adults or their disease relations.

DISTRIBUTION (fig. 213).—*Solomon Islands:* Roviana. Not known elsewhere.

2. Aedes (Geoskusea) daggyi Stone & Bohart

Figs. **213-216**

1944. *Aedes* (*Geoskusea*) *daggyi* Stone and Bohart, Ent. Soc. Wash., Proc. 46:215–217. *TYPE: holotype ♂, Espiritu Santo, New Hebrides, from crabhole, July 24, 1943, R. H. Daggy (USNM, 56981).—All the paratypes from Solomons are *perryi* except for 1 ♀ *longiforceps.*

Aedes (*Geoskusea*) *daggyi* of Perry (1946:17); Iyengar (1955:28, in part); Laird (1956:82, in part); Rageau (1958*a*:877); Rageau and Vervent (1958:19); Stone, Knight, and Starcke (1959).
Aedes (*Geoskusea*) sp. of Knight, Bohart, and Bohart (1944:27).
Aedes (*Skusea*) ? *fimbripes* of Buxton and Hopkins (1927:101).

FEMALE.—*Wing:* 2.33 mm. *Proboscis:* 2.0 mm. *Forefemur:* 1.58 mm. *Abdomen:* about 2.08 mm. In general very similar to *longiforceps,* from which it differs chiefly in the following characters; apparently generally lighter in coloration, with dark scales and integument a lighter brown. *Head:* light scaling more extensive, usually light scales along orbital lines; labium with more conspicuous short hairs; palpus longer, about 0.18 of proboscis, with numerous long hairs; antenna about 0.8 of proboscis. *Thorax:* midlobe of scutellum with variable number of small broad scales, always present at base; pleural scaling more restricted, small hairs more numerous; *ppl* usually with 1,2 light scales; posterior hairs of *mep* more numerous and extensive but shorter. *Legs:* claws apparently all simple.

MALE.—Essentially as in the female. *Palpus:* about 0.2 of proboscis, apparently without long hairs. *Antenna:* same length as in female. *Legs:* upper posterior margin of foreleg with only a few widely spaced thin bristles in a single row; hindtibia as in *longiforceps;* claws apparently as in *becki.*

MALE GENITALIA (figs. **214, 215**).—As figured; diagnostic characters as in the key; very similar to *perryi,* from which it differs chiefly in the median lobe of sidepiece. *Segment VIII:* tergite as in *longiforceps. Segment IX:* tergite with rather narrow transverse median bridge between lobes; tergal lobe small, prominent, with 2,3 short bristles. *Sidepiece:* very long and slender, more than 8.0 as long as width proximad of lobe, outer outline sigmoid, bulging basad of lobe; dorsal surface without hairs or bristles except considerably distad of lobe; ventral surface with hairs in basal portion, with hairs and bristles in distal; scales largely restricted to lateral surface from base to apex; a large prominent tergomesal lobe with hairs on mesal surface, outer dorsal margin with a continuous row of thickened hairs from apex to about middle of hairy portion. *Clasper:* rather long, strongly widened in dorsoventral plane, with a subapical microseta; spiniform long, slender, tapered apically. *Phallosome:* aedeagus small, simple, poorly sclerotized. *Proctiger:* paraproct small, apical dorsal spine simple; cercal setae 2,3 pairs.

PUPA (fig. **215**).—*Abdomen:* 3.5 mm. *Trumpet:* 0.5 mm. *Paddle:* 0.67 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *longiforceps* and differing from it chiefly in the following; pigmentation of integument and hairs distinctly darker; integumentary sculpturing more distinct; caudal margin of abdominal tergite VII with long spinelike spicules; hair 9-VIII usually 6b(4–9); paddle spicules indistinct.

LARVA (fig. **216**).—*Head:* 0.75 mm. *Siphon:* 0.68 mm. *Anal Saddle:* 0.27 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *longiforceps* and differing chiefly in the following; pigmentation stronger throughout, hairs darker; majority of hairs stronger and with more branches; hair 5-C frequently triple; 7-C usually 8-12b; antenna usually uniformly pigmented, spicules longer; hair 6-I usually 3b, 7-I frequently 2b; 6-II usually at least 4b; 6-III,IV rather strong, usually 2,3b; comb scales strongly pigmented; siphon index about 2.0–2.5, pigmentation very dark, hair 1-S longer; anal saddle moderately to strongly pigmented; gills very short, rounded.

MATERIAL EXAMINED.—127 specimens; 64 ♀; 44 ♂; 4 pupae; 5 larvae; no individual rearings.

SYSTEMATICS.—*A. daggyi* is superficially very similar to *perryi* from the Solomons, with which it has been confused in the past. It differs from the latter most conspicuously in lacking short thin hairs on the midfemur and in the greater development and stronger and more numerous hairs on the median lobe of the male sidepiece.

The association of the sexes and the immature stages of *daggyi* is only presumptive since no individual rearings have been made. However, it is likely to be correct, as only 1 species seems to be present in the New Hebrides. There is not enough material from the different islands to determine whether or not local racial differences exist. Perry (1946:17) states that there are 2 "varieties," a freshwater and a saltwater; I can find no difference in the available material, which carries no indication as to its origin.

BIONOMICS AND DISEASE RELATIONS.—Immature stages as well as adults of *daggyi* have been collected in crabholes and lobsterholes near freshwater swamps or in brackish water near the ocean; occasionally immature stages have been found in temporary ground pools, probably flushed there from flooded crabholes. Females are said not to bite man (Perry 1946:17).

DISTRIBUTION (fig. **213**).—*New Hebrides:* Espiritu Santo; Ulilappa (small island south of Espiritu Santo); Pentecost; Efate. Not known elsewhere; specimens reported as *daggyi,* including most paratypes, from the Solomons are *perryi;* one female paratype is *longiforceps.*

3. Aedes (Geoskusea) perryi Belkin, n. sp.

Figs. 213, 214

TYPES.—*Holotype:* ♂ (JNB, 1281) with genitalia mount (580828-15), Naro village, Guadalcanal, Solomon Islands, from crabhole, Oct. 15, 1944, J. N. Belkin (USNM,64778). *Paratypes:* 3♂ (JNB, 1281) with genitalia mounts (580828-1, 2, 14), same data as holotype.—This species is dedicated to W. J. Perry in recognition of his contributions to the knowledge of the mosquitoes of the South Pacific.

Aedes (Geoskusea) daggyi in part of Stone and Bohart (1944:215–217, including all paratypes from Solomons except 1♀ *longiforceps*); Iyengar (1955:28); Laird (1956:82); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.42 mm. *Proboscis:* 2.08 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.0 mm. Not definitely associated with male; in general very similar to *longiforceps* and even more so to *daggyi,* differing from the latter chiefly in the following characters. *Head:* labium with even more conspicuous hairs; antenna nearly as long as proboscis. *Thorax:* midlobe of scutellum with nearly all scales broad; posterior hairs of *mep* longer, with a distinct caudal row of enlarged ones. *Legs:* midfemur with a patch of short hairs as in *becki* but patch smaller and hairs shorter.

MALE.—Essentially as in the female; differing further from male of *daggyi* as follows. *Palpus:* distinctly longer, about 0.22 of proboscis. *Legs:* hindtibia with a row of about 8–10 bristles on lower anterior surface, about 4,5 of the hairs greatly elongate; claws as in *becki.*

MALE GENITALIA (fig. **214**).—As figured; diagnostic characters as in the key; very similar to *daggyi* and differing from it chiefly in the following characters. *Sidepiece:* shorter and broader; length less than 8.0 width basad of lobe; median lobe shorter, its hairs less numerous and shorter, only 3 thickened apical hairs on outer dorsal margin, not continued as regular row basad.

PUPA and LARVA.—Unknown.

MATERIAL EXAMINED.—24♀; 13♂; **no immature** stages.

SYSTEMATICS.—*A. perryi* is superficially very similar to *daggyi* but is easily differentiated by the diagnostic characters given above. In several respects *perryi* is intermediate between *becki* and *longiforceps.* The development of the thin hairs on the midfemur in both sexes and of the elongate bristles on the hindtibia of the male are suggestive of *becki.*

The sexes of *perryi* are not definitely associated since no individual rearings were made. Therefore the females are not designated as allotype and paratypes. However, it is very likely that they are correctly associated, since the general morphology is similar to the males.

BIONOMICS AND DISEASE RELATIONS.—Adults of *perryi* have been collected several times in crabholes and once each in a night- and a day-biting collection. In every instance *longiforceps* was associated and was the dominant species. This species does not seem to be common on the north coast of Guadalcanal.

DISTRIBUTION (fig. **213**).—*Solomon Islands:* Guadalcanal; ? Banika (Russell). Not known elsewhere.

4. Aedes (Geoskusea) longiforceps Edwards

Figs. 213, 217, 218

1929. *Aedes* (*Skusea*) *longiforceps* Edwards *in* Paine and Edwards, B. Ent. Res. 20:315–316. *TYPE: holotype ♂, Kaylan, Cape Marsh, Pavuvu (Russell), Solomon Islands, from crabhole, Sept. 29, 1928, R. W. Paine (BMNH).

Aedes (*Geoskusea*) *longiforceps* of Edwards (1929*b*:341–342; 1932:159); Taylor (1934:19); Knight, Bohart, and Bohart (1944:27, 53); Iyengar (1955:28); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.75 mm. *Proboscis:* 2.25 mm. *Forefemur:* 1.78 mm. *Abdomen:* about 2.42 mm. *Head:* decumbent scales all broad, densely imbricate, largely dark, a pale patch laterally and sometimes a few paler scales caudad of ocular border; erect scales rather numerous, moderately long, all dark, largely restricted to posterior portion of vertex and to occiput but several in front caudad of orbital bristles, sometimes more numerous laterally; labium dark-scaled, with inconspicuous short hairs; palpus about 0.125 of proboscis, dark-scaled, segment 5 minute; antenna slightly shorter than proboscis; torus apparently with only a few hairs, no scales; flagellar segment 1 with a few broad elongate scales. *Thorax:* integument dark brown above, lighter on pleuron; mesonotum with rather dense vestiture of narrow bronzy scales, majority linear and curved, a few lighter, coppery to whitish scales on lateral prescutal line; all mesonotal bristles strongly developed, acrostichal and dorsocentral rows complete; scutellum with narrow scales, usually numerous on midlobe, very sparse on lateral; paratergite without scales or hairs; pleural scaling usually restricted to *ppn, stp,* and *mep,* apparently 1,2 broad translucent scales sometimes developed on *apn* and *ppl,* never on *psp;* pleural scales largely broad, small, and translucent, frequently replaced partially by short light hairs; *ppn* scales restricted to upper half, largely broad, beige or pale yellowish brown, some darker, a variable number of dark narrow scales along mesonotal border; *stp* scales broad, beige to whitish, usually in a large patch extending from upper part to lower caudal border, small hairs numerous; *mep* with small upper patch of broad beige to whitish scales; several light hairs near posterior portion of middle of *mep* extending to lower third, usually several short hairs in middle; metameron with numerous short hairs. *Legs:* coxae and trochanters with light bronzy to coppery scales, forecoxa sometimes with basal patch of light scales; remainder of legs largely dark-scaled except for usual pale-scaled areas ventrally and posteriorly on femora; apparently base of all claws with slender spicules, toothlike on foreleg and midleg. *Wing:* dorsal scales all dark; plume scales moderately long; remigium with 1,2 rather short hairs, sometimes not projecting beyond scales. *Haltere:* knob with light bronzy scales. *Abdomen:* tergite I with extensive dark scaling; laterotergite with hairs only; tergites II-VI largely dark-scaled, with inconspicuous basolateral area of pale scales, beige to dingy golden; tergite VII largely dark-scaled, without distinct basolateral pale-scaled area; sternites II-VI largely pale-scaled, beige to pale golden, darkened apically; sternite VII darker.

MALE.—Essentially as in the female. *Palpus:* about 0.2 of proboscis. *Antenna:* distinctly shorter than proboscis; flagellar whorls long; flagellar segments 12 and 13 greatly elongate, together subequal to rest of flagellum. *Legs:* forefemur with a line of moderately long thin bristles in a partial double row on basal part of dorsoposterior surface; claws of foreleg and midleg enlarged, both members of pair with subbasal tooth. *Abdomen:* tergite VII with distinct basolateral pale-scaled area; abdominal segments densely scaled, without very long bristles.

MALE GENITALIA (fig. 217).—As figured; diagnostic characters as in the key. *Segment VIII:* tergite with long median sclerotized lobe extending into caudal membrane. *Segment IX:* tergite long; tergal lobe small but prominent, with 2,3 bristles; sternite with a median sclerotization bearing 4,5 long hairs apically and 3,4 shorter hairs proximad. *Sidepiece:* very long and slender, concave mesally in proximal half, somewhat widened distally; scales restricted to lateral surface but extending from near base to near apex; basal tergomesal area with short, moderately slender hairs; no median lobe. *Clasper:* long, strongly widened in dorsoventral plane, without apparent hairs; spiniform long, slender, tapered to apex. *Phallosome:* aedeagus small, simple, poorly sclerotized. *Proctiger:* small; paraproct with simple dorsal spine; usually 3 pairs of cercal setae.

PUPA (fig. 217).—*Abdomen:* 2.8 mm. *Trumpet:* 0.45 mm. *Paddle:* 0.6 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly lightly pigmented; hairs lightly to moderately pigmented. *Trumpet:* uniformly moderately pigmented. *Abdomen:* uniformly lightly pigmented, darkened on anterior intersegmental sclerites; hairs moderately to rather strongly pigmented; tergite VII without spinelike spicules on posterior border; hair 9-VIII usually 2b (1–3b). *Paddle:* uniformly lightly pigmented, midrib and external buttress brighter and darker; dorsal surface, chiefly along external margin with small but distinct spicules.

LARVA (fig. **218**).—*Head:* 0.73 mm. *Siphon:* 0.75 mm. *Anal Saddle:* 0.3 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *daggyi;* possibly several species confused. *Head:* uniformly lightly to moderately pigmented, yellowish except for dark collar; hairs moderately to lightly pigmented; integumentary sculpturing not apparent; mental plate as figured; inner mouthbrushes very long, filamentous; hair 4-C very small and thin, cephalad of 6-C which is very long, single and thickened; 5-C long, usually double; 7-C usually 4,5b. *Antenna:* long, slender, slightly tapered apically; lightly to moderately pigmented, somewhat darkened apically; spicules small but distinct; hair 1-A premedian, usually double. *Thorax:* integument without distinct spiculation; small hairs poorly pigmented, large moderately to strongly; hair 6-I usually double, 7-I single; 6-II usually single, sometimes double; 6-III,IV usually single, weak. *Segment VIII:* comb of several rows of small poorly pigmented scales; scale in middle of posterior row trapezoidal, widened and fringed apically. *Siphon:* index about 2.5–3.0; integumentary sculpturing rather distinct; acus attached by long stem; moderately to strongly pigmented, darkened apically; pecten teeth usually 15–18, with large premedian tooth and sometimes smaller denticles proximad; hair 1-S beyond pecten, weak, usually 2,3b. *Anal Segment:* saddle incomplete, small, poorly pigmented; marginal spicules short, broad, apically fringed; hair 1-X not on saddle; ventral brush of 6 pairs of hairs, all on grid; gills rather long.

MATERIAL EXAMINED.—290 specimens; 83 ♀; 61 ♂; 46 pupae; 100 larvae; 19 individual rearings (18 larval, 1 pupal).

SYSTEMATICS.—*A. longiforceps* is strikingly different from all the other known species of *Geoskusea* in the absence of a hairy median lobe on the sidepiece of the male genitalia and in the possession of only narrow scales on the midlobe of the scutellum in both sexes. Other than the unique male type specimen, I have seen only 1 female from the Russell Islands; these appear to be quite similar to the specimens from Guadalcanal. The Roviana population differs considerably from the latter in having fewer and narrower scales on the midlobe of the scutellum and shorter hairs on the basal tergomesal area of the male sidepiece. The specimens of *longiforceps* from Bougainville are too few and in such a poor condition as to preclude comparison. At any rate, it is evident that *longiforceps* is a variable species. It is of interest that a form with practically identical male genitalia but with a patch of broad scales on the midlobe of the scutellum occurs on Bougainville (sp. 5) together with apparently typical *longiforceps.*

Since *longiforceps* appears to be the dominant species of *Geoskusea* in the Solomons, I have identified all the miscellaneous larvae of this subgenus from the Solomons as this species. It is very likely that among these are larvae of *becki* and *perryi,* but without individual rearings it is impossible to associate them with certainty. I have noted considerable variation in the larvae from Roviana as well as those from Bougainville but feel that it is not worthwhile to spend a great deal of time in an attempt to separate them.

BIONOMICS AND DISEASE RELATIONS.—On Guadalcanal, where *longiforceps* is the dominant *Geoskusea* of the north coast, the immature stages as well as the adults have been collected in the holes of land crabs. One collection of immature stages was made in a large temporary flood pool over an extensive field of crabholes; the larvae and pupae were concentrated over the submerged crabholes. Females of *longiforceps* bite man very readily on Guadalcanal. Both sexes were frequently collected in night- and more rarely in day-biting collections. In one military outpost on the northwest coast of Guadalcanal, *longiforceps* was the dominant night-biting mosquito and was reported as a pest of the first magnitude.

DISTRIBUTION (fig. **213**).—*Solomon Islands:* Bougainville; New Georgia; Roviana; Pavuvu; Banika; ? Florida; Guadalcanal. Not known elsewhere.

5. Aedes (Geoskusea) sp., Bougainville form

Fig. 213

Aedes (*Geoskusea*) *longiforceps* in part of wartime collections.

The majority of males with genitalia of the *longiforceps* type from Bougainville differ markedly from other *longiforceps* in the development of numerous broad scales on the midlobe of the scutellum, much as in *becki*, *perryi*, and *daggyi*. There are also several Bougainville females which appear to be close to *longiforceps* but have similar broad scutellar scales. At the same time, I have seen several apparently typical adult *longiforceps* from Bougainville. Among the larvae from Bougainville are several specimens which differ markedly from typical *longiforceps* from Guadalcanal and the New Georgia group.

It seems, therefore, that there are 2 *longiforceps*-like forms on Bougainville. The male genitalia of the broad-scaled type (the Bougainville form) differ from the Guadalcanal *longiforceps* in the greater development of the hairs of the tergomesal basal area of the sidepiece as well as in the presence of scales in the dorsoapical area. This form may prove to be a distinct species. Since there are no individual rearings, it is impossible to associate with certainty the stages and sexes of this form; it is left unnamed for the present. Material examined: 2 ♀; 6 ♂.

Subgenus FINLAYA Theobald

1903. *Finlaya* Theobald, Monog. Culicidae 3:281–283. TYPE SPECIES: *Culex kochi* Doenitz, 1901, New Guinea; the second of 2 included species, selection of Blanchard (1905:415).

1904. *Finlayia* Giles, J. Trop. Med. 7:366. TYPE SPECIES: automatically *C. kochi* Doenitz.—Invalid emendation.

1904. *Gualteria* Lutz *in* Bourroul, Mosq. do Brasil, Euculicidae, p. 4; 1905, Lutz, Imprensa Medica, São Paulo 13:65–67. TYPE SPECIES: (*G.*) *oswaldoi* Lutz *in* Bourroul, 1904, Brazil (specific name corrected); the first of 2 included species, selection of Brunetti (1914:61).

1904. *Danielsia* Theobald, Entomologist 37:78. *TYPE SPECIES: *D. albotaeniata* Leicester *in* Theobald, 1904, Malaya; monobasic.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Usually ornate. *Head:* eyes usually approximated above antennae; decumbent scales varied, narrow or broad; erect scales usually numerous and not restricted to occiput; clypeus bare; proboscis slender, length varied, longer or shorter than forefemur; palpus length varied, 0.12–0.7 of proboscis length, apparently usually 5-segmented, segments 1,2 more or less ankylosed, segment 5 minute. *Thorax:* scutellar scaling varied; *apn* scaling varied; paratergite bare or scaled, often scaled on lower surface; *pra* often with scales; acrostichals and dorsocentrals present or absent; lower *mep* bristles usually but not always absent. *Legs:* claws of foreleg and midleg toothed, those of hindleg simple. *Abdomen:* laterotergite usually completely scaled. *Genitalia:* segment VIII only slightly retracted, sternite large and usually at least somewhat compressed; cercus short; postgenital plate reaching to at least 0.6 of cercus (Knight and Marks, 1952:516).

MALES.—Essentially similar to the females. *Palpus:* from 0.5 to distinctly longer than proboscis; 5-segmented, segments 4 and 5 varied. *Legs:* anterior claws of foreleg and midleg with 1,2 teeth.

MALE GENITALIA.—*Segment IX:* varied. *Sidepiece:* mesal surface more or less membranous; basal tergomesal area frequently more or less distinctly differentiated; apical tergomesal lobe not developed; specialized setae or scales frequently developed on mesal or sternal surfaces. *Claspette:* basal mesal lobe of sidepiece developed as claspette; apically with a specialized seta which is usually developed as a filament or bladelike appendage. *Clasper:* simple; spiniform simple or rarely branched, apical or subapical. *Phallosome:* aedeagus simple, without denticles or spicules. *Proctiger:* paraproct strongly developed; cercal hairs 1 to several pairs.

PUPAE.—Subgeneric characters not apparent, as only a small percentage of species described.

LARVAE.—Extremely varied. *Head:* hairs 5,6-C never both very long *and* at the same time placed caudad of level of antennae. *Thorax:* metathoracic pleural group (9–12) normal. *Abdomen:* segment I with hair 12 developed. *Segment VIII:* comb frequently in a more or less triangular patch of several rows of scales; comb plate not developed. *Siphon:* acus usually developed. *Anal Segment:* saddle always incomplete; acus not developed; ventral brush of 4–6 pairs of hairs all on a grid or boss or in a group, no detached proximal hairs.

EGGS.—Laid above water surface in treeholes, rockholes, or leaf axils of plants.

SYSTEMATICS.—*Finlaya* as understood at present is a large heterogeneous assemblage of species of *Aedes,* characterized chiefly by the presence of a more or less well developed claspette and the absence of a prominent basal tergomesal lobe in the male genitalia and by the development of a large, only slightly retracted abdominal segment VIII and a short cercus in the female. There has been a tendency to include all plant container-breeding forms of *Aedes* in this subgenus, but it is evident that this habitat is shared by several distinct primitive lines in the genus. Over 200 species and subspecies of *Finlaya* are recognized at present from the world.

As pointed out most recently by Knight and Marks (1952:516–517), *Finlaya* shows numerous affinities with the subgenera *Ochlerotatus* and *Howardina* of *Aedes* and with the genus *Haemagogus.* The separation of *Finlaya* from all of these is rather tenuous, as annectent forms occur in both the Old and the New World.

Knight and Marks (1952) have catalogued and reclassified the subgenus and have excluded from

Finlaya some of the most disturbing elements. The groups these workers recognize within the subgenus are still based entirely on adult characters and often on very superficial features of ornamentation. I believe that a natural classification of *Finlaya* cannot be developed until the immature stages are carefully studied. It may be necessary to divide *Finlaya* into 2 or more subgenera when this is accomplished.

For the present I am following the classification of Knight and Marks for the South Pacific species of *Finlaya.* Four groups are represented in the area, as follows: (1) the *aureostriatus* group (D), represented by *rubiginosus* apparently from the Solomons; (2) the *mediovittatus* group (E), represented by the indigenous *albilabris* in the Solomons and the apparently introduced *notoscriptus* in New Caledonia and New Zealand; (3) the *alboannulatus* group (F), represented by *lauriei* on Lord Howe Island and *argyronotum, buxtoni,* and *roai* in the Solomons, all endemic; and (4) the *kochi* group (A), with 14 named species and 3 unnamed and several undescribed species occurring in the Solomons, Fiji, Samoa, and Tonga, all endemic.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of species of *Finlaya* are usually restricted to small water collections in plants and in rocks. They have been reported from treeholes, bamboo, fallen leaves, leaf axils and bracts of many species of plants, in *Nepenthes* pitchers, and in rockholes. Several species have been collected in artificial containers of various types and a few in ground pools, particularly in salt marshes or near the seacoast. In many species the aquatic cycle is prolonged, and the larvae of some species in temperate regions may hibernate for several months.

The females of relatively few species attack man. The populations of many species are relatively small and attract little attention. As a result, the subgenus as a whole does not appear to be of significant economic importance, although a few species may become serious pests. Several species are crepuscular or nocturnal in biting activity. The normal hosts for blood meals are unknown, but it is likely that birds and arboreal mammals may be the principal ones. Very little work has been done on the disease relations of *Finlaya.* Several species have been shown to be capable of transmitting encephalitis viruses (Horsfall, 1955:37–39). Some members of the *kochi* group are involved in the transmission of human filariasis.

DISTRIBUTION (fig. 219).—*Finlaya* is nearly worldwide in distribution, but the majority of species are found in the Oriental and Indomalayan regions. In the South Pacific the subgenus occurs naturally in the Solomons, Fiji, Samoa, and possibly Tonga, and it is probable that it will be found also in the Santa Cruz group. It has not been found in the New Hebrides, and the one species (*notoscriptus*) occurring in New Caledonia and New Zealand may be a human introduction.

KEYS TO SPECIES

(Keys to tribe Aedini, pp. 318–321)

ADULTS

1. Wing scales all dark above 2
   Wing scales usually in a distinct pattern of light and dark spots or largely light . . . 8

2(1). Median anterior portion of mesonotum without contrasting pattern or with only narrow longitudinal silvery or golden lines . . . 3
   Median anterior portion of mesonotum largely silvery or with a broad median longitudinal golden or silvery line 5

AUREOSTRIATUS GROUP

3(2). Proboscis without submedian light ring; median anterior portion of mesonotum without distinct contrasting pattern; midfemur without median longitudinal light line . . . . 1. *rubiginosus*
   Proboscis with submedian light ring; median anterior portion of mesonotum with distinct silvery or light golden line or lines; midfemur with median longitudinal silvery line 4

MEDIOVITTATUS GROUP

4(3). A small but distinct group of silvery scales at the lower caudal portion of the patch of dark scales on *ppn;* prescutal lateral silvery line always connected to posterior dorsocentral silvery line; patch of silvery scales in front of wing root strongly developed; female labium dark-scaled dorsoapically . . . . 2. *notoscriptus*
   Upper part of *ppn* with all scales dark, including those toward lower caudal portion of

patch; prescutal lateral silvery line usually not connected to posterior dorsocentral line, rarely broadly connected; patch of silvery scales in front of wing root usually represented by only 1–3 narrow scales; female labium usually with a more or less extensive white-scaled patch dorsoapically . . . . 3. *albilabris*

ALBOANNULATUS GROUP

5(2). Anterior part of mesonotum with a median longitudinal wedge-shaped stripe and a pair of humeral spots, all golden . . . 4. *lauriei*
Anterior part of mesonotum either almost completely silvery white or with a broad median longitudinal stripe of silvery scales 6

6(5). Hindtarsus with basal white rings on segments 1–3 only . . . . 5. *roai*
Hindtarsus with basal white rings on segments 1–5 7

7(6). Anterior part of mesonotum almost entirely silvery white; *ppn* with narrow scales only . . . . 6. *argyronotum*
Anterior part of mesonotum with broad median longitudinal silvery white stripe not reaching dorsocentrals laterally; *ppn* scales predominantly broad . . . . 7. *buxtoni*

KOCHI GROUP

8(1). Tibiae largely white-scaled; dorsal wing scales almost all white, no distinct pattern . . . . 22. Fiji albino form
Tibiae with contrasting dark and light scales; dorsal wing scales in contrasting pattern of dark and light scales 9

9(8). Hindtarsal segment 1 almost entirely yellow or white on lower surface, without complete dark rings; haltere largely light-scaled 10
Hindtarsal segment 1 predominantly dark on all surfaces, with complete broad dark rings separated by light rings; haltere largely dark-scaled 14

10(9). Hindtarsal segment 4 usually completely black . . . . 9. *burnetti*
Hindtarsal segment 4 with at least some yellow scales ventrally or white scales apically 11

11(10). Femora with very poorly developed subapical tufts of outstanding scales, midfemoral tuft with no scales as long as width of femoral shaft . . . . 12. *freycinetiae*
Femora with strongly developed subapical tufts of outstanding scales, midfemoral tuft with several scales at least as long as width of femoral shaft 12

12(11). Hindtarsal segment 4 always with a large preapical dorsal patch of dark scales in addition to basal dark ring, sometimes dorsal surface almost completely dark; midtarsal segment 4 with large basal dark band . . . . 14. *fuscitarsis;* . . . . 21. *solomonis* from Bougainville
Hindtarsal segment 4 usually with dark scales restricted to basal ring, rarely with a few preapical dark scales; midtarsal segment 4 usually without basal dark scales 13

13(12). *Female:* labium dark-scaled to well beyond apex of palpus, latter with only a few apical white scales and a few light scales elsewhere; *male:* labium largely dark-scaled in distal half, palpal segment 4 with numerous dark scales . . . . 13. *fuscipalpis;* . . . . 21. *solomonis* from Bougainville
Female: labium usually with dark scaling not extending to apex of palpus dorsally, latter with numerous apical white scales and usually light scales elsewhere; *male:* labium largely light-scaled in distal half, palpal segment 4 with few or no dark scales . . . . 21. *solomonis*

14(9). Pale scales of mesonotum all pure white . . . . 10. *fijiensis*
At least some of the pale scales of mesonotum dingy white, pale golden, yellowish, or light coppery 15

15(14). Hindtarsal segments 2 and 3 with basal dark scaling extending to 0.75 or more 16
Hindtarsal segments 2 and 3 with basal dark scaling not extending much beyond 0.6 17

16(15). Vein C distad of subcostal dark area with an extensive preapical dark area . . . . 16. *knighti*
Vein C distad of subcostal dark area almost entirely light, with only a small preapical dark spot . . . . 23. Guadalcanal form

17(15). Prehumeral pale spot of vein C not at all developed, humeral pale spot small or large 18
Prehumeral pale spot of vein C more or less developed, sometimes fused with humeral so that base of C is predominantly light 20

18(17). Accessory subcostal light area strongly developed, extensive on veins C and R_1 . . . . 24. Malaupaina form
Accessory subcostal light area poorly developed, usually small on vein R_1 and not developed on C 19

19(18). Vein R before humeral crossvein usually entirely dark, sometimes with a few light scales at base . . . . 15. *hollingsheadi*

Vein R before humeral crossvein usually pale-scaled in basal 0.3 . . . . 18. *oceanicus*

20(17). Wing dark; base of vein C usually predominantly dark, accessory subcostal pale area not developed on vein C and usually small on R_1; preapical femoral scale tufts poorly developed . . . . 8. *bougainvillensis;* . . . . 17. *neogeorgianus;* 20. *schlosseri*

Wing extensively pale; base of vein C predominantly light, accessory subcostal pale area extensive on vein C as well as R_1; preapical femoral scale tufts strongly developed 21

21(20). *Female:* labium with dingy white or light yellowish ring; *male:* labium with broad light ring . . . . 11. *franclemonti*

Female: labium with pure white ring, sometimes with yellowish scales at ends; *male:* labium with very narrow light ring . . . . 19. *samoanus*

MALE GENITALIA

(7. *buxtoni* and sp. 22–24 not included)

1. Aedeagus not mushroom-shaped in outline in dorsal aspect, apex at most gradually and slightly widened, frequently produced 2

Aedeagus mushroom-shaped in outline in dorsal aspect, apex usually suddenly widened and broadly rounded or emarginate . . . 6

2(1). Clasper very short, less than 0.33 of sidepiece; latter very long and narrow 3

Clasper moderate or long, usually about 0.5 of sidepiece or distinctly longer; latter moderately long and wide 4

AUREOSTRIATUS and MEDIOVITTATUS GROUPS

3(2). Aedeagus relatively short and broad, widest beyond middle; sidepiece with very long striated scales on sternomesal border and on basal tergomesal area . . . . 1. *rubiginosus*

Aedeagus long and narrow, widest at or before middle; sidepiece without long striated scales on sternomesal border or on basal tergomesal area . . . . 2. *notoscriptus;* . . . . 3. *albilabris*

ALBOANNULATUS GROUP

4(2). Sternomesal margin of sidepiece with long striated scales; tergite IX with distinct bristle-bearing lobe; spiniform of clasper bifid . . . . 5. *roai*

Sternomesal margin of sidepiece without long striated scales; tergite IX without bristles or distinct lobe; spiniform of clasper simple 5

5(4). Appendage of claspette with sharply produced basal angle; basal tergomesal area of sidepiece without fingerlike process . . . . 4. *lauriei*

Appendage of claspette with smoothly rounded basal angle; basal tergomesal area of sidepiece with small fingerlike process . . . . 6. *argyronotum*

KOCHI GROUP

6(1). Clasper with 1-3 subapical hairs almost as long as the spiniform . . . . 10. *fijiensis*

Clasper with minute subapical setae 7

7(6). No specialized seta on lower portion of mesal surface of sidepiece . . . . 16. *knighti*

A specialized curved or bent seta arising from a distinct tubercle on lower portion of mesal surface of sidepiece 8

8(7). Specialized basal mesal seta hairlike, slender, smoothly curved, at most slightly flattened distally 9

Specialized basal mesal seta not hairlike, distinctly flattened, expanded, widened or angled before apex 10

9(8). Middle of tergal surface of sidepiece with large patch of long bristles, middle of mesal surface with patch of long hairs distad of basal tergomesal area . . . . . 19. *samoanus*

Middle of tergal and mesal surfaces of sidepiece without such patches of bristles and hairs . . . . 12. *freycinetiae*

10(8). Basal tergomesal area of sidepiece with some long scales or differentiated heavy bristles at base, longer and distinctly different from the more mesal hairs 11

Basal tergomesal area of sidepiece without differentiated bristles or scales at base . . . 13

11(10). Basal tergomesal area with a patch of very long striated scales at base . . . . 11. *franclemonti*

Basal tergomesal area with differentiated bristles or only a few flattened but no striated long scales 12

12(11). Appendage of claspette with strong crest with acute basal angle; middle of tergal surface of sidepiece with numerous long hairs; spiniform less than 0.5 of clasper length . . . . 13. *fuscipalpis*

Appendage of claspette with very inconspicuous, smoothly rounded, thin expanded portion; middle of dorsal surface of sidepiece with less numerous shorter hairs; spiniform more than 0.6 of clasper length . . . . 14. *fuscitarsis*

13(10). Mesal surface of sidepiece with a distinctly differentiated patch of long straight hairs dorsad of inner sternal scales, very different in appearance from adjacent hairs . . . 14

Mesal surface of sidepiece with hairs dorsad of inner sternal scales not strikingly differentiated from adjacent hairs, may be straight or curved 16

14(13). Distal portion of basal tergomesal area with hairs sparse, the most mesal usually strongly differentiated . . . . 21. *solomonis*

Distal portion of basal tergomesal area with hairs very dense, the most mesal not markedly differentiated 15

15(14). Specialized basal mesal seta very large; clasper strongly swollen . . . . 9. *burnetti*

Specialized basal mesal seta small; clasper only slightly swollen . . . . . . 18. *oceanicus*

16(13). Median portion of tergal surface of sidepiece with hairs restricted to distal half . . . . 15. *hollingsheadi*

Median portion of tergal surface of sidepiece with hairs continued in basal half toward base of basal tergomesal patch 17

17(16). Most mesal distal hairs of the basal tergomesal patch with very broad bladelike apical expansions; median portion of tergal surface of sidepiece with basal hairs in a single row . . . . 20. *schlosseri*

Most mesal distal hairs of the basal tergomesal patch with simple or lanceolate tips; median portion of tergal surface of sidepiece with basal hairs in 2,3 rows 18

18(17). Most mesal distal hairs of basal tergomesal patch with simple apices . . . . 8. *bougainvillensis*

Most mesal distal hairs of basal tergomesal patch with distinctly lanceolate tips . . . . 17. *neogeorgianus*

PUPAE

(1. *rubiginosus*, 4. *lauriei*, 5. *roai*, 7. *buxtoni*, and sp. 22–24 not included)

1. Hair 1-C short, usually about length of trumpet or less, about same order of magnitude as hairs 2,3-C 2

Hair 1-C long, usually 2.0 length of trumpet and at least 2.0 length of hairs 2,3-C . . . 4

ALBOANNULATUS GROUP

2(1). Hair 6-VII strong, usually with 4 or more primary branches and inserted near caudolateral angle . . . . 6. *argyronotum*

Hair 6-VII weak, usually with less than 4 primary branches and removed from caudolateral angle 3

MEDIOVITTATUS GROUP

3(2). Paddle margins with distinct and numerous spicules; hair 1-III usually single or double . . . . 2. *notoscriptus*

Paddle margins without spicules or with a few scattered small spicules; hair 1-III usually at least 3b . . . . 3. *albilabris*

KOCHI GROUP

4(1). Integument with sharply contrasting median dark streak on mesonotum, metanotum, and abdominal tergites I-IV 5

Integument with more diffuse color pattern, without sharply marked dorsal median dark streak 7

5(4). Mesonotal and metanotal dark areas uniformly pigmented, without clear unpigmented spots; trumpet uniformly dark . . . . 11. *franclemonti*

Mesonotal and metanotal dark areas with clear unpigmented spots; apical portion of trumpet lighter than basal 6

6(5). Caudal border of dark streak on each of abdominal tergites II-IV with a pair of clear unpigmented spots . . . . 21. *solomonis*

Caudal border of dark streak of abdominal tergites II-IV without clear unpigmented spots . . . . 13. *fuscipalpis*

7(4). Abdominal tergites II-IV each with 1 or more pairs of unpigmented submedian spots 8

Abdominal tergites without clear unpigmented spots 10

8(7). Abdominal tergites II-IV each with 1 pair of clear unpigmented spots at caudal border; mesonotum with 4 or more pairs of clear unpigmented sopts . . . . 14. *fuscitarsis*

Abdominal tergites II-IV each with 1,2 pairs of clear unpigmented spots cephalad of caudal border; mesonotum with 1,2 pairs of clear unpigmented spots 9

9(8). Abdominal tergites II-IV each with 1 pair of clear unpigmented spots distad of middle; mesonotum with 2 pairs of clear unpigmented spots . . . . 9. *burnetti*

Abdominal tergites II-IV each with 2 pairs of clear unpigmented spots, the proximal larger; mesonotum with 1 pair of clear unpigmented spots . . . . 12. *freycinetiae*

10(7). Mesonotum without clear unpigmented streaks or spots . . . . 19. *samoanus*

Mesonotum with clear unpigmented streaks or spots 11

11(10). Mesonotum with 1 pair of longitudinal clear unpigmented streaks near midline 12

Mesonotum with 1 or 2 pairs of small, more lateral clear unpigmented spots 13

12(11). Mesonotal clear streaks very long, connected in front on pronotum and separated by

poorly pigmented area on mesonotum . . . . 8. *bougainvillensis*
Mesonotal clear streaks not extending to pronotum and not connected, separated on mesonotum by strongly pigmented area . . . 10. *fijiensis*

13(11). Mesonotum with 2 pairs of clear unpigmented spots 14
Mesonotum with only 1 pair of clear unpigmented spots 15

14(13). Metanotum with 1 pair of distinct lateral clear unpigmented spots . . . . 17. *neogeorgianus*
Metanotum without clear unpigmented spots, at most an indefinitely paler lateral area . . . 20. *schlosseri*

15(13). Metanotum without clear unpigmented spots . . . . 16. *knighti*
Metanotum with 1 pair of lateral clear unpigmented spots 16

16(15). Mesonotal and metanotal clear unpigmented spots small . . . . 15. *hollingsheadi*
Mesonotal and metanotal clear unpigmented spots large . . . . 18. *oceanicus*

LARVAE

(1. *rubiginosus,* 5. *roai,* 7. *buxtoni,* 19. *samoanus,*
and sp. 22–24 not included)

1. Thorax and abdomen without conspicuous stellate hairs 2
Thorax and abdomen with conspicuous stellate hairs 5

2(1). Head hair 1-C heavy and sharply hooked mesad beyond middle; hair 5-C single 3
Head hair 1-C slender, attenuate and straight or smoothly curved; hair 5-C multiple . . 4

MEDIOVITTATUS GROUP

3(2). Acus of siphon large and broadly joined to siphon . . . . 2. *notoscriptus*
Acus of siphon small, usually detached, rarely narrowly joined to siphon . . . 3. *albilabris*

ALBOANNULATUS GROUP

4(2). Head hair 6-C far cephalad of 5,7-C . . . . 4. *lauriei*
Head hair 6-C more or less in line with 5,7-C . . . . 6. *argyronotum*

KOCHI GROUP

5(1). Head hair 14-C very small, single or double 6
Head hair 14-C large, multiple, stellate . . 7

6(5). Head hair 4-C single, 6-C usually double; hair 1-X usually double . . 11. *franclemonti*
Head hairs 4,6-C usually 3,4b; hair 1-X usually 3,4b . . . . 16. *knighti*

7(5). Head hairs 4,6,7-C not in a straight diagonal line, hair 4-C distinctly caudad or at about level of hair 6-C 8
Head hairs 4,6,7-C usually in a more or less straight diagonal line, hair 4-C usually distinctly cephalad of 6-C and in line with 6,7-C 11

8(7). Abdominal hair 1-III-V with a few uneven branches, the longest more than twice as long as hairs 2,3 of corresponding segments; hair 13-II-V usually double or triple . . . 9
Abdominal hair 1-III-V stellate and with numerous branches of same order of magnitude as hairs 2,3 of corresponding segments or slightly longer; hair 13-II-V usually at least 4b 10

9(8). Prothoracic hair 2-P only slightly longer than longest branch of 1,3-P; hair 7-P usually double . . . . 9. *burnetti*
Prothoracic hair 2-P almost twice as long as longest branches of 1,3-P; hair 7-P usually triple . . . . 12. *freycinetiae*

10(8). Anal hair 1-X usually 2,3b; abdominal hair 6-III-V usually 2,3b; siphon uniformly densely short-spiculate . . . . 10. *fijiensis*
Anal hair 1-X usually at least 4b; abdominal hair 6-III-V usually at least 4b; siphon largely bare or with short spicules in patches . . . . 18. *oceanicus*

11(7). Abdominal hair 7-II at least 4b . . . . 21. *solomonis*
Abdominal hair 7-II usually double 12

12(11). Mesothoracic hair 14-M poorly developed, usually 6b or less 13
Mesothoracic hair 14-M a strongly developed stellate tuft, usually at least 12b 14

13(12). Prothoracic hair 2-P about twice as long as longest branch of 1-P; hair 7-P usually 2,3b, about half as long as 5-M; hair 6-M at least 4b . . . . 13. *fuscipalpis*
Prothoracic hair 2-P shorter than or subequal to longest branch of 1-P; hair 7-P single or with very short basal branch, almost as long as 5-M; hair 6-M usually 2,3b . . . . 14. *fuscitarsis*

14(12). Siphon index 3.0 or less . . 15. *hollingsheadi*
Siphon index 3.5 or more 15

15(14). Siphon inconspicuously short-spiculate . . . . 20. *schlosseri*
Siphon conspicuously long-spiculate 16

16(15). Mesothoracic hair 6-M at least 4b . . . . 8. *bougainvillensis*
Mesothoracic hair 6-M single or double . . . . 17. *neogeorgianus*

AUREOSTRIATUS GROUP

1. Aedes (Finlaya) rubiginosus Belkin, n. sp.

Figs. **220, 235**

TYPES.—*Holotype:* ♂ with genitalia slide (G-29A, 570523-12), ? Guadalcanal, Solomon Islands, ? Nov.–Dec., 1943, ? A. B. Gurney, leg. W. J. Perry (USNM, 64779). *Allotype:* ♀ (ABG, 52), Guadalcanal, Solomon Islands, Nov. 20, 1943, A. B. Gurney (USNM). *Paratypes:* 1 ♀ (G-29A), 1 ♂ with genitalia slide (G-29A, 570523-11), 1 ♂ (G-36), all apparently with same data as holotype.

FEMALE.—*Wing:* 3.58 mm. *Proboscis:* 2.7 mm. *Forefemur:* 2.47 mm. *Abdomen:* about 2.65 mm. *Head:* decumbent scales of dorsum of vertex all narrow, very sparse except along orbital border where they are very dense, all pale golden except a few bronzy ones caudad of orbital line; erect scales very long and very numerous, dark brown; lateral decumbent scales broad but elongate, whitish; clypeus bare; proboscis and palpus dark-scaled; torus of antenna with hairs only; flagellar segment 1 with a few dark scales. *Thorax:* integument rather light rusty brown throughout; mesonotum with a very sparse vestiture of short narrow curved dark bronzy scales and a very inconspicuous pattern of very light golden narrow scales as follows, (1) a few at extreme anterior end of median anterior promontory followed by a few scattered scales caudad on acrostichal line, (2) a pair of rather extensive sparse patches at humeral angles, (3) a pair of rather broad curved fossal lines from scutal angle to dorsocentral lines, (4) a few scattered scales between the humeral and fossal lines, (5) a few scattered scales on dorsocentral lines caudad of fossal lines, (6) a pair of small patches of somewhat deeper golden scales in front of wing roots continued into supraalar areas where scales are lighter, (7) a few scales around prescutellar space; scutellum with flat broad but elongate silvery scales on all lobes; paratergite with very inconspicuous translucent whitish scales below; *apn* with sparse, rather broad light golden scales; *ppn* with a very few dark bronzy narrow curved scales in extreme upper part, similar to those on mesonotum, 1,2 lighter scales may be present; *ppl* with a small patch of broad translucent silvery scales below bristles; *stp* with rather large upper and posterior caudal patches of broad translucent silvery scales; *pra* with a very inconspicuous small patch of broad translucent silvery scales below bristles; *mep* with a long dorsoventral patch of broad translucent silvery scales; other pleural areas without scales; acrostichals and dorsocentrals in complete rows, numerous; *ppl* bristles continued as a long row on *pst;* lower *mep* bristles absent. *Legs:* coxae with light scales, forecoxa with some dark scales; forefemur with some pale scales dorsally at base and a few beyond, ventral and posterior surfaces light-scaled, a few light scales on apex, remainder dark; midfemur light at base and apex, ventral surface light, posterior surface light near base, remainder dark; hindfemur light at base and apex, anterior surface with broad light streak extending to about middle and continued as narrower streak or scattered light scales beyond, lower surface light throughout, posterior surface light on about basal half, remainder dark; tibiae largely dark, apex and lower surface lighter; tarsi dark except for silvery markings as follows, (1) foretarsal and midtarsal segments 1–3 narrowly at base, very restricted on 3, segment 1 with a few silvery scales on apex, (2) hindtarsal segments 1–4 broadly at base and a few silvery scales on apex of 1–3, segment 5 entirely silvery. *Wing:* entirely dark-scaled. *Haltere:* knob largely dark-scaled, a few light scales at base anteriorly. *Abdomen:* tergites dark-scaled, brown with violet reflections and with silvery basal lateral patches on II-VII; tergite I apparently with scaling restricted to median area; laterotergite with silvery scales; sternites apparently largely dingy white, with dark scales in the middle caudally.

MALE.—Essentially as in the female. *Palpus:* about as long as or slightly shorter than proboscis, with basal silvery scales on segments 3–5. *Legs:* both anterior and posterior claws of foreleg and midleg with a single tooth.

MALE GENITALIA (fig. **235**).—As figured; diagnostic characters as in the key. *Segment IX:* tergal lobes small but prominent, close together, each with about 6 bristles; sternite with a patch of several bristles. *Sidepiece:* long and narrow; dorsal surface with short hairs and scales, long bristles restricted to lateral surface; basal tergomesal area not prominent but indicated dorsally by a cluster of long narrow pointed scales and very numerous long hairs which extend on mesal surface as shorter straight hairs; middle of mesal surface at sternal border with a large patch of very long and very slender hairs with bent distal part, widened spoon-shaped subapical enlargement and pointed apex; upper part of mesal surface with a larger patch of similar specialized hairs except that more distal ones are straighter and without distinct apical modifications; sternomesal border with a very long line of several rows of very long slender scales, line starting at about level of basal portion of the proximal mesal patch of specialized hairs and extending to near apex, scales at both ends merging into bristles. *Claspette:* stem long and slender; appendage very broad, bladelike. *Clasper:* very short; spiniform apical. *Phallosome:* aedeagus rather long, moderately expanded beyond middle. *Proctiger:* paraproct apex with 3,4 denticles; 2 minute cercal setae.

PUPA and LARVA.—Unknown.

MATERIAL EXAMINED.—6 specimens: 2 ♀; 3 ♂; 1 damaged adult.

SYSTEMATICS.—This species is so distinctive that I am describing it in spite of the fact that the material is very limited and its source is uncertain. Apparently all the specimens were collected on Guadalcanal by A. B. Gurney, but the collection numbers do not correspond with those on a copy of the field notes that I have seen. The error may have occurred when the specimens were mounted and labeled. There seems to be no question that the allotype female was collected on Guadalcanal by A. B. Gurney; since all the other material is obviously the same species, I believe it must be sympatric, particularly as all the collection numbers bear G as a prefix. However, it is possible that *rubiginosus* does not occur in the Solomons. I have seen 3 females from Emirau Island (northwest of New Ireland) which appear to be very close to *rubiginosus,* but in the absence of males and other stages, it is impossible to identify them with certainty.

A. rubiginosus falls into the *quasirubithorax* subgroup of the *aureostriatus* group of Knight and Marks (1952:529) which includes *keefi* King & Hoogstraal, 1946 and *quasirubithorax* (Theobald, 1910) from Australia and New Guinea. The male genitalia of *rubiginosus* are markedly different from the other 2 species, and there are distinct differences in the ornamentation of the mesonotum, scutellum, and *ppn* of the adults, as noted in the diagnosis.

There seems to be little justification for the separation of the *aureostriatus* and *mediovittatus* groups on characters given by Knight and Marks (1952). The *quasirubithorax* subgroup, for instance, shows many more affinities with the *notoscriptus* subgroup of the *mediovittatus* group than it does with other subgroups of its own group, particularly the neotropical *scutellalbum* Boshell-Manrique, 1939.

BIONOMICS AND DISEASE RELATIONS.—Nothing is known of the bionomics of *rubiginosus,* but it is probable that it breeds in treeholes. The majority of specimens were apparently reared, but the female allotype may have been collected biting as it fully hardened.

DISTRIBUTION (fig. **220**).—? *Solomon Islands:* ? Guadalcanal. Not definitely known elsewhere.

MEDIOVITTATUS GROUP

FEMALES.—*Head:* antennal torus usually with distinct scale patch. *Thorax:* mesonotum with distinct pattern of narrow longitudinal silvery or yellowish lines; paratergite scaled. *Legs:* at least midfemur and usually 1 or more tibiae with a narrow longitudinal pale line for nearly entire length on anterior surface; hindtarsal segments 1–4 with basal light bands, segment 5 varied, apical light scaling sometimes developed (Knight and Marks, 1952:530).

SYSTEMATICS.—The *mediovittatus* group is a heterogeneous assemblage of forms. The nominate species from the New World has very little in common with the remaining species, which are all found in the Old World, and probably does not belong to the same group as the others. The general color pattern which these forms share is an extremely common one in other subgenera of *Aedes,* as well as in other genera, and is not a very good criterion of affinity.

The 2 South Pacific species placed in the group form a part of the *notoscriptus* subgroup, which is largely Australasian and probably should be recognized as a distinct group. *A. notoscriptus* and *albilabris* are very similar; it is possible that the latter is only a subspecies of the former, but conclusive evidence to that effect is not available at present; therefore *albilabris* is treated here as a full species.

2. Aedes (Finlaya) notoscriptus (Skuse)

Figs. **221, 226-229**

1889. *Culex notoscriptus* Skuse, Linn. Soc. N.S. Wales, Proc. (2)3:1738–1740. TYPES: syntypes, ♂, ♀, Sydney, Australia, Masters and Skuse (MACL).

Aedes (*Finlaya*) *notoscriptus* of Edwards (1922*a*:100; 1924:382; 1932:152); Graham (1929:205–215); Taylor (1934:18); Lee (1944*a*:57); Knight, Bohart, and Bohart (1944:38, 53); Knight and Marks (1952:558–559); Laird (1954*a*:286–287; 1956:83); Iyengar (1955:27); Rageau (1958*a*:877; 1958*b*:3); Stone, Knight, and Starcke (1959).

Aedes notoscriptus of Graham (1939:212), Perry (1950*a*:112), Miller (1950:42–43), Miller and Phillipps (1952:12–15).

Ochlerotatus notoscriptus of Miller (1920).

FEMALE.—*Wing:* 3.5 mm. *Proboscis:* 2.26 mm. *Forefemur:* 1.91 mm. *Abdomen:* about 2.58 mm. *Head:* dorsum of vertex with a pair of lateral patches of broad dark decumbent scales, separated caudally by a triangular patch of light decumbent scales, narrow in the middle, broad laterally, in front this patch usually does not reach the frontal pair of orbital bristles; a narrow complete orbital line of narrow densely packed silvery white scales; a rather conspicuous but short frontal tuft of silvery or yellowish scales; erect scales rather numerous but short; sides and lower surface with broad decumbent scales, largely light; proboscis dark except for a narrow submedian white ring; palpus tipped with varied number of silvery scales; torus of antenna with a large mesal patch of silvery scales. *Thorax:* integument rather uniformly dark brown; mesonotum with rather dense vestiture of short narrow curved dark bronzy scales; a very conspicuous pattern of silvery, yellowish, or golden scales in narrow lines as follows, (1) a very narrow median acrostichal line to prescutellar space where it divides into more or less definite prescutellar lines, (2) a pair of anterior dorsocentral lines, yellowish or golden, often reduced and even absent, (3) a pair of lateral prescutal lines from lateral anterior promontory to scutal angles where each broadens and curves as a posterior fossal line and then continues caudad as posterior dorsocentral line, (4) a pair of supraalar lines usually strongly developed; a pair of conspicuous large patches of broad outstanding silvery scales in front of wing root; all lobes of scutellum with broad flat silvery or slightly yellowish scales; paratergite with conspicuous silvery scales on undersurface; pleuron with broad scales, silvery except on upper part of *ppn* where they are dark, silvery scales tending to be in diagonal longitudinal lines; *apn* with narrow line of scales; upper part of *ppn* with large patch of dark scales with several, at least 3, silvery scales in lower posterior portion of patch; lower anterior part of *ppn* with band of silvery scales in line with *apn;* lower *ssp* area against *stp* with patch of scales; *ppl* with patch of scales below bristles, both extending cephalad on *pst; stp* with small upper and lower caudal patches of scales; *pra* with conspicuous patch below bristles; *mep* with restricted upper and lower median patches; scales absent elsewhere on pleuron; acrostichal and dorsocentral bristles strongly developed, in complete rows; lower *mep* bristles absent. *Legs:* coxae largely with silvery scales, forecoxa with large band of dark scales in middle; trochanters largely silvery-scaled; femora dark with conspicuous silvery or whitish markings at base and apex and a narrow, more or less median, longitudinal white line from base to near apex on anterior and posterior surfaces of all femora, posterior line broad at base on midfemur and hindfemur and encroaching on ventral surface, on midfemur a second subventral posterior narrow light-scaled line distally; all tibiae with median anterior and posterior lines of silvery or whitish scales, usually nearly reaching apex, short or poorly developed on anterior surface of foretibia and posterior surface of hindtibia; foretarsus and midtarsus with conspicuous white basal patches and usually a few light apical scales on segments 1 and 2 and rarely 3 (New Caledonia), usually a few light scales dorsally on base of segment 3 and rarely 4 (New Caledonia); hindtarsus with conspicuous large basal white rings and usually very narrow apical incomplete rings on segments 1–4, segment 5 varied from completely white to completely dark. *Wing:* scales all dark. *Haltere:* knob light-scaled above, dark-scaled below. *Abdomen:* tergites largely dark-scaled; tergite I with scaling restricted to small patch in middle; laterotergite silvery-scaled; tergites II-VII with conspicuous but small basolateral silvery patches, a few pale scales dorsally at base, particularly in middle; sternites largely dingy white or yellowish, with more or less distinct basal lateral silvery markings, distal segments with dark scales caudomesad.

MALE.—Essentially as in the female. *Labium:* with narrower white-scaled ring. *Palpus:* about as long as proboscis; segments 4 and 5 with basal dorsal patch of silvery scales; apex of segment 3 and base of 4 with very long ventral bristles. *Legs:* anterior and posterior claws of foreleg and midleg all with a single tooth. *Abdomen:* tergites with more conspicuous dorsal pale scaling, sometimes developed as transverse bands (New Caledonia).

MALE GENITALIA (fig. 226).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe prominent, with 3–8 long bristles; sternite with several hairs near apex. *Sidepiece:* long and slender; dorsal surface with long hairs but no heavy bristles; no concentration of hairs or bristles on basal tergomesal area and no indication of lobe; a line of long slender apically curved and lanceolate-tipped setae from about middle of mesosternal margin to near apex, number of setae varied, sometimes in patch on lower portion of line, those toward apex of sidepiece straighter and with less defined lanceolate tip. *Claspette:* as figured; appendage bladelike and with long apical part. *Clasper:* very short, swollen in basal 0.5; spiniform relatively long and slender. *Phallosome:* aedeagus long and slender, slightly swollen in basal 0.5. *Proctiger:* paraproct with a single large tooth; cercal setae about 3–5.

PUPA (fig. 226).—*Abdomen:* 2.89 mm. *Trumpet:* 0.46 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately to strongly pigmented, mesonotum darker; hairs moderately to strongly pigmented; hair 1-C short. *Trumpet:* uniformly darkly pigmented. *Metanotum:* darkened. *Abdomen:* moderately to lightly pigmented, proximal segments darker; hairs moderately to strongly pigmented; hair 6-VII single or double, much weaker than 9-VII, latter usually double. *Paddle:* moderately to lightly pigmented, midrib darker; inner and outer margins with rather distinct short spicules distally.

LARVA (figs. 227-229).—*Head:* 0.76 mm. *Siphon:* 0.53 mm. *Anal Saddle:* 0.28 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* usually uniformly moderately to darkly pigmented, ocular area lighter; hairs moderately to darkly pigmented; hair 1-C heavy, usually very conspicuously hooked mesad in distal half; 5,6-C both single, 5-C removed caudad. *Antenna:* moderately long, uniform in width, without spicules; hair 1-A single, variable in position. *Thorax:* hairs and tubercles moderately to strongly pigmented; none of the hairs stellate; hair 13-P not developed. *Abdomen:* hairs moderately to strongly pigmented, tubercles small and lightly pigmented; none of the hairs stellate. *Segment VIII:* comb extremely variable, sometimes with only 2 rows of scales; comb scales extremely variable, sometimes spatulate. *Siphon:* index variable, usually about 1.7–2.5; usually moderately to strongly pigmented; acus usually strongly developed and broadly joined to siphon; pecten extremely variable in length, number and development of teeth. *Anal Segment:* saddle moderately to strongly pigmented; marginal spicules well developed but relatively short; ventral brush with 6 pairs of hairs on moderately developed grid.

MATERIAL EXAMINED.—468 specimens; 211 ♀; 104 ♂; 4 pupae; 149 larvae; no individual rearings.

SYSTEMATICS.—*A. notoscriptus* is one of the most variable mosquitoes I have seen. Very striking variation has been observed in the ornamentation of the adults and in the caudal segments of the larva. This species appears to be an extremely plastic and adaptable one. Although a great deal of the variation observed is undoubtedly individual, there are indications that some populations are characterized by certain peculiar features. Whether these characteristics are genetic or are caused by environmental differences remains to be determined. An analysis of *notoscriptus* is greatly complicated by the fact that it is a semidomestic species which probably has been widely spread by man in recent times.

The New Zealand populations are at first glance strikingly different in that the light scaling of the mesonotum is largely yellowish and the anterior dorsocentral light line is very strongly developed. A somewhat similar coloration is found in some populations in Australia. In *notoscriptus* from New Zealand, the light markings of the legs are notably reduced; this is particularly evident on the hindtarsi, which have much narrower basal white bands on all segments and usually have segment 5 white only at the base dorsally or even completely dark. The abdomen, on the other hand, appears to have more distinct and larger basal dorsal pale patches than in other populations. I suspect that all these color differences are related to a lower temperature. The New Zealand larvae (fig. 227) tend to have elongate comb scales in the middle of the posterior row and in general resemble those of some Australian populations. I believe that *notoscriptus* is not indigenous to New Zealand and that it is a recent introduction through commerce. Being an adaptable species, *notoscriptus* has spread widely in New Zealand, and apparently utilizes even leaf axils for breeding, but is most abundant in association with man in the larger settlements. It is possible that an endemic species resembling *notoscriptus* in adult color pattern is present on New Zealand and has been confused with it. Graham (1929:211) figures the head of a "*notoscriptus*" from New Zealand with a chaetotaxy entirely different from any specimen I have seen.

On New Caledonia, adults of *notoscriptus* also present a characteristic facies. The light scaling of the mesonotum is silvery white and the anterior dorsocentral light line is usually not developed at all; the foretarsus and midtarsus are marked with a large basal dorsal silvery patch on segment 3 and usually there are some white or pale scales dorsobasally on segment 4; the hindtarsus is well marked but segment 5 is usually completely dark, rarely with a few dorsobasal white scales; the foretibia is usually completely dark on the anterior surface; in the male, tergites III-V usually have conspicuous transverse pale, sometimes even silvery, bands. All these characters occur sporadically in some Australian populations of *notoscriptus.* There are 2 rather distinct types of larvae of *notoscriptus* on New Caledonia. These apparently may be found in the same breeding site. Type A (fig. 228) larvae are less numerous and have a shorter siphon and a small comb of only 2,3 rows of a few rather elongate large scales. Type B (fig. 229) larvae usually have a longer siphon and a comb of 5–7 rows of short, relatively broader, and much more numerous scales. I have seen larvae from Australia which resemble Type A in the comb but none which could be interpreted as Type B; the prevalent type in Australia seems to be intermediate between these and is quite variable. Unfortunately no individual rearings of *notoscriptus* have been available for this study, and it is impossible to determine whether or not any of the adult characters are correlated with the larval differences. The situation on New Caledonia is difficult to interpret. It is quite possible that an endemic form of *notoscriptus* existed on this island prior to the arrival of man. It seems very likely also that 1 or more introductions of *notoscriptus* have been made from Australia since that time, particularly during the last century. This interesting problem cannot be resolved without detailed analysis of both wild and semidomestic populations from this island, as well as from Australia.

In all the populations of *notoscriptus* I have examined, the male genitalia conform to the same general type; I have not been able to find any constant differences in any of them. In general the genitalic characters are quite variable in all populations, particularly in the shape of the aedeagus and the number and extent of the specialized setae of the sidepiece.

I regard *notoscriptus* as a highly plastic and adaptable dominant species which originated somewhere in the Australia–New Guinea area, most probably in Australia. It seems to have extended its range both naturally and through the agency of man. It may now be invading the range of earlier segregates of its parental stock, such as the very closely related *albilabris* (see below) and possibly the more or less distinct form on New Caledonia. Another segregate of the *notoscriptus* stock is *montanus* Brug, 1939, described from Java.

BIONOMICS AND DISEASE RELATIONS.—*A. notoscriptus* is a semidomestic species in several portions of its range and it breeds readily in artificial containers of all types and in coconut husks and shells. The natural breeding places are treeholes but leaf axils of various plants and even rockholes may be utilized at times.

Apparently *notoscriptus* females differ considerably in blood-feeding habits in various portions of the range of the species. They are said to attack man persistently and to enter houses frequently in New Zealand (Graham, 1929:209). Nothing is known of the disease relations of *notoscriptus,* but because of its semidomestic breeding habits, it is a potentially important species.

DISTRIBUTION (fig. 221).—*New Caledonia:* widely distributed; Ile des Pins. *Loyalty Islands:* Ouvea; Lifu; Tiga; Mare. *New Zealand:* North Island (Auckland); South Island (Nelson City). Also reported from *Australia, New Britain, New Ireland, New Guinea,* and the *Moluccas.*

3. Aedes (Finlaya) albilabris Edwards

Figs. 221, 230, 231

1925. *Aedes* (*Finlaya*) *albilabris* Edwards, B. Ent. Res. 15:258. *TYPE: holotype ♀, Tulagi Island, Solomon Islands, caught feeding in the morning, Sept. 27, 1923, A. G. Carment (BMNH).

Aedes (*Finlaya*) *albilabris* of Paine and Edwards (1929:306, 315); Edwards (1932:151); Taylor (1934:17); Lee (1944*a*:57); Knight, Bohart, and Bohart (1944:38, 49); Knight and Marks (1952:557); Iyengar (1955:27); Laird (1956); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.3 mm. *Proboscis:* 2.28 mm. *Forefemur:* 2.1 mm. *Abdomen:* about 2.63 mm. Very similar to *notoscriptus*, differing chiefly in the following characters. *Head:* vertex with rather narrow median longitudinal stripe of narrow silvery scales usually continuous from frontal tuft to occiput; frontal tuft better developed, often extending to lower edge of eyes; dark scales more extensive on dorsum and sides; labium with a more or less extensive apical dorsal light-scaled patch. *Thorax:* acrostichal silvery line broader; anterior dorsocentral line deep golden or coppery; curved posterior fossal line rarely developed, usually with some coppery scales; supraalar silvery line usually very poorly developed; silvery patch in front of wing root greatly reduced, sometimes absent; paratergite with more extensive scaling; *ppn* without any silvery scales at lower caudal end of upper patch of dark scales. *Legs:* forefemur without apical pale scaling; foretibia without anterior silvery line; foretarsus and midtarsus with rather extensive dorsal basal light patch on segment 3; hindtarsal segment 5 always entirely white. *Abdomen:* tergites rarely with distinct dorsal basal pale scales; sternites largely dark-scaled, silvery or whitish scales restricted to narrow basal band, widened laterad.

MALE.—Essentially as in the female and differing from *notoscriptus* in same characters except as follows. *Palpus:* usually slightly longer than proboscis, silvery scaling more extensive than in *notoscriptus,* covering most of segments 4 and 5. *Legs:* white basal patch usually not developed on segment 3 of foretarsus and midtarsus but longer on segments 1 and 2. *Abdomen:* tergites without distinct basal transverse bands.

MALE GENITALIA (fig. 230).—As figured; diagnostic characters as in the key; extremely similar to *notoscriptus,* from which it cannot be separated; aedeagus appears to be broader, particularly distally, and the specialized setae of sidepiece are somewhat shorter, fewer, and with less well-developed lanceolate tips.

PUPA (fig. 230).—*Abdomen:* 2.75 mm. *Trumpet:* 0.48 mm. *Paddle:* 0.55 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *notoscriptus* but readily separated by characters in the key; hairs usually with more branches than in *notoscriptus.*

LARVA (fig. 231).—*Head:* 0.81 mm. *Siphon:* 0.45 mm. *Anal Saddle:* 0.28 mm. Chaetotaxy as figured; diagnostic characters as in the key; extremely similar to *notoscriptus* but usually differing in the following. *Segment VIII:* comb usually with 3,4 rows of large scales, those in middle of posterior row long, more or less parallel-sided and with strongly sclerotized shaft. *Siphon:* index usually less than 2.0; acus small, usually detached or at most very narrowly joined; pecten teeth with long submedian or subbasal tooth. *Anal Segment:* marginal spicules of saddle more extensive, larger and heavier.

MATERIAL EXAMINED.—1,660 specimens; 446 ♀; 395 ♂; 133 pupae; 686 larvae; 9 individual larval rearings.

SYSTEMATICS.—*A. albilabris* is very similar to *notoscriptus;* there is a slight overlap in some characters between the 2 forms and the genitalia appear to be identical. However, no difficulty should be experienced in identifying even individual specimens, using the combination of diagnostic characters mentioned above. In the past the most reliable characters to distinguish *albilabris* adults from *notoscriptus* have been considered to be the absence of the posterior fossal light line and the presence of a dorsoapical light patch on the labium of the female. I have seen a considerable number of specimens of *albilabris* in which one or the other (and rarely both) of these characters is not typical and approaches or even exceeds (in the fossal line, for example) the condition found in *notoscriptus;* in each instance, however, there was no doubt that these were aberrant specimens of *albilabris,* judging on the basis of other characters.

The taxonomic status of *albilabris* is open to question. I regard *albilabris* as a relatively early offshoot of a parental stock which later gave rise to *notoscriptus,* the dominant modern form. *A. albilabris* is now apparently restricted to the Solomons, while *notoscriptus* is widespread and is extending its range, probably to a considerable extent through the agency of man. Typical *notoscriptus* is not found in the Solomons; previous reports of this species are based on the aberrant specimens noted above. For the present I am treating *albilabris* as a full species, but it is possible that, with further study of the *notoscriptus* complex, it may be shown to be a subspecies.

There is considerable variation in *albilabris.* Small populations have a tendency to be characteristically developed; for example, the isolated Bellona Island population has the fossal light line very strongly developed, even more so than *notoscriptus.*

BIONOMICS AND DISEASE RELATIONS.—*A. albilabris* is an adaptable species and uses a wide variety of breeding places. It has been found in treeholes, bamboo, leaf axils of various plants (including pandanus and palms), coconut shells and husks, and a wide variety of artificial containers, including canoes. It is possible that its dispersal to such islands as Rennell and Bellona has been accomplished by man. Females of *albilabris* are very seldom attracted to man; only a few specimens have been collected attempting to feed, despite the fact that the species readily adapts to semidomestic breeding and is extremely abundant. This species does not seem to be of any economic importance.

DISTRIBUTION (fig. 221).—*Solomon Islands:* Bougainville; Sterling (Treasury); Kolombangara; New Georgia; Roviana; Rendova; Florida; Tulagi; Guadalcanal; Malaita; Ugi; Bellona; Rennell. Not known elsewhere.

ALBOANNULATUS GROUP

FEMALES.—*Legs:* femora and tibiae without spots, rings or long anterior lines of pale scales; hindtarsus with basal light bands usually on segments 1–3, if only on 1 and 2 then band on 1 smaller than on 2, sometimes some pale apical scales. *Thorax:* mesonotal pattern varied but not consisting largely of longitudinal pale lines, if such are present then a patch in front of wing root is also developed (Knight and Marks, 1952:532).

SYSTEMATICS.—This is another very heterogeneous assemblage of species from all zoögeographic regions except the Ethiopian and Malagasy. Of the 11 subgroups recognized by Knight and Marks, 3 are represented in the South Pacific: (1) the *alboannulatus* subgroup by the endemic *lauriei* on Lord Howe Island, (2) the *biocellatus* subgroup by the endemic *roai* in the Solomons, and (3) the *papuensis* subgroup by the endemic *argyronotum* and *buxtoni* in the Solomons (fig. 222).

4. Aedes (Finlaya) lauriei (Carter)

Figs. 223, 232

1920. *Ochlerotatus laurei* (!) Carter, Zool. Soc. London, Proc. 1920:623–628. *TYPES: syntypes, 1 ♂ (genitalia slide lost?) and 1 ♀, Lord Howe Island (Australia), from hollow in fallen tree trunk, 1914, R. D. Laurie (LIVER *in* BMNH). —Specific name corrected to *lauriei* by Edwards (1924:383).

Aedes (Finlaya) lauriei of Edwards (1924:383; 1932:151); Taylor (1934:18); Lee (1944*a*:59); Knight and Marks (1952:573); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 5.2 mm. *Total length:* about 5.5 mm. (after Carter). *Head:* median part of dorsum of vertex with long curved narrow golden decumbent scales, lateral part with shorter curved narrow dark decumbent scales; orbital line of narrow golden scales expanding laterad into large patch; erect scales largely dark, numerous; sides and venter of head with broad whitish scales; proboscis dark; palpus with 2 very narrow light bands indicated by a few scales and an apical patch of white scales. *Thorax:* integument reddish brown; mesonotum with a general vestiture of dark bronzy narrow curved scales and a pattern of golden scales as follows, (1) a median longitudinal acrostichal line, broad anteriorly and gradually tapering posteriorly to a point near middle of mesonotum, (2) a narrow border around the anterior promontory, (3) a pair of more or less circular humeral spots, (4) a pair of narrow posterior dorsocentral lines joined to broader posterior fossal lines, (5) a pair of very narrow prescutellar lines, (6) a few scattered scales in supraalar lines; scutellum lighter in color of integument, with sparse vestiture of narrow golden scales on all lobes and a few dark curved narrow scales on midlobe and more on lateral lobes; paratergite without scales; pleural whitish scales somewhat creamy; *apn* with broad whitish scales and light hairs in addition to bristles; *ppn* scaled in upper part only, scales dark, elongate, some broad, others narrow; *ppl* with patch of long broad whitish scales; *psp* without scales; *ssp* with patch of broad whitish scales against *stp; stp* with upper and lower caudal patches of broad whitish scales; *pra* without scales; *mep* with upper and middle patches of broad whitish scales; lower *mep* bristles absent. *Legs:* femora largely dark-scaled, lighter ventrally, a few pale scales at base on dorsal surface, on hindfemur this pale area connected to a larger ventral pale area which extends as a streak on anterior face for about 0.2 of femur; dark creamy knee spots, most prominent on hindleg; tibiae entirely dark, somewhat paler apically and ventrally; foretarsus and midtarsus with small basal dorsal patches of white or pale scales on segments 1 and 2, and a few pale scales on segment 3 of midleg; hindtarsal segments 1–5 with dorsal basal white patch, more extensive and forming a ring at extreme base on segments 2 and 3, segment 1 with streak of yellowish hairs on venter at base. *Wing:* scales all dark. *Haltere:* stem light, knob somewhat darker; upper part of stem with whitish scales, knob dark-scaled. *Abdomen:* tergites apparently entirely dark-scaled above; tergite I with scaling restricted to small median apical patch; tergites II,III with small light lateral basal patches, possibly present in reduced state on other segments as well; sternites dark-scaled in middle, with large lateral white patches which extend about 0.67 on II and become smaller on distal segments.

MALE.—Essentially as in the female. *Palpus:* about 0.67 of proboscis; segments 2–5 with basal white scales. *Legs:* light scaling of tarsi reduced.

MALE GENITALIA (fig. 232, after Carter).—As figured; diagnostic characters as in the key; material not seen. *Segment IX:* tergite poorly sclerotized, lobe not developed, no bristles. *Sidepiece:* moderately long; dorsal surface with long bristles; basal tergomesal area poorly defined, not produced, with short hairs; sternomesal margin without scales or specialized setae but with some heavy bristles distally. *Claspette:* appendage with sharply produced basal angle. *Clasper:* long; with a moderate, simple apical spiniform. *Phallosome:* aedeagus relatively short, gradually broadened from base. *Proctiger:* paraproct apparently with a single apical tooth; 3 distinct cercal setae.

PUPA (fig. 232, after Carter).—Material not seen; insufficiently described for inclusion in key; trumpet and paddle as figured.

LARVA (fig. 232, after Carter).—Material not seen; insufficiently described but may be recognized by diagnostic characters in the key and the figures from Carter.

MATERIAL EXAMINED.—1 ♀, 1 ♂.

SYSTEMATICS.—Knight and Marks (1952:573, fn.) suggest that *lauriei* shows marked relationship to the *alboannulatus* subgroup (fig. 222) but indicate that it does not fit into this subgroup as defined by them. The true affinities of *lauriei* cannot be determined at present.

BIONOMICS AND DISEASE RELATIONS.—The original and only known collection of *lauriei* was made in a hollow in a fallen tree trunk. Nothing is known of the habits of the adults.

DISTRIBUTION (fig. 223).—*Lord Howe Island* (Australia). Not known elsewhere.

5. Aedes (Finlaya) roai Belkin, n. sp.

Figs. 223, 232

TYPES.—*Holotype:* ♂ with genitalia slide (580725-5), Wright's Creek, Matanikau Valley, Guadalcanal, Solomon Islands, from treehole, Sept. 23, 1944, H. E. Milliron (USNM, 64780). *Allotype:* ♀, same data as holotype, Sept. 30, 1944 (USNM). *Paratypes:* 1 ♂, same data as holotype; 1 ♂, 2 ♀, same data as allotype. —This species is dedicated to Vernon R. Roa, a member of the 20th Malaria Survey Unit on Guadalcanal.

FEMALE.—*Wing:* 3.55 mm. *Proboscis:* 2.58 mm. *Forefemur:* 2.15 mm. *Abdomen:* about 2.87 mm. *Head:* decumbent scales of vertex all golden and very narrow, long, slightly curved, shorter and more densely packed along orbital line, only a few projecting on upper part of the very narrow frons; erect scales very numerous, moderately long, largely golden, darker caudolaterad; sides and venter of head with broad scales, largely pale golden; proboscis and palpus entirely dark-scaled; torus of antenna with a few small dark broad scales among the hairs. *Thorax:* integument dark brown with some lighter areas on pleuron; mesonotum pale-scaled from extreme anterior end to wing root and all the way across to pleuron, scaling silvery except above paratergite where it gradually changes to pale golden; posterior border of pale area uneven, extending caudad on acrostichal line to prescutellar area, encroached by dark scaling cephalad along dorsocentral line, and extending caudad in supraalar area, all along posterior border some of the pale scales are pale golden; posterior part of mesonotum largely with dark bronzy narrow curved scales except for prescutellar lines of pale golden scales; scutellum largely with pale narrow scales, on midlobe silvery white except for very pale golden apically, lateral lobes with pale golden scales and a few dark bronzy; paratergite with very inconspicuous pale golden scales on lower surface; *apn* with large patch of very pale golden scales, rather narrow in front, broad but elongate caudally; *ppn* with scaling restricted to upper part, scales densely packed, narrow, curved, appressed and distinctly golden; *ppl* with very large patch of silvery white broad scales, with a slight yellowish tinge caudally, extending together with bristles to *pst; psp* without scales; *ssp* without scale patch; *stp* with usual upper and lower caudal patches of broad silvery white scales; *pra* with large patch of broad silvery scales occupying the upper anterior quarter; acrostichals and anterior dorsocentrals absent, posterior dorsocentrals well developed, continuous with prescutellars; bristles on anterior promontory golden; lower *mep* bristles absent. *Legs:*

coxae pale-scaled, forecoxa light golden, midcoxa and hindcoxa silvery; trochanters and base of femora pale-scaled; forefemur largely dark-scaled, posteroventral surface with light streak to apex, broadened at base, no distinct knee spot; midfemur largely dark-scaled, anterior surface with ventral light streak from about 0.2 to 0.9, posterior surface largely light basoventrally to about middle and somewhat mottled beyond, indistinctly paler apically; hindfemur largely silvery to about 0.7 except for dark upper line distally, a large pale golden apical anterior patch; tibiae pale at base, foretibia and midtibia with posteroventral pale streak, remainder dark-scaled; foretarsus with small basal dorsal patch of pale scales on segment 1 and a small but conspicuous white basal ring on 2; midtarsus with large white basal rings on segments 1 and 2, larger on 1, and a few pale scales at base of 3 anteriorly; hindtarsus with broad basal white rings on segments 1–3; remainder of tarsi dark-scaled. *Wing:* all scales dark. *Haltere:* upper part of stem and knob largely with pale golden scales, some darker scales above. *Abdomen:* tergites predominantly dark-scaled; tergite I with small median caudal patch of dark scales; laterotergite with silvery scales; tergites II-VII with basolateral triangular silvery patches, proportionately larger distally; tergites II-VI with a small median basal patch of yellowish scales; sternite II entirely silvery-scaled; sternites III-VII silvery-scaled at base, narrowly in middle and triangularly expanded laterad but not reaching apical margins, remainder dark-scaled, more extensively on basal segments.

MALE.—Essentially as in the female. *Palpus:* about as long as proboscis; segment 3 with large basal band of white scales; segment 4 with small basal band of white scales; segment 5 with about basal half pale-scaled; apex of segment 3 with patch of long outer bristles; segment 4 with long bristles on mesal surface and fewer on outer; segment 5 with long bristles. *Legs:* claws of foreleg and midleg apparently all unidendate. *Abdomen:* tergal light scaling much more extensive than in female, median basal dorsal pale scaling more distinctly white, connected basally with lateral patches to form uneven broad transverse bands, very conspicuous on IV,V but present on other segments as well.

MALE GENITALIA (fig. 232).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe very prominent, with 6 or more strong bristles. *Sidepiece:* elongate; dorsal surface with long hairs; basal tergomesal lobe not produced but strongly indicated by concentration of long hairs; mesal surface with a tergal subapical line of relatively short bristles; middle of mesal surface with a patch of long slender specialized setae curved beyond middle and with short slightly lanceolate tips; sternomesal margin with a long line of long striated scales, the more basal shorter and curved, the distal longer and straight. *Claspette:* stem very short; appendage very long and strongly developed, strongly expanded beyond middle to form a conspicuous crest. *Clasper:* relatively long, with a few hairs subapically; spiniform deeply bifid. *Phallosome:* aedeagus poorly sclerotized, rather broad, distinctly narrowed subapically. *Proctiger:* paraproct with a single apical spine; cercal setae very small.

LARVA and PUPA.—Unknown.

MATERIAL EXAMINED.—3 ♀; 3 ♂.

SYSTEMATICS.—*A. roai* falls well within the limits of the *biocellatus* subgroup (fig. 222) as defined by Knight and Marks (1952:537). This subgroup includes *australiensis* (Theobald, 1901), *biocellatus* (Taylor, 1914), and *monocellatus* Marks, 1948, all from Australia. The male genitalia of *roai* are very similar to those of *biocellatus* and *australiensis* but apparently can be differentiated by the shorter claspette stem and different development of the sternomesal scales, the specialized mesal setae, the basal tergomesal area, and the dorsal hairs of the sidepiece. The ornamentation of the adults differs markedly from the other 3 species of the group. The adults of *roai* are superficially very similar to *argyronotum* but are readily distinguished by the characters given in the keys.

BIONOMICS AND DISEASE RELATIONS.—The known adults were reared from immature stages collected in treeholes. Unfortunately the larvae and pupae from these collections have been lost. Nothing is known of the habits of the adults.

DISTRIBUTION (fig. 223).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

6. Aedes (Finlaya) argyronotum Belkin, n. sp.

Figs. 223, 233, 234

TYPES.—*Holotype:* ♂ with associated larval and pupal skins (JNB, 753-26), Matanikau Valley, Guadalcanal, Solomon Islands, from rockhole near stream bed, Nov. 21, 1944, M. Cohen and V. R. Roa (USNM, 64781). *Allotype:* ♀ with associated larval and pupal skins (JNB, 753-27), same data as holotype (USNM).

Paratypes: 10 ♀, 10 ♂, 23 pupae, 32 larvae (JNB, 753), all same data as holotype, including 8 ♀ (JNB, 753-15–19, 22, 28, 29) and 6 ♂ (JNB, 753-12–14, 20, 21, 25), with associated larval and pupal skins.

Aedes (*Finlaya*) *papuensis* in part of Knight and Marks (1952:565); Laird (1955*a*:280–282, 285); in part of Iyengar (1955:28); in part of Stone, Knight, and Starcke (1959); and of wartime collections in the Solomon Islands.

FEMALE.—*Wing:* 3.32 mm. *Proboscis:* 2.3 mm. *Forefemur:* 2.08 mm. *Abdomen:* about 2.82 mm. *Head:* decumbent scales of dorsum of vertex largely narrow and curved, silvery in a rather broad median patch which extends on upper part of frons and narrows caudad, various shades grading into dark bronzy laterally, lateral scaling dense and including progressively more very broad flat scales which are largely dark and form a conspicuous lateral patch at level of upper part of *apn;* a narrow interrupted orbital line of narrow golden scales; erect scales numerous, rather short, golden in center where they are largely restricted to posterior part, and dark laterally; sides and venter of head with broad flat scales, largely pale golden; proboscis dark; palpus largely dark, usually with several pale or white scales at base of segment 3 dorsally; torus of antenna with a few small broad dark scales in addition to hairs. *Thorax:* integument dark brown with some lighter areas on pleuron; mesonotum with anterior part with sharply delineated silvery-scaled area which extends caudad in the middle almost to prescutellar space, laterally the silvery scaling extends all the way across from the anterior promontory to level of about the middle of *ppn* and from there caudad it is marked off sharply by dark bronzy scaling along an evenly curved line to near level of anterior prescutellar bristles, a slight cephalic indentation of dark scales is usually present at this point, a few golden scales sometimes developed at level of *ppn,* median caudal portion usually more or less but always slightly produced; remainder of mesonotum with dark bronzy narrow curved scales contrasting sharply with the silvery pattern, a few coppery or golden scales at posterior end of prescutellar lines; scutellum with dark bronzy narrow scales on all lobes, a few golden or coppery scales sometimes intermixed; paratergite with a very few dingy white or yellowish broad scales below; light scaling of pleuron with distinct yellowish tinge; *apn* with dark scales in upper part and light below, majority of scales broad; *ppn* with scaling restricted to upper part, dark bronzy narrow curved scales above contrasting sharply with silvery mesonotal ornamentation, and a few light broad scales below along lower posterior portion of scale patch; *ppl* with broad light scales below bristles and extending with them to *pst; psp* with a few broad light scales; *ssp* with a few broad light scales against *stp; stp* with usual upper and lower patches of broad light scales; *pra* with a large patch of broad light scales below base of bristles; *mep* with small separate patches of broad light scales, in upper posterior part against upper bristles and an anterior median patch; scales absent elsewhere on pleuron; all acrostichal and dorsocentral bristles absent, prescutellars very weak; lower *mep* bristles absent. *Legs:* forecoxa largely with dark scales, some beige scales at base and apex, midcoxa with dark and beige scales, hindcoxa with beige scales; trochanters largely with dark scales; bases of femora light; forefemur with a few scattered pale scales on anterior surface and a long pale line dorsally on posterior surface; midfemur with a few scattered pale scales on anterior surface, a nearly complete pale ventral streak and extensive whitish scaling in basal half of posterior surface; hindfemur with a long whitish streak on anterior surface extending on ventral surface on basal half, posterior surface whitish to about middle; some pale scales on apices of femora but not forming distinct knee spots; tibiae entirely dark-scaled; foretarsus and midtarsus with rather broad silvery white bands forming complete ring at extreme base on segments 1 and 2; hindtarsus with broad complete basal silvery white rings on all segments. *Wing:* all scales dark. *Haltere:* knob dark-scaled above, some light scales below and on upper part of stem. *Abdomen:* tergites largely dark-scaled; tergite I with scaling restricted to small median posterior patch; laterotergite with silvery scales; tergites II-VII with long narrow lateral lines of silvery scales prolonged dorsomesad at base and connected transversely by narrow even basal band of dingy white scales on II-V, sometimes dorsal light scales silvery and bands conspicuous and rather broad; sternites largely dark-scaled, with some pale or silvery scales basolaterad, conspicuous on II.

MALE.—Essentially as in the female. *Head:* scaling of vertex sometimes distinctly lighter. *Palpus:* slightly shorter than proboscis; segments 3–5 with basal white bands; apex of segment 3 and inner and outer lower margins of 4 with long hairs, segment 5 with short sparse hairs. *Thorax:* mesonotal pattern similar to female, only slightly narrower. *Abdomen:* tergites II-VI with conspicuous basal transverse silvery bands but without lateral lines.

MALE GENITALIA (fig. **233**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite poorly sclerotized, without distinct lobe or bristles; sternite with 8 or more bristles apically. *Sidepiece:* moderately long; dorsal surface with very long slender bristles; basal tergomesal area with a small but distinct knoblike dorsal process bearing 4,5 very long bristles; apex of mesal surface with patch of long slender simple hairs directed cephalomesad; sternomesal margin without specialized scales but apicosternal area with concentration of short heavy bristles. *Claspette:* stem long and slender; appendage longer than stem, very narrow, sickle-shaped, and with very slight premedian crest. *Clasper:* rather long and slender, slightly swollen near base, with 2,3 subapical hairs; spiniform simple, long and slender. *Phallosome:* aedeagus rather short, with postmedian swelling. *Proctiger:* paraproct with single apical tooth; 2 small but distinct cercal setae.

PUPA (fig. 233).—*Abdomen:* 2.94 mm. *Trumpet:* 0.45 mm. *Paddle:* 0.64 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* mesonotum very strongly pigmented, remainder moderately; hairs moderately to strongly pigmented; hair 1-C short. *Trumpet:* uniformly moderately pigmented. *Metanotum:* very strongly pigmented. *Abdomen:* moderately to lightly pigmented, anterior segments and anterior median portions of tergites strongly darkened; hairs moderately to strongly pigmented; hair 6-VII strongly developed, multiple, similar to 9-VII. *Paddle:* very broad; lightly pigmented, midrib darker, external buttress rather distinct; margins without distinct serrations.

LARVA (fig. 234).—*Head:* 0.8 mm. *Siphon:* 0.65 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* very strongly pigmented, lighter on ocular area; mental plate as figured; hairs moderately to strongly pigmented; hair 1-C long and slender; 5,6-C both multiple and at about same level. *Antenna:* uniformly strongly pigmented; rather long, slender and uniform in width; spicules very small and rather sparse; hair 1-A branched. *Thorax:* hairs and tubercles strongly pigmented; no stellate hairs; hair 13-P not developed. *Abdomen:* hairs and tubercles strongly to moderately pigmented; no stellate hairs. *Segment VIII:* comb a triangular patch of numerous short scales; scales in middle of posterior row conspicuously fringed laterally and apically. *Siphon:* index about 2.0; moderately to strongly pigmented, darkened on basal ring; acus large and attached; pecten teeth usually 5–10; hair 8-S usually 2,3b. *Anal Segment:* rather uniformly moderately to strongly pigmented; marginal spicules moderate; hair 1-X usually single; ventral brush with 6 pairs of hairs on strong grid.

MATERIAL EXAMINED.—227 specimens; 37 ♀; 31 ♂; 53 pupae; 106 larvae; 20 individual rearings (19 larval, 1 pupal).

SYSTEMATICS.—*A. argyronotum* is a typical member of the Australasian *papuensis* subgroup of Knight and Marks (1952:534–535) and is very similar to *papuensis* (Taylor, 1914) from New Guinea (fig. 222). The adults differ from the latter in the greater extent of the silvery scaling of the mesonotum in the fossal area; in the male genitalia the basal tergomesal area is more prominent and has a larger number of large bristles on the dorsal knob and the claspette has a more slender and longer appendage. The immature stages appear to be quite similar but have not been studied in detail. Adults of *argyronotum* are superficially deceptively similar to *roai* but are readily distinguished by the characters given in the keys.

BIONOMICS AND DISEASE RELATIONS.—The immature stages have been collected in about equal frequency in treeholes (JNB, 569, 570, 571, 622, 627, 778) and rockholes and rock pools in small shaded streams (JNB, 753, 774, 805, 823, 826, 865, 866). Females do not bite man, and neither sex has ever been collected in the field. This strikingly marked species is entirely sylvan and has rarely been collected.

DISTRIBUTION (fig. 223).—*Solomon Islands:* New Georgia, Guadalcanal; probably occurs on other islands. Not known elsewhere.

7. Aedes (Finlaya) buxtoni Belkin, n. sp.

Fig. 223

TYPES.—*Holotype:* ♀, Bougainville, Solomon Islands, Feb. 17–25, 1945, F. N. Ratcliffe (SYDN). *Paratypes:* 3 ♀, same data as holotype.—This species is named in honor of the late P. A. Buxton, pioneer investigator of the mosquito fauna of the South Pacific.

FEMALE.—*Wing:* 3.1 mm. *Proboscis:* 2.3 mm. *Forefemur:* 2.1 mm. *Abdomen:* about 2.5 mm. *Head:* decumbent scales of dorsum of vertex largely narrow and curved, silvery in a broad median patch which is slightly narrowed caudally, scales dark laterally and becoming progressively broader anterolaterad toward sides; no orbital line of scales; erect scales all dark, numerous caudally on occiput, sparse anteriorly on dark-scaled areas, not developed on median silvery patch; sides with broad flat decumbent scales, dark in the middle at about level of middle of *apn*, beige or pale golden dorsoanteriorly and ventrally; proboscis dark-scaled; palpus entirely dark-scaled; torus of antenna with a few small broad dark scales. *Thorax:* integument dark brown; mesonotum with a uniform vestiture of narrow dark bronzy scales except for a broad median sharply delineated stripe of narrow silvery scales from anterior promontory to just before level of wing root, this stripe approaching but not reaching the dorsocentral lines laterally; all scutellar lobes with narrow silvery scales; paratergite with a patch of broad silvery scales on lower surface; *apn* with broad scales, dark above, silvery in lower part; *ppn* largely with small broad scales in upper half, a few narrow scales along mesonotal margin, scales largely dark but a few pale or beige in lower caudal part; remaining pleural scaling in small patches of broad silvery decumbent or semierect scales as follows, (1) a patch on *ppl* below bristles, (2) a few scales at base of *psp* bristles, (3) an upper and a lower caudal patch on *stp*, (4) a patch below *pra* bristles, (5) a patch at base of upper *mep* bristles and another patch on anterior *mep* at level of upper *stp* patch; scales absent elsewhere on pleuron; acrostichal and anterior dorsocentral bristles absent, a few large posterior dorsocentrals present, prescutellars rather weak; lower *mep* bristles absent. *Legs:* forecoxa largely with dark scales, a few silvery or pale metallic beige scales at base; midcoxa with silvery scales at base, dark scales distally; hindcoxa with pale scales, silvery at base, beige distally; forefemur largely dark-scaled and with a variable inconspicuous dorsoposterior line of scattered dingy pale scales; midfemur largely dark-scaled but with a pale posterior line broad at base and tapering distally to about 0.6–0.7; hindfemur dark-scaled except for pale line on anterior and posterior surfaces, the 2 broad and connected at base and narrowed distally, extending to about 0.6 on anterior surface and 0.5 on posterior; all femora with very small indistinct pale apex; foretarsus with small basal incomplete ring or dorsal patch of silvery to beige scales on segments 1 and 2, remainder dark-scaled; midtarsus similar to foretarsus except that basal pale markings are slightly more extensive and form a complete ring at least on segment 1; hindtarsus with broad silvery basal rings on all segments, usually about 0.3 or slightly more of each segment dorsally. *Wing:* scales all dark. *Haltere:* knob dark-scaled. *Abdomen:* tergites largely dark-scaled; tergite I with scaling restricted to small median posterior patch; laterotergite with silvery scales; tergites II-VII with short, broadly triangular basolateral silvery patches, largely invisible from above; sternite II largely silvery to beige and with a median apical triangular patch of dark scales; sternites III-VII largely dark-scaled and with basolateral patches of silvery scales, connected at base on III and progressively shorter on distal segments.

MALE, PUPA, and LARVA.—Unknown.

MATERIAL EXAMINED.—4 ♀; no immature stages.

SYSTEMATICS.—*A. buxtoni* is a typical member of the Australasian *papuensis* subgroup of Knight and Marks (1952:534–535) and is generally similar to *hollandius* King & Hoogstraal, 1946 and *subalbitarsis* King & Hoogstraal, 1946, both from New Guinea (fig. 222). In several respects the female of *buxtoni* seems to be intermediate in ornamentation between these 2 species, but it is conspicuously different from both in details of ornamentation and particularly in the predominance of broad scales on the *ppn*.

This species apparently replaces *argyronotum* in the western Solomons, but, as indicated below under distribution, there is a possibility that it was not even collected in the Solomons or anywhere in the South Pacific area.

BIONOMICS AND DISEASE RELATIONS.—No information other than that given under the types is available for *buxtoni*, but it is probable that this species breeds in treeholes and is not anthropophilic.

DISTRIBUTION (fig. 223).—? *Solomon Islands:* ? Bougainville. The original label accompanying the specimens bears only the date as given above, but this and other poorly labeled collections were found among a lot collected on Bougainville by F. N. Ratcliffe. D. J. Lee (*in lit.*) informs me that this material was probably collected by Ratcliffe or obtained by him from other wartime collectors in the area. Since all the material with definite localities in this lot is from Bougainville and since all the poorly labeled collections consist of species typical not only of the Solomons but of the western islands of the group, I believe that it is safe to assume that *buxtoni* was collected on Bougainville. Not known elsewhere.

KOCHI GROUP

FEMALES.—*Head:* decumbent scales of vertex largely broad except for narrow median longitudinal stripe, orbital lines and frontal tuft of narrow pale scales; erect scales numerous; proboscis usually distinctly shorter than forefemur, labium with more or less extensive pale scaling contrasting with dark; palpus about 0.3 of proboscis, 5-segmented, segment 5 very small, hidden by apical scales of segment 4 and without scales, largely dark-scaled and usually with pale scaling restricted to apex of segment 4 and indefinite patches proximally; antennal torus with small broad light scales; flagellar segment 1 with a more or less distinct patch of dark scales. *Thorax:* mesonotum usually with narrow scales only, a more or less indefinite and variable pattern of light scales usually blending but sometimes contrasting with dark scales, sometimes some broad scales in supraalar and prescutellar areas; scutellum usually with broad scales only, sometimes narrow scales present, scales largely light but usually also some dark ones distally on at least midlobe; paratergite with broad light scales extending into upper surface; pleuron with broad scales only, largely light except sometimes some dark ones on upper part of *ppn;* scales distributed as follows: (1) large part of *apn,* (2) posterior half of *ppn* to lower part, scales in lower part somewhat narrower and frequently whiter, (3) *ppl* among and below bristles and extending short distance on *pst,* (4) a few usually on *psp,* (5) a streak across lower *ssp* connecting lower *ppn* scales to those on upper *stp,* (6) a larger upper *stp* patch and a variable lower caudal *stp* patch, (7) above and usually below *pra,* (8) a large patch from about middle *mep* to lower edge of upper bristles, caudal portion of this patch usually strongly emarginate; pleural scales quite variable in development, particularly on lower *ppn, ssp, psp,* and *pra;* acrostichals and dorsocentrals strongly developed and in complete rows; *ppl* bristles few, not extending on *pst;* lower *mep* bristles absent, occasionally a rather elongate light or dark scale in this area. *Legs:* forecoxa and midcoxa largely with dark scales and with variable patch of light scales at base and sometimes apex; hindcoxa usually with small patch of dark scales, rarely a few light scales; trochanters usually largely with dark scales; femora usually extensively barred with light scales, hindfemur sometimes largely light-scaled; a preapical anteroventral femoral tuft of elongate outstanding scales usually developed, most conspicuously on midfemur; all femora rarely largely light-scaled; tibiae usually mottled or barred with light or dark scales, rarely completely light-scaled; tarsi usually extensively light-scaled, rarely completely light, tarsal segments 5 entirely pale-scaled; leg scaling extremely variable except on tarsi of some species; both claws of foreleg and midleg unidentate. *Wing* (fig. **235**): usually with conspicuous pattern of dark and light scales, rarely almost completely light-scaled; all dorsal vein scales broad, some very broad ones sometimes present; remigium without bristles; alula with marginal scales or hairs or both; upper calypter with complete fringe of long hairs. *Abdomen:* tergites usually with distinct light and dark pattern, dorsum sometimes largely or completely light, sides usually with distinct lateral light line expanded mesad apically or subapically; tergite I with scaling largely restricted to caudal middle area; laterotergite always light-scaled; sternites with scaling varied; sternites V-VII or VI,VII frequently with median caudal tufts of outstanding scales more or less strongly developed.

MALES.—Essentially similar to the females. *Labium:* sometimes entirely dark-scaled. *Palpus:* about as long or slightly longer than proboscis; 5-segmented; segment 3 (distal part of "long" segment) slightly swollen distad, upturned and with long hairs on outer surface; segments 4 and 5 turned down; segment 4 with long hairs on both sides from base to apex; segment 5 with long hairs toward apex; light scaling usually conspicuous. *Legs:* claws of foreleg and midleg enlarged, anterior member of pair usually much larger, all (?) unidentate.

MALE GENITALIA (fig. **235**).—*Segment IX:* tergite shortened on middorsal line and with closely approximated, usually poorly defined pair of lobes in this area bearing 1-5 hairs or short bristles; sternite strongly developed, distally with 1 or more pairs of hairs. *Sidepiece:* short to moderately long; numerous short to moderately long scales dorsolaterally, laterally, and ventrolaterally; usually a well-defined basal tergomesal area densely covered with hairs, bristles, and sometimes scales, extending sternad on mesal surface; in South Pacific species, except *knighti,* a specialized basal mesal seta arises from a tubercle at the most sternal extension of this area; upper part of this basal tergomesal area extending on to about middle of sidepiece on mesal surface, sometimes this upper mesal portion with specialized hairs with flattened or lanceolate tips; middle of mesal surface often with a more or less distinct group of specialized hairs on sternal sclerotization, upper part with variable number of usually simple curved hairs; distal portion of dorsal surface with short or long hairs or sometimes bristles, in some instances connected by scattered hairs with basal tergomesal bristle area; sternal face with a group of several very long striated scales slightly beyond middle of mesal margin; usually several strong bristles on distal portion of sternal face near mesal margin, 1 of these is usually strongly differentiated as a subapical bristle and may be developed as a very long linear scale. *Claspette:* appendage variously developed, bladelike, with or without sharp subbasal angle, or narrower and spearlike. *Clasper:* short to moderately long, slender or expanded near middle or subapically; usually without setae except near apex; spiniform apical, usually long and slender. *Phallosome:* aedeagus usually short; in dorsal aspect, basal portion of aedeagus with sides subparallel, distal widened, more or less in form of a cap, and rounded or emarginate apically, never produced; ventral paramere strongly developed, broad; basal piece moderate, poorly differentiated from dorsal mesal angle of sidepiece. *Proctiger:* paraproct usually with only 1 differentiated apical dorsal tooth; cercal setae variable, from 1 to several pairs.

PUPAE.—*Cephalothorax:* hair 1-C long, usually about 2.0 length of trumpet and at least 2.0 length of hairs 2,3-C; mesonotum often with clear unpigmented spots or lines. *Trumpet:* usually short. *Metanotum:* often with clear unpigmented spots. *Abdomen:* tergites I-IV sometimes with strongly contrasting median dark pattern; tergites II-IV sometimes with clear unpigmented spots; hairs 1-3-II and usually 5-II in a close group; 1-II removed from midline in South Pacific species; 3-II,III usually single and markedly stronger than other hairs on respective segments; 9-II-VI removed a considerable distance cephalad; 9-VII removed a considerable distance cephalad on dorsal surface, usually with few branches; 8-VII dorsal and mesad of spiracular sensillum in all South Pacific species; 6-VII poorly developed; 9-VIII strongly developed, multiple. *Terminal Segments:* female cercal lobe distinct but short. *Paddle:* varied in shape, with or without marginal spicules.

LARVAE.—*Head:* relatively small, rounded; usually lightly pigmented except for dark collar; dorsal hairs lightly to moderately pigmented; larger ventral hairs more strongly pigmented; hair 1-C always split into at least 2 branches in all South Pacific species; 0-C very small, visible in only a few species (not shown in most figures); 2,3-C both absent or at most represented by a short spicule (not shown in figures); 4-C strongly developed, subequal to 6-C, varied in position but near level of 6-C; 5-C always single, removed far caudad of 7-C; 11-C and often 14-C large, more or less stellate; 15-C short, median or premedian; basal maxillary hair usually strongly developed and stellate. *Antenna:* short, usually about 0.25 head length; shaft smooth, without spicules; uniformly pigmented; hair 1-A usually postmedian, single, long. *Thorax:* hairs 0,1,3,5,8,9,10-P, 1,13(and sometimes 14)-M, 1,3,5,8,13-T more or less stellate; 0-P often strongly displaced laterad and caudad; 1-3-P on common tubercle, 2-P single; 4-P usually small and with few branches; 6-P single; 7-P single to 3b; 12-P single; 13-P absent; 2,4-M small, single, or with a few branches; 3-M long, single; 5-M strong, very long, always single; 7-M long, single; 6,8-M long, usually multiple; 9-M,T long multiple; 10-M,T very long, single; 12-M very long, single; 2,6-T single; 4-T short, branched; 7-T long, multiple; 12-T relatively short, usually single. *Abdomen:* hair 12-I present; 1,2,5,7,9-III-VI, and often 13, more or less stellate; 0,14 normal, minute, not developed on I; 6-I,II multiple, with more branches than 6-III-VI; 7-I single or double; hair 5 displaced cephalad on I-VI, hair 4 mesad on II-V. *Segment VIII:* comb a patch of several rows of scales, those of distal row elongate and varied in development; hairs 1,5-VIII usually more or less stellate; 3,4-VIII close together, 3 with few branches or single. *Siphon:* index moderate; acus rarely distinct; usually poorly pigmented; nearly bare to strongly spiculate; pecten teeth in form of spine with short fringes; valves short; hair 1-S with few branches; 6,8-S very long. *Anal Segment:* saddle widely incomplete, usually with long marginal spicules; hair 1-X long, usually with a few branches; dorsal brush long, hair 3-X single, 2-X multiple; ventral brush with 5 pairs of hairs with long basal stalk, all arising from basal boss without distinct bars; gills varied.

EGGS.—Described briefly and figured for "*samoanus*" (probably *oceanicus*); "in nature eggs are laid in strings on the surface of the leaf base . . . just above water level" (Buxton and Hopkins, 1927:97, 99, 109).

SYSTEMATICS.—The *kochi* group as interpreted here does not include *gani* Bonne-Wepster, 1940 from *Nepenthes* pitchers in western New Guinea, since this species differs markedly from all the other forms in adult ornamentation and in male genitalia (immature stages undescribed) and should probably be segregated into a separate group.

The group is a very difficult one and is very imperfectly known at present. The majority of species do not feed on man and are seldom collected as adults in nature. The immature stages are confined almost entirely to small water collections in the leaf axils of certain plants and are usually overlooked unless a special effort is made to locate them. The reared adults are usually weak and may not show the full development of characters, particularly if the laboratory rearings are from young larvae. This is of taxonomic importance since members of this group are highly ornamented in the adult stage and the various species show rather subtle but apparently reliable differences in ornamentation.

The group as a whole, in common with other mosquitoes utilizing confined breeding places, is very prone to speciation. My impression is that much of the speciation has taken place sympatrically, with the effective barrier being ecological. On the island of Vitu Levu in Fiji, 4 species of the *kochi* group are known, in contrast to only 1 species in any given group in all other mosquitoes except in human introductions. On Guadalcanal, at least 4 species have been collected at the same time in the same pandanus plant, but it is not definitely known whether or not they were found in the same leaf axils. My recollection is that each of these species was found predominantly in axils of only a definite type, or at a certain specific level in the pandanus plant, and that there is little overlap between species except in members of different complexes. This point has to be checked carefully in the field. It is my impression also that some of the species in the group may have originated through hybridization. This appears to be true with *solomonis, fuscipalpis,* and *fuscitarsis* (see under *solomonis*) and also in the *bougainvillensis* complex, which includes also *hollingsheadi, neogeorgianus,* and *schlosseri.* As can be expected in a group such as this, what has been interpreted as a single wide-ranging species with local geographical variants may prove to be a complex of distinct species; similarly, a form reported from a wide range of unrelated host plants may prove to be composed of ecological variants, some of which may be distinct species. In the *kochi* group it is absolutely essential to study a large series of individual rearings from as many specific habitats and areas as possible before a decision can be made as to the taxonomic status of any form. Unfortunately such rearings are very few, and only in 1 or 2 instances is the species of host plant definitely known.

In the South Pacific the various species of the *kochi* group are most easily recognized in the pupal stage by the characteristic color pattern, particularly by the development of clear unpigmented spots or lines on the thorax and abdomen. In life these unpigmented areas are iridescent blue in color. It is of interest that very similar iridescent spots and striking color patterns are found in the pupae of many New World sabethines and species of *Culex* (*Microculex*) breeding in leaf axils in that region. The significance of these patterns or spots is not known, but it seems to be in the nature of a camouflage or adaptive coloration which may protect the pupae from predators. In the South Pacific, ants are often extremely numerous in the leaf axils of Pandanaceae and aroids and have been observed to gather drowning insects. Lane (*in* Stone, Ent. Soc. Wash., Proc. 53:54, 1951) observed that similar spots in plant-breeding sabethines and culicines are luminescent or phosphorescent.

At first glance, all the larvae of this group appear to be extremely similar and variable. However, once the association with the pupal stage is made, clear-cut differences are evident, and the variation is seen to be relatively minor. The same situation prevails with the adults, which at first appear to show a bewildering amount of variation in coloration but which actually conform to very distinct types for each species, although the differences are sometimes rather subtle. The male genitalia are characteristically developed in every species.

Including the new forms described here, the *kochi* group consists at present of 29 named species (14 in the South Pacific) and several unnamed forms (at least 3 and probably 5 in the South Pacific). A few attempts have been made at a classification of the group. In the most recent general review of the group, Marks (1947) recognized 2 main types in the adults: (1) the *flavipennis* type with extensive yellow scaling of the labium and tarsi and (2) the *kochi* type with the light scaling largely white and less extensive on the labium and tarsi; *wallacei* and *knighti* do not conform to either type. Marks (*op. cit.*) also attempted to determine relationships on the basis of specializations in the male genitalia and in the comb scales of the larvae, with largely conflicting results. Knight and Marks (1952:520) considered *gani* as forming a separate subgroup, segregated *lewelleni* Starkey & Webb, 1946 from Angaur Island, Palau, into a distinct subgroup, and placed all the other forms in the typical or *kochi* subgroup. Bohart (1957:22) continued to recognize the *gani* subgroup but separated the remaining species into the Papuan-Australian *kochi* subgroup and the Malayan *poicilius* subgroup. As I have indicated above, the *kochi* group is a most complex one and very imperfectly known at the present. The attempts at an internal classification of the group have been based on very superficial characters, largely limited to adult structures. A natural classification of the group cannot be developed until all the stages are studied and all the species thoroughly compared. Just how complex the evolution of this group has been can be judged from the situation in the South Pacific. I have made no attempt to study the extralimital species or to develop a more natural classification. However, I find that the larval stage promises to be of paramount importance as an indication of affinities.

The *kochi* group is very strongly represented in the South Pacific, with 14 of the total of 29 named species being known from the Solomons and the Fiji-Tonga-Samoa area. I have recognized 3 other forms which I have not named because they are represented by females only. In addition, there are probably 2 or more unrecognized forms in the material that I have examined of "*bougainvillensis*" and "*solomonis*" from Bougainville. Without association with immature stages, it is too difficult and too time-consuming to segregate these forms. In all probability, many other forms await recognition. The Santa Cruz group, in particular, should have several endemic species where none are reported now, and the islands of Rotuma, the Futuna (Horne) group, and the Wallis group may also harbor species of the *kochi* group. All the South Pacific species of the group are endemic to the area.

Since the group is very imperfectly known in the South Pacific, I have made no real attempt to determine the affinities of the various species. This cannot be done until the majority of the forms are thoroughly known. However, certain trends are evident. As in other mosquito groups in the South Pacific, the most primitive and ancient forms are found at the eastern end of the range, in Fiji, Tonga, and Samoa, and include *fijiensis, oceanicus, samoanus, burnetti, freycinetiae,* and sp. 22. All the known larvae (unknown in *samoanus* and sp. 22) appear to have the most generalized chaetotaxy in the group and are particularly distinctive in the caudal position of hair 4 on the head capsule. It is of interest that this same character is retained in the peripheral species at the western end of the range of the group in the Oriental and Indomalayan regions. In the adults of the eastern species, both the *flavipennis* and the *kochi* types of Marks are represented, but *burnetti* has a combination of characters of the 2 types, and sp. 22 represents apparently an albinistic form of the *kochi* type. In several respects the ornamentation and the male genitalia of *samoanus* are the most primitive in the entire group.

In the Solomons, the known species fall into several complexes: (1) the *bougainvillensis* complex, which also includes *hollingsheadi, neogeorgianus,* and *schlosseri,* is of the *kochi* type, (2) the *solomonis* complex, which also includes *fuscipalpis* and *fuscitarsis,* is of the *flavipennis* type, (3) the *knighti* complex, which also includes sp. 23, has the general ornamentation of the *kochi* type, but *knighti* has a larva of the same type as *franclemonti* and lacks a specialized basal mesal seta in the male genitalia, (4) the *franclemonti* complex, which also includes sp. 24, is more extensively pale than is usual in the *kochi* type but resembles *samoanus* in this respect. *A. knighti* and *franclemonti,* although markedly different in adult ornamentation and in male genitalia, have strikingly similar larvae which are intermediate in the position of head hair 4 between the eastern species and the remaining species in the Solomons. In several respects they are suggestive of an intermediate type between the dark *kochi* and the light *flavipennis* and may have arisen through hybridization.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of the *kochi* group are almost entirely restricted to water in the leaf axils of plants. In the South Pacific the chief plants involved are members of the Pandanaceae and the Araceae, but it is possible that other plants (such as *Canna* and pineapple) may provide suitable habitats (O'Connor, 1923:56–57). Although *A. kochi* has been reported to breed in coconut shells and husks, this is evidently in error; all modern records are from leaf axils. On occasion some species may be found in small treeholes; Laird (1956:28) reports a single collection of "*samoanus*" (probably *oceanicus*) from a step in a coconut tree. The specificity of the association of members of the *kochi* group with a particular host plant is not known and should be checked carefully for every species. On Guadalcanal I noted that at least 4 species of the group may be found in a single host plant at the same time but that each species occurred predominantly in certain leaf axils and generally at a specific level of the tree. The immature stages are sometimes found in extremely shallow water. The larvae can crawl out of the water readily and apparently can move into a more suitable environment in nature. As noted above under Systematics, the pupae usually have a distinctive color pattern of markings and iridescent spots or lines which seem to be in the nature of camouflage from predators. The aquatic cycle is usually long, and most species are difficult to rear in the laboratory.

Only a few forms are known to bite man. *A. kochi* appears to be a common pest species in parts of New Guinea; *fijiensis, samoanus,* and *oceanicus* attack man readily and persistently. These species appear to be predominantly nocturnal biters but there are records of diurnal attacks. The natural hosts are not known but are likely to be birds and possibly bats.

Because relatively few species are known to attack man, little work has been done on the disease relations of the *kochi* group. *A.* "*kochi*" from New Britain has been shown experimentally to be capable of transmitting human filariasis (Backhouse and Heydon, 1950), and *fijiensis* (see below) is probably an important vector of *Wuchereria bancrofti* in Fiji. Therefore it seems advisable to reëxamine carefully the role of members of the *kochi* group in the epidemiology of both periodic and nonperiodic filariasis and not to neglect it in connection with the transmission of other human diseases.

DISTRIBUTION (figs. 224, 225).—The *kochi* group has been reported from India to Samoa and Tonga and from the Philippines to New South Wales. Nearly half of the described forms are reported from the South Pacific, where they are now known only from the Solomon Islands and from the Fiji-Tonga-Samoa area; it seems likely that other species will be found in the Santa Cruz group and possibly also on Rotuma, Wallis, and Futuna Islands.

8. Aedes (Finlaya) bougainvillensis Marks

Figs. **225**, **236**, **237**

1947. *Aedes* (*Finlaya*) *bougainvillensis* Marks, Queensland U., Papers Dept. Biol. 2(5):19–26). TYPE: holotype ♂ with associated larval and pupal skins, Bougainville I., Solomon Islands, from axil of lilylike plant (probably *Sararanga*), Dec., 1944, J. R. Cowell (QUEEN).

Aedes (*Finlaya*) *bougainvillensis* of Knight and Marks (1952:543); Iyengar (1955:27); Stone, Knight, and Starcke (1959).

Aedes (*Finlaya*) *kochi* in part of Lee (1944*a*:63); Knight, Bohart, and Bohart (1944:34, 52); Stone and Bohart (1944:211); and wartime collections in the Solomons.

FEMALE.—*Wing:* 2.8 mm. *Proboscis:* 1.48 mm. *Forefemur:* 1.7 mm. *Abdomen:* about 2.25 mm. *Head:* median longitudinal light stripe of vertex with scales predominantly narrow, a few broad ones usually present, some of the light scales with yellowish tinge; narrow occipital scales largely light yellowish; erect scales black; some of the light scales of orbital line light yellowish; labium with median light ring less than 0.3 of proboscis length, pure white in color, and with small dorsoapical patch of white scales; palpus with a few white scales on apex of segment 4. *Thorax:* integument dark brown; mesonotal light scaling not sharply contrasting with dark, some of the scales white, others yellowish and light coppery; prescutellar area with a conspicuous posterior line or patch of broad light scales posteriorly; scutellum with dingy white scales on all lobes, usually a very few dark scales on apex of midlobe; paratergite scales pure white; pleural scaling rather extensive, all pure white except for very slightly yellowish on *apn* and *ppn*, latter sometimes with a few scattered dark scales; *psp* usually with a few scales; *pra* with conspicuous scales below as well as above bristles, those above sometimes slightly yellowish or dingy white. *Legs:* femora barred with white scales, some dingy or slightly yellowish, particularly at and near apex; preapical femoral tufts poorly to moderately developed on foreleg and midleg, largely with dark scales, very poorly developed on hindleg where scales are shorter than width of femur; tibiae barred and spotted with white to light yellowish scales, less extensively on hindleg; tarsal segment 1 with basal and apical white rings on all legs, a variable amount of whitish or slightly yellowish scaling in between on foreleg and midleg, usually with a small submedian white ring on hindleg which is extensively dark in the middle on all surfaces; tarsal segment 2 of foreleg and midleg with apical white ring, segments 3 and 4 usually completely dark, sometimes segment 3 with a few apical whitish scales, segment 5 entirely white; hindtarsal segments 2 and 3 white from 0.5–0.67 to apex, segment 4 all dark, segment 5 all white. *Wing:* dorsal scales predominantly dark; a conspicuous pattern of light scales, mostly pure white, some dingy, usually a few light yellowish; vein C usually with small sectoral and subcostal light areas; small preapical light area on vein R_1; prehumeral light spot on vein C always present, usually continuous with humeral so that base of C is predominantly light; prehumeral section of remigium white-scaled for basal half. *Haltere:* knob with dark scales above and some white or whitish scales below and proximad. *Abdomen:* light scaling of dorsum of tergites dingy white to light yellow, variable in extent but usually less extensive than dark scaling on proximal segments; sternites V-VII with short apical tufts of dark scales.

MALE.—Essentially as in the female. *Labium:* median light ring very narrow and dorsal apical patch reduced, rarely a line of light scales dorsally proximad of ring. *Palpus:* exceeding proboscis by almost length of segment 5; light scaling usually white and variable in extent, usually as follows, (1) basal and apical bands on segment 2, (2) a submedian, usually a distinctly preapical band, and sometimes a few apical scales on segment 3, (3) a narrow basal band and a few apical scales on segments 4 and 5. *Abdomen:* sternites VI,VII with rather distinct apical tufts, V and VIII with very poorly developed tufts.

MALE GENITALIA (fig. **236**).—As figured; diagnostic characters as in the key; lateral scales and sternal tuft dark; basal tergomesal and mesal hairs golden. *Segment IX:* tergite lobe very poorly defined, usually with 2 hairs. *Sidepiece:* relatively long and narrow; basal tergomesal area with very dense large patch of hairs, the more basotergal thickened, long and rather straight, the more distal and mesal more slender, shorter and rather strongly curved but with apices simple; specialized basal mesal seta strongly developed; distal tergomesal margin with setae not markedly differentiated; middle of tergal surface with long slender hairs in about 2 rows merging into basal tergomesal patch; middle of mesal surface with poorly defined, sparse concentration of hairs similar to those occurring distad and ventrad; inner sternal scales about 8–16, all broad and striated, the distal longer. *Claspette:* appendage short-pedunculate, expanded portion bladelike, sharply pointed and with obtuse basal angle. *Clasper:* relatively short, slender, with 1 short subapical seta; spiniform long and slender, nearly straight except for moderate subapical curvature. *Phallosome:* aedeagus short and broad, distal portion strongly expanded, apex truncate or slightly emarginate.

PUPA (fig. **236**).—*Abdomen:* 2.74 mm. *Trumpet:* 0.37 mm. *Paddle:* 0.76 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately to strongly pigmented, ventral surface lighter; mesonotum with a pair of very long submedian clear unpigmented lines joined across midline on pronotum but separated by lightly pigmented median stripe in caudal portion; hairs moderately pigmented. *Trumpet:* uniformly moderately pigmented. *Metanotum:* without clear spots laterad where it is very dark, central area lightly pigmented. *Abdomen:* moderately to strongly pigmented, indefinitely lighter on broad median dorsal area; no clear unpigmented spots; hairs moderately to strongly pigmented. *Paddle:* strongly pigmented except for much lighter broad lateral margin and black midrib; external margin with distinct but sparse dorsal spicules.

LARVA (fig. **237**).—*Head:* 0.76 mm. *Siphon:* 0.87 mm. *Anal Saddle:* 0.24 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Head:* hair 1-C usually 2,3b; 4,6-C usually with 5 or more branches; pigmentation of head capsule rather strong. *Segment VIII:* comb scales in middle of posterior row well pigmented, base of free portion elongate and with 1 or sometimes 2 pairs of sharp denticles, distal part long, slender, pointed apically and without fringes. *Siphon:* index about 3.5; moderately to rather strongly pigmented, uniformly very densely long-spiculate. *Anal Segment:* long marginal spicules with few or no fringes; body of saddle densely long-spiculate ventrolaterally.

MATERIAL EXAMINED.—470 specimens; 139 ♀; 116 ♂; 46 pupae; 169 larvae; 6 individual larval rearings.

SYSTEMATICS.—The adults of *bougainvillensis* are superficially similar to *schlosseri, neogeorgianus, hollingsheadi,* and *samoanus* and the larvae to the first 3 species (*samoanus* unknown). The pupa is markedly different from all these, however, and superficially resembles *fijiensis* in the mesonotal pattern of clear areas.

There is a great deal of variation in the adult ornamentation and in the larvae of *bougainvillensis.* It is probable that more than 1 species is confused under this name, but without individual rearings it is impossible to determine the status of the variants. This species appears to be dominant on Bougainville Island and has been collected only a few times elsewhere. The illustrations are based on individually reared specimens from Guadalcanal; these agree with the Bougainville series described by Marks except in a few details of the chaetotaxy of immature stages.

I have identified as *bougainvillensis* all the material of the dark *kochi* type from Bougainville except for a few specimens which appear to be *hollingsheadi.* As suggested above, it seems probable that this material includes more than 1 species.

It is probable that *bougainvillensis, hollingsheadi, neogeorgianus,* and *schlosseri* form a complex similar to the *solomonis* complex (see under *solomonis*) and that some of these species were formed through hybridization.

BIONOMICS AND DISEASE RELATIONS.—On Bougainville the immature stages of this species have been collected most commonly in the leaf axils of a species of *Sararanga* (Pandanaceae) and in pandanus. Two collections from this island are from treeholes and 2 from ground pools; it is very likely that in both instances these reports are due to an error in labeling. On Guadalcanal, *bougainvillensis* was collected only once, in a pandanus in association with *fuscipalpis.*

Apparently all known adults of *bougainvillensis* have been reared, and none have been collected in nature. Nothing is known therefore of their habits or disease relations.

DISTRIBUTION (fig. **225**).—*Solomon Islands:* Bougainville; Guadalcanal; reported also from Vella Lavella and Banika (Russell) by Marks (1947:26), but these specimens could be *neogeorgianus, hollingsheadi, schlosseri,* or *bougainvillensis.* Not known elsewhere.

9. Aedes (Finlaya) burnetti Belkin, n. sp.

Figs. **225, 238, 239**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins (F44) and genitalia slide (580725-3), Tholo-i-Suva, Viti Levu, Fiji, from leaf axil of *Freycinetia Storkii,* Feb. 20, 1958, G. F. Burnett (USNM, 64782). *Allotype:* ♀ with associated larval and pupal skins (F38), same data as holotype (USNM). *Paratypes:* 5 ♀ with associated larval and pupal skins (F32, 35, 41, 42, 46), 1 ♀ with associated pupal skin (F27), same data as holotype.—This species is dedicated to G. F. Burnett in recognition of his contributions to the knowledge of the mosquitoes of Fiji.

FEMALE.—*Wing:* 2.85 mm. *Proboscis:* 1.52 mm. *Forefemur:* 1.92 mm. *Abdomen:* about 2.53 mm. In general similar to *freycinetiae* but darker and with yellow scaling paler and dingy, even less differentiated from the white scaling; differing from *freycinetiae* chiefly in the following additional characters. *Head:* many of the pale scales of vertex dingy white or with yellowish tinge, broad pale scales more numerous on sides of median light stripe; yellow scaling of labium lighter, no preapical ventral dark scales and basal dorsal pale scales not as numerous; torus of antenna with scales pale yellowish. *Thorax:* light scaling of scutellum pale yellowish, scales small and very scanty, particularly on midlobe; scales of *apn, ppn,* and usually *psp* pale yellowish, the latter usually more numerous; no scales below *pra* bristles but a patch against upper *stp. Legs:* femora and tibiae barred with dark, yellowish and dingy white scales, tibiae with some pure white scales; foretarsus and midtarsus with extensive dorsal dark scaling in the middle on segment 1, segment 2 with dorsal dark scaling extending from base to usually at least 0.5, segments 3 and 4 largely dark dorsally, segment 3 with conspicuous apical dorsal white patch; hindtarsus with more extensive dorsal dark scaling and more conspicuous median white ring on segment 1, segment 2 with dorsal scaling extending at least to 0.5 from base dorsally, segment 3 dark dorsally from base to about 0.7, the apex white, segment 4 completely dark on all surfaces. *Wing:* darker than in *freycinetiae,* yellowish scaling very pale and less extensive on vein C. *Abdomen:* dorsum of tergites with dark scaling more extensive but pale scaling still predominating on proximal segments; sternites with better developed apical tufts, present on V-VII.

MALE.—Essentially as in the female and differing from *freycinetiae* in the same characters except for following. *Head:* median light stripe of vertex very broad and with scales largely broad, dingy white or yellowish, a few narrow whitish scales restricted to caudal portion; erect scales yellowish in middle. *Labium:* pale yellowish in distal 0.6–0.55 and with some yellowish scales on basal dark part dorsally. *Palpus:* exceeding proboscis by about length of segment 5; extensively pale-scaled; segment 2 with broad subbasal and apical whitish bands; segment 3 with broad submedian band, lateral preapical patch and large apical band of whitish and yellowish scales; segments 4 and 5 largely pale, segment 5 with submedian dark band. *Abdomen:* dorsum of tergites almost entirely yellow.

MALE GENITALIA (fig. 238).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe poorly defined, with 2 hairs. *Sidepiece:* short and broad; basal tergomesal area with the more basal hairs moderately long, densely packed, and with simple curved apex, the more distal somewhat shorter, densely packed, particularly the most distal and mesal, and with more or less strongly expanded lanceolate curved apices; specialized basal mesal seta strongly developed, distal portion strongly expanded and with thickened distal tapered shaft (in dorsal aspect); distal tergomesal area with numerous hairs; middle of tergal surface with a single row of hairs extending basad toward basal tergomesal area; middle of mesal surface with a large patch of moderately long straight hairs distinctly different but not much longer than more distal or ventral hairs; inner sternal scales all broad and striated, in a long row, the more proximal very short, the distal extending beyond apex of sidepiece. *Claspette:* details not studied; appendage apparently of the usual bladelike type with strong basal angle on expanded portion. *Clasper:* short, widened in the middle, with a small subapical seta; spiniform long, moderately curved distally. *Phallosome:* aedeagus short, strongly swollen distally; apex slightly emarginate. *Proctiger:* 1 pair of cercal setae.

PUPA (fig. 238).—*Abdomen:* 2.95 mm. *Trumpet:* 0.35 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, mesonotum strongly darkened but without sharp line of demarcation, with 2 pairs of large submedian clear unpigmented spots (and probably a median caudal spot); hairs moderately to rather strongly pigmented. *Trumpet:* strongly pigmented, basal portion darker. *Metanotum:* strongly darkened but without sharp line of demarcation; with a very large lateral spot, a small submedian spot, and a transverse submedian streak of clear unpigmented integument on each side. *Abdomen:* tergites I-III darkened, less on IV, not sharply contrasting with remainder of tergites which are lightly pigmented; tergites II-IV each with a single pair of poorly pigmented submedian spots or streaks in distal half; hairs moderately pigmented. *Paddle:* very lightly pigmented; apex very slightly emarginate; dorsal marginal spicules small, indistinct.

LARVA (fig. 239).—*Head:* 0.55 mm. *Siphon:* 0.61 mm. *Anal Saddle:* 0.23 mm. Chaetotaxy as figured, hairs moderately to rather strongly pigmented; diagnostic characters as in the key; more strongly pigmented than any other yellowish species. *Head:* bright light yellowish brown except for black collar; hair 0-C distinct; 3-C apparently represented by a spicule at the anterior margin; 4-C not in line with 7,6-C, removed caudad; 4,6-C usually double. *Segment VIII:* comb moderately pigmented; comb scales in middle of posterior row with base of free part slender, usually without lateral denticles but sometimes with 1 or even 2 pairs of minute denticles, distal part strongly broadened, spatulate, apparently without marginal fringe. *Siphon:* index about 4.0; lightly to moderately pigmented; spiculation practically invisible except apically in small patches. *Anal Segment:* saddle lightly to moderately pigmented; large spicules restricted to caudal margin.

MATERIAL EXAMINED.—35 specimens; 8 ♀; 2 ♂; 9 pupae; 16 larvae; 8 individual rearings (7 larval, 1 pupal).

SYSTEMATICS.—*A. burnetti* is closely related to *freycinetiae,* which it resembles in all stages but from which it is readily differentiated. The fact that 2 such closely related species occur on a single island is indicative, I believe, of sympatric ecological speciation. In several respects *burnetti* is intermediate between *freycinetiae* and *fijiensis* and may have been formed through hybridization of the ancestral stocks of these 2 species.

BIONOMICS AND DISEASE RELATIONS.—Burnett (*in lit.*) found the immature stages of this species in the leaf axils of *Freycinetia Storkii,* a forest vine of the family Pandanaceae, but this species may also occur in *F. Milnei,* from which Laird (1957) reported the related *freycinetiae.* All the known adults are reared; nothing is known of their bionomics or disease relations.

DISTRIBUTION (fig. **225**).—*Fiji:* Viti Levu. Not known elsewhere.

10. Aedes (Finlaya) fijiensis Marks

Figs. 225, 240, 241

1947. *Aedes* (*Finlaya*) *fijiensis* Marks, Queensland U., Papers Dept. Biol. 2(5):26–32. TYPE: holotype ♂ (D·856), from pandanus axil, Samabula, Viti Levu, Fiji, Aug. 13, 1943, R. A. Lever (QUEEN).

Aedes (*Finlaya*) *fijiensis* of Iyengar (1955:27); Laird (1956, 1957); Stone, Knight, and Starcke (1959).

Aedes (*Finlaya*) *kochi* of Taylor (1934:17); Edwards (1935:129–130); Insects of Samoa (1935:109); Paine (1935, 1943:23–24); Lee (1944*a*:63, in part); Knight, Bohart, and Bohart (1944:34, 52, in part); Stone and Bohart (1944:211, in part).

Finlaya poicilia of Bahr (1912:18).

FEMALE.—*Wing:* 2.98 mm. *Proboscis:* 1.77 mm. *Forefemur:* 1.98 mm. *Abdomen:* about 2.32 mm. Light scaling largely pure white, sharply contrasting with dark. *Head:* vertex with rather wide median longitudinal stripe of pure white scales which are largely broad and only a very few narrow; submedian patch of broad dark scales contrasting sharply; erect scales black; labium with median white ring quite variable in extent, 0.15–0.35 of proboscis, and a variable apical dorsal white patch; palpus with a few white scales. *Thorax:* integument very dark; mesonotal light scaling pure white, extremely variable in extent but always contrasting very sharply with dark scaling; scutellum with pure white scales on all lobes, a variable but usually very large apical patch of dark scales on midlobe; paratergite with pure white scales; pleuron with pure white scaling restricted in extent; *psp* without scales; *ppn* usually with some of the broad scales dark; lower part of *pra* with few scales. *Legs:* femora barred with white scales, subapical tufts of long dark scales strongly developed on forefemur and midfemur, poorly on hindfemur; tibiae barred with white scales; foretarsal segment 1 with a very narrow basal white ring, a small median dorsal patch or incomplete white ring, and a wide apical white ring, segment 2 with very narrow white or whitish dorsal patch or incomplete ring, segments 3 and 4 completely dark, segment 5 all white; midtarsal segment 1 similar to that of foreleg except that basal and apical rings are much wider and subequal, median patch is larger, and usually a premedian white patch is present, segments 2–5 as on foreleg; hindtarsal segment 1 with broad basal and apical and narrow median white rings, segments 2 and 3 with broad apical white rings, about 0.35–0.4 of segment length, segment 4 all dark, segment 5 all white. *Wing:* dorsal scales very broad and short; light scales white, variable in extent but usually restricted; vein C with sectoral, subcostal, and apical pale areas small, prehumeral and humeral pale areas variable. *Haltere:* knob with very dark scales above, a few light scales below. *Abdomen:* light scaling of dorsum of tergites variable in extent, usually with both white and yellowish scales, nearly always less extensive than dark scaling; sternites with dark scales predominating; sternites V-VII with outstanding apical tufts of dark scales, sometimes reduced on V.

MALE.—Essentially similar to the female. *Labium:* very narrow median white ring. *Palpus:* moderate dorsal bands or incomplete rings of white scales, (1) subbasally and apically on segment 2, (2) premedially, postmedially, and sometimes preapically on 3, (3) basally on 4, (4) basally and apically on 5. *Legs:* light scaling usually more extensive. *Abdomen:* dorsal light scaling of tergites more extensive; abdominal sternite VIII with dark outstanding apical scales.

MALE GENITALIA (fig. **240**).—As figured; diagnostic characters as in the key; external scales of sidepiece dark; sternal mesal scales and basal tergomesal and mesal hairs all golden. *Segment IX:* tergite lobe poorly defined, usually with 1,2 hairs. *Sidepiece:* short and broad; basal tergomesal area with very dense large patch of hairs, the more basal moderately curved and with simple attenuate apices, the more distal straight and with short curved lanceolate apices; specialized basal mesal seta strongly developed; distal tergomesal margin with a more or less definite line of 4-6 long curved hairs; middle mesal surface with dense clump of short straight hairs continued distally and sternally as a more diffuse field; inner sternal scales 4-7, the more distal very long, narrow and striated, the more proximal shorter and becoming bristlelike basad. *Claspette:* appendage pedunculate, expanded portion bladelike and with acute basal angle. *Clasper:* very long, slender; 1-3 subapical hairs which are at least 0.5 of spiniform length; spiniform very long, slender, sickle-shaped. *Phallosome:* aedeagus short and broad, apex truncate or emarginate in dorsal aspect. *Proctiger:* cercal setae 1,2.

PUPA (fig. **240**).—*Abdomen:* 2.78 mm. *Trumpet:* 0.5 mm. *Paddle:* 0.65 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, mesonotum darker; mesonotum with a pair of submedian clear unpigmented lines separated by darkly pigmented median area, not extending much cephalad of hair 8-C and not connected anteriorly; hairs moderately to strongly pigmented. *Trumpet:* uniformly moderately to rather strongly pigmented. *Metanotum:* darkened and without unpigmented areas. *Abdomen:* moderately pigmented, darker on segments I,II and middorsally on III,IV but without sharp separation between darker and lighter areas; no clear unpigmented areas on tergites; hairs moderately to rather strongly pigmented. *Paddle:* moderately pigmented, midrib darker and bright; external margin with some very poorly defined short dorsal spicules.

LARVA (fig. **241**).—*Head:* 0.7 mm. *Siphon:* 0.75 mm. *Anal Saddle:* 0.2 mm. Chaetotaxy as figured, hairs moderately to rather strongly pigmented; diagnostic characters as in the key. *Head:* hair 1-C usually 3b; 4,6-C usually double (2-4b); hair 4-C not in line with 6,7-C, removed caudad. *Abdomen:* hair 6-III-V usually double or triple. *Segment VIII:* comb scales in middle of posterior row very poorly pigmented and difficult to see, base of free part with 1,2 pairs of sharp denticles, distal part flattened, expanded, rounded apically and fringed. *Siphon:* index about 3.0–3.5; very lightly pigmented, uniformly densely short-spiculate. *Anal Segment:* conspicuous fringed spicules restricted to caudolateral portion of saddle; hair 1-X usually double or triple; gills usually rather narrow.

MATERIAL EXAMINED.—201 specimens; 75 ♀; 23 ♂; 30 pupae; 73 larvae; 12 individual rearings (11 larval, 1 pupal).

SYSTEMATICS.—The adults of *fijiensis* are superficially very similar in coloration to *kochi* (Doenitz, 1901) from New Guinea and apparently adjacent islands and northeast Australia. The 2 species, however, differ markedly in male genitalia and in the immature stages. In the South Pacific the nearest relative of *fijiensis* appears to be sp. 22, a sympatric form which may prove to be an albinistic *fijiensis*. *A. bougainvillensis,* although possessing a pupa with a somewhat similar pattern of iridescent lines on the cephalothorax, does not appear to be closely related to *fijiensis*.

There is a great deal of variation in all features of the adults of *fijiensis,* particularly in the extent of the white scaling on the labium, thorax, wing, and abdomen. Without individual rearings from specific habitats, it is impossible to determine whether a single highly variable species or 2 or more sibling species are involved in my interpretation of *fijiensis*.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *fijiensis* are found predominantly in pandanus leaf axils and less commonly in the axils of *Alocasia indica.* Paine (1943:23) states that this species is never found in the leaf axils of the cultivated taro, which is the principal breeding site of *Uranotaenia colocasiae,* a partly predaceous species. I have seen a single female of *fijiensis* bred from *Freycinetia* sp.

Females of *fijiensis* are nocturnal feeders and attack man vigorously and persistently. The relation of this species to the transmission of filariasis in Fiji is being investigated at present. It has generally been regarded to be of no significance, but recent work suggests that it may be an important vector (Symes, Burnett). Symes (1955:280–281; 1959) found *fijiensis* to be the most heavily infected mosquito with filarial larvae in nature in Fiji and demonstrated that this species is highly susceptible to nonperiodic *Wuchereria bancrofti* and that a large percentage of the larvae of this filaria reach the infective stage in *fijiensis* under experimental conditions.

DISTRIBUTION (fig. 225).—*Fiji:* Vanua Levu; Taveuni; Vanua Mbalavu; Makongai; Viti Levu; Moala; probably present on other islands also. Not known elsewhere.

11. Aedes (Finlaya) franclemonti Belkin, n. sp.

Figs. 225, 242, 243

TYPES.—*Holotype:* ♂ (JGF, 24) with genitalia slide (45·11·7*a*), Munda, New Georgia, Solomon Islands, from axil of broad leaf pandanus, Aug. 17, 1944, J. G. Franclemont (USNM, 64783). *Allotype:* ♀, same data as holotype (USNM). *Paratypes:* 11 ♀, 24 ♂, same data as holotype.—This species is dedicated to John G. Franclemont in recognition of his numerous contributions to the knowledge of the mosquitoes of the Solomon Islands.

Aedes (*Finlaya*) *flavipennis* in part of Edwards (*in* Paine and Edwards, 1929:315; 1932:149); Taylor (1934:17).

FEMALE.—*Wing:* 2.65 mm. *Proboscis:* 1.53 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.35 mm. Superficially rather similar to *knighti* in coloration but strikingly different in the following characters. *Head:* light scaling dingy white or very pale beige; median longitudinal light stripe narrow, largely with narrow scales but some broad ones usually present; decumbent dark scales numerous, very dark brown; erect scales all dark; labium with broad to very broad median beige to yellowish median ring, usually more than 0.35 of proboscis length on ventral surface, dorsal apical light ring very narrow, on ventral surface the apical and median rings not connected; palpus with a few whitish scales on apex of segment 4. *Thorax:* mesonotal pattern indistinct, pale scales largely beige to pale golden, dark scales bronzy, some scales intermediate in color; prescutellar area with some of the scales broadened caudad; scutellum with scales pale beige or whitish, usually no dark scales on midlobe; paratergite scales pure white; pleural scales largely pure white except for *apn* and *ppn* which are pale beige; rarely 1–3 dark scales on upper part of *ppn; psp* usually without scales; *pra* with scales below and above bristles. *Legs:* femora and tibiae moderately barred or ringed with whitish to pale yellowish brown scales, lighter on hindleg; femoral preapical tufts distinct on foreleg and midleg, not developed on hindleg; tarsal segment 1 of foreleg and midleg extensively pale above, with rather broad basal, very broad apical, and single or double median pale rings usually beige or yellowish in color, midventral surface completely light; hindtarsal segment 1 with broad basal and apical and narrow median rings of pure white scales; foretarsal and midtarsal segment 2 with very broad apical beige or yellowish ring, usually nearly half of segment on midleg, segments 3 and 4 both with some apical pale scales, segment 5 all light; hindtarsal segments 2 and 3 with apical pure white ring covering at least 0.4 of segment, segment 4 all dark, segment 5 all white. *Wing:* light in appearance; light scaling largely white or whitish; base of vein C extensively white, prehumeral and humeral pale spots usually fused and prehumeral dark spot reduced; sectoral light area usually long; accessory subcostal pale area always developed on vein C, either fused with subcostal pale area or separated by only a small dark area; dorsal scales of R_{2+3} elongate but broad. *Haltere:* knob scales largely brown above. *Abdomen:* dorsum of proximal tergites with light scaling restricted, extensively light-scaled on distal tergites, scales dark beige; short apical tufts on sternites VI,VII only.

MALE.—Essentially as in the female. *Labium:* median pale ring usually sharply defined dorsally for about 0.20 or more of proboscis length. *Palpus:* about as long as proboscis or only slightly longer, extensively banded with white scales with yellowish reflections; segment 2 with very broad subbasal and narrow apical pale bands; segment 3 with very broad subbasal light band, at least as long as basal dark area, and small preapical light patch; segments 4 and 5 with variable basal light patches, apex of segment 5 with whitish scales. *Abdomen:* dorsum of tergites more extensively pale-scaled.

MALE GENITALIA (fig. 242).—As figured; diagnostic characters as in the key; lateral and inner sternal scales of sidepiece dark, some lighter ones among the latter; basal tergomesal scales and hairs and mesal hairs golden. *Segment IX:* tergal lobe poorly differentiated, usually with 3,2 hairs. *Sidepiece:* moderately long; basal tergomesal area with dense patch of long, broad and striated scales tergally and moderately long curved hairs mesally; specialized basal mesal seta strongly developed; distal tergomesal border with a row of more or less differentiated hairs extending from basal tergomesal area to apex of sidepiece; middle of tergal surface with long bristles and shorter hairs extending from basal tergomesal area to apex of sidepiece; middle of mesal surface with short hairs dense but not differentiated from the more distal or ventral; inner sternal scales about 12-10, all striated, majority not reaching apex of sidepiece; apical sternal bristle very strongly differentiated. *Claspette:* appendage sessile, very long, basal angle of expanded part obtusely rounded. *Clasper:* moderately long, apparently without subapical hairs; spiniform long, unusually heavy proximally. *Phallosome:* aedeagus rather long, distal part strongly expanded, apex rounded. *Proctiger:* 3,4 pairs of short cercal setae; tergite densely short-spiculate.

PUPA (fig. **242**).—*Abdomen:* 3.05 mm. *Trumpet:* 0.57 mm. *Paddle:* 0.75 mm. Chaetotaxy as figured; diagnostic characters as in the key; in life cream-colored and with a conspicuous Y-shaped median dorsal sharply marked black pattern embracing the trumpets, mesonotum and metanotum, and abdominal tergites I-IV. *Cephalothorax:* practically colorless except for extremely dark sharply marked mesonotum; hairs extremely lightly pigmented. *Trumpet:* uniformly and completely extremely dark. *Metanotum:* central part extremely dark and sharply differentiated. *Abdomen:* practically colorless except for sharply marked parallel-sided extremely dark narrow median dorsal stripe which is slightly narrowed on tergite IV; no clear unpigmented areas on dark stripe; hairs extremely lightly pigmented. *Paddle:* practically colorless; apex slightly emarginate; dorsal marginal spicules extremely small, practically invisible.

LARVA (fig. **243**).—*Head:* 0.59 mm. *Siphon:* 0.74 mm. *Anal Saddle:* 0.23 mm. Chaetotaxy as figured, hairs extremely lightly pigmented; diagnostic characters as in the key; in life the larva is whitish green in color. *Head:* hair 1-C usually 2b; 4-C usually single; 6-C usually double; 14-C very small, usually single. *Thorax:* hair 14-M very small, usually single. *Abdomen:* hair 13 very small, usually single or double. *Segment VIII:* comb rather small, very poorly pigmented, and difficult to see; comb scales in middle of posterior row with base of free part elongate and usually with 1 pair of sharp denticles, distal part long, rather slender, without strong central thickened shaft, sharply pointed apically or with small apical fringes or spicules. *Siphon:* index 3.7–4.5; extremely poorly pigmented; rather densely spiculate distally but spicules very fine and difficult to see. *Anal Segment:* saddle without conspicuous spicules except on caudal margin; gills unusually long.

MATERIAL EXAMINED.—175 specimens; 26 ♀; 41 ♂; 33 pupae; 75 larvae; no individual rearings.

SYSTEMATICS.—*A. franclemonti* is a very striking species and is easily recognized in all stages except perhaps in the female. It appears to combine some of the characteristic features of the dark and the light species of the group, as in *knighti*, and may have arisen through hybridization between a species of each group. In all stages the characteristics are predominantly of the light forms.

This species is known with certainty only from the New Georgia group. The populations from the several islands in this group differ considerably, but since there is also a great deal of individual variation and no individual rearings are available, it is not possible to analyze the differences at present and to determine the possible confusion of more than 1 form under *franclemonti*. The single female from Sterling Island in the Treasury group conforms in general to the rest of the females but appears to differ somewhat and may prove to belong to a distinct species. Species 24 from Malaupaina appears to be related to *franclemonti* but differs from it in having the base of vein C largely dark and without a prehumeral light spot.

BIONOMICS AND DISEASE RELATIONS.—According to J. G. Franclemont (field notes), this species utilizes the leaf axils of a broad-leaf pandanus. The single female mentioned by Edwards (*in* Paine and Edwards, 1929:314–315) was captured in the act of biting at 6:00 A.M., but all the other known specimens were apparently reared. Nothing is known of the disease relations of this species.

DISTRIBUTION (fig. **225**).—*Solomon Islands:* Sasavele; Rendova; Roviana; New Georgia; ? Sterling (Treasury); unspecified island (E. G. Sayers, 1930, LOND). Not known elsewhere.

12. Aedes (Finlaya) freycinetiae Laird

Figs. **225**, **244**, **245**

1957. *Aedes* (*Finlaya*) *freycinetiae* Laird, Pacific Sci. 11:343–351. TYPE: holotype ♂, Glen Pool, Suva, Viti Levu, Fiji, from leaf axils of *Freycinetia Milnei*, Mar. 1, 1954, M. Laird (WELL).

Aedes (*Finlaya*) *freycinetiae* of Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.68 mm. *Proboscis:* 1.47 mm. *Forefemur:* 1.72 mm. *Abdomen:* about 2.23 mm. In general appearance and tarsal coloration more or less similar to *solomonis*. *Head:* median longitudinal light stripe of vertex moderately wide, scales largely pure white and narrow, usually a few broad scales present laterally; orbital light line of similar narrow scales; dark decumbent scales numerous and black; erect scales black; labium light in about apical 0.6, scales largely yellow, a variable amount of white on apex and base of yellow dorsally and a variable amount of dark scaling preapically ventrally, dark basal part of labium with some yellowish scales dorsally; palpus largely dark-scaled, apex of segment 4 with a conspicuous but small tuft of pure white scales; torus of antenna with scales largely pure white, a few dingy. *Thorax:* mesonotal and pleural integument largely deep black; mesonotum with light and dark scales sharply contrasting in an indefinite but extensive light pattern, dark scales very deep bronzy black, light scales pure white; prescutellar area with only a few scales broadened; scutellum with dingy white or light beige broad scales on all lobes, midlobe with extensive apical patch of bronzy black scales, lateral lobes with small apical patches of similar scales; paratergite and pleuron with all scales pure white, scaling very extensive; *psp* with only 1,2 scales; *pra* with scales below and above bristles. *Legs:* femora and tibiae barred and spotted with white, remainder black and pale yellow, rather speckled on anterior surface with black predominating, largely yellow on posterior surface; forefemur and midfemur with preapical tufts extremely small, scales less than half of femoral shaft, hindfemur with no indication of tuft; foretarsus and midtarsus usually largely pale yellowish, with some white scales somewhat as in *solomonis,* segment 1 with varied amount of scattered dark scales dorsally in central part, segment 2 with some dark scales at base; hindtarsus usually predominantly yellow, segment 1 with broad basal and apical white rings and variable patches of dark scales (sometimes scattered scales) and a few white scales dorsally in the center, segments 2 and 3 with broad apical white rings and a variable dorsal patch or ring of dark scales at base, segment 4 with variable dorsal patch of dark scales at base and white scales on apex, never completely dark, sometimes dark scales greatly reduced or apparently completely absent on segments 2–4, segment 5 entirely beige or whitish; frequently all tarsi with dark scaling rather extensive. *Wing:* dorsal surface of veins with black, yellow, and white scales; yellow scaling from light to rather deep, restricted to anterior portion of wing largely on vein C where it interrupts extensively the dark scaling; base of vein C predominantly white; pattern variable but usually rather speckled; dorsal scales on vein R_{2+3} short and broad. *Haltere:* scaling of knob largely pale yellow, a few scales dark. *Abdomen:* dorsum of tergites predominantly pale yellow, with some patches of white scales and scattered dark scales, sometimes caudal tergites with light scaling restricted to patches; sternites VI,VII with poorly developed apical tufts of black scales, V with only a few outstanding apical scales.

MALE.—Essentially as in the female except for the following. *Labium:* varied in coloration, usually almost completely dark-scaled, sometimes extensively pale yellow in distal 0.3 or more and with scattered pale scales proximad. *Palpus:* exceeding proboscis usually by full length of segment 5; conspicuously but usually very narrowly banded dorsally with white scales and with a few scattered yellowish scales as follows, (1) segment 2 with subequal bands near base and at apex, (2) segment 3 with submedian and apical bands and a postmedian patch or band, latter usually slightly yellowish, (3) segments 4 and 5 with basal and apical bands, apical very small on segment 4. *Abdomen:* tergites almost entirely pale-scaled, predominantly yellowish, white patches usually small and discrete, dark scales brown and scattered, more numerous laterally on distal segments.

MALE GENITALIA (fig. 244).—As figured; diagnostic characters as in the key; lateral scales of sidepiece dark; inner sternal scales, tergomesal and mesal hairs all golden. *Segment IX:* tergite lobe poorly defined, usually with 1,2 hairs. *Sidepiece:* moderately long; basal tergomesal area basally with a very dense patch of long simple, rather straight hairs, becoming shorter and more curved mesally, all with simple apices; specialized basal mesal seta long, slender and curved, without distinct expansion distally and with sharp slender long apical part; distal tergomesal area with rather numerous relatively long simple hairs; middle of tergal surface with double or triple row of hairs connecting basal and distal tergomesal areas; middle of mesal surface with sharply differentiated small patch of long straight hairs markedly different from the shorter curved hairs distad and sternad; inner sternal scales all broad and striated, in a moderate patch, the more basal short, the more distal exceeding sidepiece shaft. *Claspette:* appendage pedunculate, distal part expanded and with rather obtuse basal angle. *Clasper:* long, slender, distal part narrowed; a small subapical seta; spiniform long. *Phallosome:* aedeagus rather long, distal part moderately expanded, apex poorly sclerotized, rounded. *Proctiger:* 1 pair of cercal setae.

PUPA (fig. 244).—*Abdomen:* 2.85 mm. *Trumpet:* 0.39 mm. *Paddle:* 0.57 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately to strongly pigmented, mesonotum strongly darkened but without sharp line of demarcation, with 1 pair of small clear unpigmented submedian spots. *Trumpet:* strongly pigmented, darkened basally. *Metanotum:* strongly darkened but without sharp line of demarcation; usually with 3 small, poorly defined, clear unpigmented spots on each side. *Abdomen:* tergites I-IV strongly darkened, contrasting sharply with light posterior segments, tergite V slightly darkened laterally at base; tergites II-IV each with 1 pair of large submedian clear unpigmented spots in basal half, a pair of indistinct submedian light areas in distal half, and more or less distinct clear areas at base of the more dorsal hairs (not shown in figure). *Paddle:* a uniform bright light yellowish brown, midrib darker; apex rounded or very slightly emarginate; spicules very distinct, rather long but very fine on outer margin.

LARVA (fig. **245**).—*Head:* 0.56 mm. *Siphon:* 0.55 mm. *Anal Saddle:* 0.22 mm. Chaetotaxy as figured, hairs moderately pigmented; diagnostic characters as in the key. *Head:* very lightly pigmented except for black collar; hair 0-C distinct; 3-C apparently represented by a spicule on anterior margin; 4-C not in line with 6,7-C, removed caudad; 4,6-C usually 3,2b. *Segment VIII:* comb very poorly pigmented; comb scales in middle of posterior row with free part without distinct separation into basal and distal half, no basal denticles, with a slender long stem and a broad spatulate apex, only latter with fringe (fringe reported on stem by Laird is that of the superimposed apex of scales from preceding row). *Siphon:* index about 3.0–3.5; extremely lightly pigmented; spicules invisible except in patches on apex. *Anal Segment:* saddle very poorly pigmented; marginal spicules largely dorsad of hair 1-X.

MATERIAL EXAMINED.—144 specimens; 23 ♀; 17 ♂; 23 pupae; 81 larvae; 11 individual rearings (5 larval, 6 pupal).

SYSTEMATICS.—*A. freycinetiae* is a very strikingly marked species, which appears to be closely related to the sympatric *burnetti.* There is considerable resemblance in adult ornamentation and the pupal pattern with *solomonis* and the related species. The larva shows several important characters in common with *fijiensis,* particularly in the position of the head hair 4-C and in the relatively strong development of 0-C as well as an indication of 3-C. All these characters, I suspect, are primitive ones in the group as a whole. There is a great deal of variation in the ornamentation of the adults, particularly in the amount of dark scaling on the legs and especially on the tarsi. It is possible that I have confused 2 or more species under *freycinetiae.*

BIONOMICS AND DISEASE RELATIONS.—Laird (1956, 1957:342–343) gives some information on the bionomics of the immature stages of *freycinetiae.* Larvae and pupae were collected by Laird in the leaf axils of *Freycinetia Milnei* Seem, a forest vine of the family Pandanaceae. A single larva (KLK, 930, USNM) was collected by K. L. Knight in a pandanus axil. The known adults have all been reared, and nothing is known of their bionomics and disease relations.

DISTRIBUTION (fig. **225**).—*Fiji:* Viti Levu. Not known elsewhere.

13. Aedes (Finlaya) fuscipalpis Belkin, n. sp.

Figs. **225, 246, 247**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 767-102), Tenaru area, Guadalcanal, Solomon Islands, from leaf axil of pandanus, Dec. 7, 1944, J. N. Belkin and L. J. Lipovsky (USNM, 64784). *Allotype:* ♀ with associated larval and pupal skins (JNB, 767-110), same data as holotype. *Paratypes:* 1 ♀, 5 ♂, 13 pupae, 12 larvae (JNB, 767-1), all with same data as holotype, as follows: 1 ♀ with associated pupal skin (JNB, 767-108), 4 ♂ with associated larval and pupal skins (JNB, 767-101, 103, 109, 113), 1 ♂ (JNB, 767-1) with genitalia slide (560528-11), 2 associated larval and pupal skins, ♀ lost (JNB, 767-111, 112), 1 associated larval and pupal skin, ♂ lost (JNB, 767-107), 6 pupal and 5 larval skins (JNB, 767-1).

Aedes (*Finlaya*) *solomonis* in part of Stone and Bohart (1944:208–209); Marks (1947:57–62); Knight and Marks (1952:545); Iyengar (1955:28); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.92 mm. *Proboscis:* 1.45 mm. *Forefemur:* 1.82 mm. *Abdomen:* about 2.42 mm. Very similar to *solomonis,* from which it differs chiefly in the following characters; yellow scaling paler and not as sharply differentiated from the white; labium with some scattered dark scales on ventral surface preapically, yellow scaling more restricted and not continued proximad on dorsal surface; palpus with only a few white scales on apex of segment 5; torus of antenna with pure white scales; wing more extensively pale-scaled; dorsum of abdominal tergite II largely pale-scaled.

MALE.—Very similar to *solomonis,* differing from it in the same characters as in the female and also in the following. *Labium:* largely dark-scaled, usually completely so on ventral surface, light yellow scaling confined to long dorsal median streak which expands laterad in the middle and a few dorsal apical scales. *Palpus:* segments 4 and 5 with broad rings of dark scales.

MALE GENITALIA (fig. **246**).—As figured; diagnostic characters as in the key; very similar to *solomonis* with the following striking exceptions; basal part of basal tergomesal area with numerous very long thickened bristles, median and distal parts with only slightly lanceolate hairs; specialized basal mesal seta narrower, more ribbonlike; clasper longer, spiniform heavier and relatively shorter.

PUPA (fig. **246**).—*Abdomen:* 2.7 mm. *Trumpet:* 0.35 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *solomonis* except that the dark abdominal stripe is without clear unpigmented spots.

LARVA (fig. **247**).—*Head:* 0.77 mm. *Siphon:* 0.62 mm. *Anal Saddle:* 0.21 mm. Chaetotaxy as figured, hairs very lightly pigmented; diagnostic characters as in the key; very similar to *solomonis;* siphon index about 2.5–3.0; marginal spicules of anal saddle very sparse.

MATERIAL EXAMINED.—38 specimens; 2 ♀; 7 ♂; 15 pupae; 14 larvae; 7 individual rearings (5 larval, 2 pupal).

SYSTEMATICS.—*A. fuscipalpis,* while very similar to *solomonis,* is strikingly distinct in a few characters in all stages, as noted above and in the keys and figures. It is known from a single collection from Guadalcanal. Several adults and larvae from Arundel and Bougainville appear to be quite similar to *fuscipalpis* but differ in details. It is probable that these represent 2 distinct forms, but since the stages are not definitely associated, all this material is provisionally identified as *solomonis.* For a discussion of the relationships of *fuscipalpis,* see under *solomonis.*

BIONOMICS AND DISEASE RELATIONS.—The single collection of *fuscipalpis* was made in pandanus leaf axils in which *solomonis* and *bougainvillensis* were also collected, but it is not definitely known whether or not they were associated in individual axils. Nothing is known of the adult bionomics or their relation to disease transmission.

DISTRIBUTION (fig. **225**).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

14. Aedes (Finlaya) fuscitarsis Belkin, n. sp.

Figs. **225, 248, 249**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 740–208), Poha area, Guadalcanal, Solomon Islands, from leaf axil of broad-leaf pandanus, Nov. 15, 1944, J. N. Belkin and M. Cohen (USNM, 64785). *Allotype:* ♀ with associated larval and pupal skins (JNB, 740-201), same data as holotype. *Paratypes:* 5 ♀, 6 ♂, 12 pupae, 6 larvae (JNB, 740-2), same data as holotype, as follows: 4 ♀ with associated larval and pupal skins (JNB, 740-204-207), 1 ♀ (JNB, 740-2), 2 ♂ with associated larval and pupal skins (JNB, 740-202,203), 4 ♂ (JNB, 740-2), 6 pupal skins (JNB, 740-2).

Aedes (*Finlaya*) *solomonis* in part of Stone and Bohart (1944:208–209); Marks (1947:57–62); Knight and Marks (1952:545); Iyengar (1955:28); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.7 mm. *Proboscis:* 1.42 mm. *Forefemur:* 1.73 mm. *Abdomen:* about 2.27 mm. Very similar to *solomonis,* from which it differs chiefly in the following characters; yellow scaling generally paler and not as sharply differentiated from the white; pale median stripe of vertex usually with several broad white scales laterally; labium with yellow ring more restricted, not continued basad on dorsal surface, with a more or less distinct white or whitish area at base of yellow area dorsally and a variable number of dark scales preapically on lower surface; palpus with only a few yellowish scales on shaft; light scales of *ppn* pure white; *pra* usually with some scales below bristles in addition to those above; midtarsal segment 4 usually with conspicuous broad basal dorsal dark band; hindtarsal segment 4 with broad basal ring and large dorsal apical patch of dark scales.

MALE.—Very similar to *solomonis* and differing from it in the same characters as in the female except for labium and midtarsal segment 4, which are as in *solomonis.*

MALE GENITALIA (fig. **248**).—As figured; diag-

nostic characters as in the key; very similar to *solomonis* with the following striking exceptions; basal part of basal tergomesal area with several very long thickened bristles, median and distal parts with simple tips on all hairs, none distinctly lanceolate; specialized basal mesal seta more slender, apical part not ribbonlike nor markedly widened but pointed; appendage of claspette with distal expanded portion much narrower, almost completely sclerotized and without distinct basal angle; spiniform of clasper heavier.

PUPA (fig. **248**).—*Abdomen:* 2.65 mm. *Trumpet:* 0.4 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *solomonis* except that mesonotum, metanotum, and abdomen diffusely darkened middorsally so that there is no distinct sharply marked middorsal stripe; mesonotum and metanotum with clear unpigmented spots more numerous; trumpet uniformly pigmented.

LARVA (fig. **249**).—*Head:* 0.68 mm. *Siphon:* 0.57 mm. *Anal Saddle:* 0.2 mm. Chaetotaxy as figured, hairs lightly pigmented; diagnostic characters as in the key; very similar to *solomonis;* hair 6-C usually 3-5b; siphon index about 2.5; marginal spicules of anal saddle very sparse.

MATERIAL EXAMINED.—76 specimens; 12 ♀; 17 ♂; 26 pupae; 21 larvae; 13 individual larval rearings.

SYSTEMATICS.—*A. fuscitarsis* is superficially very similar to *solomonis* but is easily distinguished in all stages. It is almost certainly a distinct species, as it is known from 5 separate collections from widely separated localities on Guadalcanal, with all specimens agreeing in the diagnostic characters. Several females and males from Bougainville resemble *fuscitarsis* in a number of characters but probably represent a distinct form or may be a geographical race of *solomonis;* they have been provisionally identified as *solomonis.* For a discussion of the relationships of *fuscitarsis,* see under *solomonis.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *fuscitarsis* have been collected in several species of pandanus, narrow-leafed as well as broad-leafed, sometimes apparently in association with *solomonis, hollingsheadi,* and *schlosseri,* but it is not definitely known whether or not they were utilizing the same axil. All the adults are reared and nothing is known of their bionomics or disease relations.

DISTRIBUTION (fig. **225**).—*Solomon Islands:* Guadalcanal. Not known elsewhere.

15. Aedes (Finlaya) hollingsheadi Belkin, n. sp.

Figs. **225, 250, 251**

TYPES.—*Holotype:* ♂ with associated pupal skin and genitalia slide (JNB, 741-25), Poha area, Guadalcanal, Solomon Islands, from leaf axil of a narrow-leaf pandanus, Nov. 15, 1944, J. N. Belkin and M. Cohen (USNM, 64786). *Allotype:* ♀ with associated larval and pupal skins (JNB, 741-24), same data as holotype. *Paratypes:* 4 ♀ with associated larval and pupal skins (JNB, 741-22, 23, 26, 27), 1 ♀ (741-2), same data as holotype.—This species is dedicated to Charles Hollingshead, a member of the 20th Malaria Survey Unit on Guadalcanal.

Aedes (*Finlaya*) *bougainvillensis* in part of Marks (1947:19–26); Knight and Marks (1952:543); Iyengar (1955:27); Stone, Knight, and Starcke (1959).

Aedes (*Finlaya*) *kochi* in part of Edwards (1932:149); Taylor (1934:17); Lee (1944*a*:63); Knight, Bohart, and Bohart (1944:34, 52); Stone and Bohart (1944:211–212); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.82 mm. *Proboscis:* 1.58 mm. *Forefemur:* 1.87 mm. *Abdomen:* about 2.32 mm. In general very similar to *bougainvillensis,* from which it differs chiefly in the following characters. *Head:* median longitudinal light stripe of vertex usually much narrower and usually with a few broad scales, all scales with slight yellowish tinge; labium with median light ring with distinct slight yellowish tinge, apical light spot with some scales slightly yellowish, usually more extensive; palpus usually without light scales. *Thorax:* light scales of mesonotum all golden or with yellowish tinge, none pure white; at most 1,2 broad light scales in prescutellar area; apical dark scales of midlobe of scutellum more numerous; *ppn* usually with numerous dark scales in upper part; *psp* usually without scales; a large patch of scales at base of *pra* against upper scale patch of *stp,* usually a few or no scales above *pra* bristles. *Wing:* prehumeral pale spot of vein C usually not developed, base of C predominantly dark; prehumeral part of remigium almost entirely dark, occasionally with a few white scales at base. *Abdomen:* dorsum of tergites usually with light scaling very restricted, confined to small patches of yellowish scales; sternites VI,VII with distinct apical tufts, V with none or a very inconspicuous tuft.

MALE.—Essentially as in the female and differing from *bougainvillensis* in same characteristics. *Labium:* usually without median light ring, sometimes with small dorsal median patch, apical patch usually reduced. *Palpus:* marked essentially as in *bougainvillensis* except that light scales of segments 2 and 3 have a yellowish tinge. *Abdomen:* dorsum of tergites more extensively marked with light scales than in the female.

MALE GENITALIA (fig. **250**).—As figured; diagnostic characters as in the key; lateral scales of sidepiece dark; sternal tuft light, scales darker at base; basal tergomesal and mesal hairs golden. *Segment IX:* tergite lobe poorly differentiated, usually with 2,3 hairs. *Sidepiece:* relatively long and slender; basal tergomesal area with very dense large patch of hairs, the more basal thickened but rather straight, the more distal and mesal thickened and straight basally, sharply bent preapically and with apex flattened and sharp-lanceolate; specialized basal mesal seta strongly developed, its stem rather short and thick; distal tergomesal border with short setae not markedly differentiated; middle of tergal surface with short hairs in distal half only; middle of mesal surface with poorly defined patch of slender rather short hairs not markedly differentiated from and only slightly longer than the more distal and sternal hairs; inner sternal scales about 8–16, all striated, majority rather short, only 1,2 extending beyond apex of sidepiece; apical sternal bristle strongly differentiated. *Claspette:* appendage relatively long-pedunculate, expanded portion bladelike, sharply pointed and with obtuse basal angle. *Clasper:* relatively long, rather slender, with 1 short subapical hair; spiniform long and slender, moderately curved subapically. *Phallosome:* aedeagus short and broad, distal portion strongly expanded, apex truncate or slightly emarginate.

PUPA (fig. **250**).—*Abdomen:* 2.47 mm. *Trumpet:* 0.4 mm. *Paddle:* 0.52 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, except for darkened mesonotum; mesonotum with 1 pair of small submedian clear unpigmented spots. *Trumpet:* uniformly darkly pigmented. *Metanotum:* darkened; with 1 pair of small poorly defined lateral unpigmented spots. *Abdomen:* moderately pigmented, dark on tergites I-III, darker pigmentation extensive and blending into moderate laterally, not sharply marked off; no clear unpigmented spots. *Paddle:* uniformly moderately pigmented except for darker and brighter midrib; apex rather strongly emarginate near hair 1; marginal spicules indistinct.

LARVA (fig. **251**).—*Head:* 0.6 mm. *Siphon:* 0.49 mm. *Anal Saddle:* 0.28 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key. *Head:* pigmentation a bright moderate brownish yellow; hair 1-C usually 3,4b; 4,6-C usually at least 6b, branches usually thin and long. *Segment VIII:* comb scales in middle of posterior row strongly pigmented, base of free part elongate and usually with 2 pairs of lateral denticles, distal part long and slender, thickened in center and sharp apically, no fringes. *Siphon:* short, index usually less than 3.0; moderately to strongly pigmented, uniformly very densely long-spiculate. *Anal Segment:* long marginal spicules with few fringes; body of saddle densely long-spiculate ventrolaterally.

MATERIAL EXAMINED.—270 specimens; 59♀; 51♂; 41 pupae; 119 larvae; 23 individual rearings (22 larval, 1 pupal).

SYSTEMATICS.—The adults of *hollingsheadi* are extremely similar to *oceanicus,* and there may be difficulty in differentiating them at times from *bougainvillensis, neogeorgianus, schlosseri,* and *samoanus.* In *hollingsheadi* the light scaling of the mesonotum very seldom includes white or whitish scales, which predominate in the other species (except *oceanicus* and *samoanus*). In the male genitalia and in the larva, *hollingsheadi* resembles *bougainvillensis, neogeorgianus,* and *schlosseri.*

A. hollingsheadi is apparently a widespread species. It is common on Guadalcanal, and I have identified it also from Bougainville, the New Georgia group, and Sikiana. There seem to be some striking differences between the various populations, but the material from all localities other than Guadalcanal lacks individual rearings and is too scanty to permit an analysis of differences. It is possible that more than 1 species is confused under *hollingsheadi.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *hollingsheadi* have been collected only in the leaf axils of pandanus species. All the adults in collections are reared and nothing is known of their bionomics or disease relations.

DISTRIBUTION (fig. **225**).—*Solomon Islands:* Bougainville; Arundel; New Georgia; Guadalcanal; Sikiana. Not known elsewhere.

16. Aedes (Finlaya) knighti Stone & Bohart

Figs. **225**, **252**, **253**

1944. *Aedes* (*Finlaya*) *knighti* Stone and Bohart, Ent. Soc. Wash., Proc. 46:210–211. *TYPE: holotype ♂, Rendova Island, New Georgia group, Solomon Islands, Aug., 1943, K. L. Knight (USNM, 56978).

Aedes (*Finlaya*) *knighti* of Marks (1947:2); Knight and Marks (1952:544); Iyengar (1955:27); Stone, Knight, and Starcke (1959).
Aedes (*Finlaya*) *wallacei* in part of Knight, Bohart, and Bohart (1944:34, 56).

FEMALE.—*Wing:* 2.52 mm. *Proboscis:* 1.6 mm. *Forefemur:* 1.63 mm. *Abdomen:* about 2.3 mm. *Head:* light scales chiefly a very light yellowish brown; median longitudinal light stripe broad, chiefly with narrow scales; broad decumbent scales restricted, dark brown; erect scales chiefly dark brown, some light in middle anteriorly and in caudolateral areas; labium with a variable median ring of beige scales, usually about 0.3–0.35 of proboscis length, apex with a broad beige ring, on ventral surface the 2 rings more or less connected by beige scales; palpus with a few beige scales on apex of segment 4, dark scales dark brown. *Thorax:* mesonotal pattern indistinct, light scales numerous, pale yellowish to deep golden, dark scales usually restricted, dark bronzy, some scales intermediate; prescutellar area with narrow scales only; scutellum with pale to deep beige scales, midlobe with variable number of dark bronzy scales; paratergite scales pure white; pleural scales pure white except those on *apn* and *ppn* which are pale beige to very light yellowish brown; no dark scales on *ppn; psp* usually without scales; *pra* with scales below and above bristles, latter sometimes dingy white. *Legs:* femora and tibiae extensively barred or ringed with pale beige to light yellowish brown scales, dark scaling dark brown; femoral preapical tufts at most very small on foreleg and midleg, undeveloped on hindleg; tarsal segment 1 of foreleg with a very small basal, rather large median and apical beige rings, that of midleg and hindleg similar but with broad basal beige ring and often additional submedian beige rings or markings, that of foreleg and midleg frequently extensively pale ventrally; tarsal segment 2 of foreleg and midleg with broad apical beige ring, usually about 0.25–0.30 of segment length, segment 3 usually with small dorsal apical beige patch, segment 4 all dark, segment 5 all light; hindtarsal segments 2 and 3 with apical light beige or whitish ring usually restricted to apical 0.25, segment 4 all dark, segment 5 all light. *Wing:* moderately dark in appearance; light scaling largely light to dark beige, usually some whitish scales present; base of vein C extensively light, prehumeral and humeral pale spots usually fused and prehumeral dark spot reduced; sectoral light area usually long; subcostal light area usually small; vein C without accessory subcostal pale area which is usually very restricted on vein R_1; dorsal scales of R_{2+3} elongate but broad. *Haltere:* knob with brown scales above. *Abdomen:* dorsum of tergites with extensive spotting of dingy pale yellowish brown scales, some white scales at base on segment II, dark scaling brown, distal segments largely light; short apical tufts on sternites VI, VII only.

MALE.—Essentially as in the female. *Labium:* light scaling extremely variable, from a small median light ring to entire distal half, usually extensively pale on distal half ventrally. *Palpus:* about as long as proboscis or only slightly longer; pale banding moderately extensive; segment 2 with broad light bands subbasally and apically; segment 3 with moderate subbasal light band subequal to basal dark area and usually with some preapical light scales; segments 4 and 5 with basal light bands usually less than half of segments; segment 5 with some light scales apically. *Abdomen:* dorsum of tergites largely pale scaled.

MALE GENITALIA (fig. **252**).—As figured; diagnostic characters as in the key; lateral scales of sidepiece dark, inner sternal tuft of scales and basal tergomesal and mesal hairs golden. *Segment IX:* tergite lobe practically undifferentiated, usually without hairs, rarely with 1. *Sidepiece:* rather long; basal tergomesal area poorly defined, the more basal hairs long and straight, the more distal and mesal short and with apical bent portion slightly flattened and expanded; specialized basal mesal seta not developed; distal tergomesal border with a few undifferentiated hairs; middle of tergal surface with numerous long hairs in 3,4 rows merging with basal tergomesal patch and extending to apex; middle of mesal surface with a concentration of hairs similar in length to the more distal and sternal hairs but somewhat straighter; inner sternal scales about 12–16, all striated, usually majority reaching apex of sidepiece; apicosternal bristle strongly differentiated. *Claspette:* appendage pedunculate, basal angle obtusely rounded. *Clasper:* moderately long, usually distinctly widened in middle; apparently without subapical hair; spiniform long, distinctly thickened proximally. *Phallosome:* aedeagus short, very strongly expanded distally, apex truncate or slightly emarginate. *Proctiger:* usually 1 pair of cercal setae.

PUPA (fig. **252**).—*Abdomen:* 2.47 mm. *Trumpet:* 0.4 mm. *Paddle:* 0.67 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key; in life brownish in color and with mesonotal iridescent bluish spots forming a triangle as indicated below. *Cephalothorax:* lightly pigmented except for slightly darker irregular areas on midline of pronotum and mesonotum; mesonotum with 1 pair large submedian clear unpigmented spots and 1 median caudal clear unpigmented spot. *Trumpet:* moderately pigmented, darker at base. *Metanotum:* without lateral clear unpigmented spots but with 2,3 indefinite lighter submedian areas, light laterally, irregularly darkened middorsally. *Abdomen:* tergites I-IV rather dark, at least in middle, V-VIII lightly pigmented but with some darker areas at base on V-VII; no clear unpigmented spots; hair 5-V,VI sometimes single or 3b, usually double as in other species, not as figured. *Paddle:* very lightly uniformly pigmented, midrib brighter; apex rounded; marginal spicules very small but rather distinct.

LARVA (fig. **253**).—*Head:* 0.58 mm. *Siphon:* 0.65 mm. *Anal Saddle:* 0.17 mm. Chaetotaxy as figured, hairs lightly pigmented; diagnostic characters as in the key; in life the larva is straw-colored. *Head:* hair 1-C usually 2b; 4-C usually 4b; 6-C usually 3,4b; 14-C very small, usually 2b. *Thorax:* hair 14-M very small, usually 3b. *Abdomen:* hair 13 small, usually 2,3b. *Segment VIII:* comb rather small, poorly pigmented except for base of scales of posterior row; comb scales in middle of posterior row with base of free part elongate, usually with 1, sometimes with 2 pairs of long denticles, distal part long, rather broad, without distinct central shaft, sharply pointed apically and apparently without spicules or fringes. *Siphon:* index about 4.0 or more; lightly to moderately pigmented; with very long, extremely slender, and practically invisible spicules distally. *Anal Segment:* saddle without conspicuous spicules except on caudal margin; gills rather long, pointed.

MATERIAL EXAMINED.—377 specimens; 111 ♀; 107 ♂; 55 pupae; 104 larvae; no individual rearings.

SYSTEMATICS.—*A. knighti* is a very clearly marked species which is easily differentiated in all stages. The adults are unique in the reduction of the light scaling of the hindtarsal segments 2 and 3, but this character is somewhat variable. The male genitalia differ conspicuously from those of all other South Pacific species of the group in the absence of the specialized basal mesal seta of the sidepiece. The pupa resembles that of several dark species but has a distinctive pattern. The larva is in general very similar to that of *franclemonti.*

The association of the stages in *knighti* is presumptive only since there are no individual rearings, but J. G. Franclemont made careful mass rearings of this and other species on New Georgia, and it is very likely that the association is correct.

A. knighti is known definitely only from the New Georgia group of islands. On Guadalcanal and possibly Florida there occurs a form (sp. 23) which is superficially very similar to *knighti* but which shows some striking differences. It appears probable that this is a distinct related species, which remains unnamed since the material is inadequate for description.

In the combination of the characters of the dark and light species in *knighti,* there is a suggestion that this species may have arisen through hybridization of a form of each complex, as in *franclemonti.* In the latter, the characters of the light species seem to predominate, while in *knighti,* those of the dark species are more evident.

BIONOMICS AND DISEASE RELATIONS.—According to the field notes of J. G. Franclemont, *knighti* breeds in the axils of the broadest-leafed pandanus encountered in the New Georgia group and is confined to the lower leaves on this plant. All the known adults are apparently reared and no information is available on their bionomics or disease relations.

DISTRIBUTION (fig. **225**).—*Solomon Islands:* New Georgia; Rendova. Not known elsewhere.

17. Aedes (Finlaya) neogeorgianus Belkin, n. sp.

Figs. **225, 254, 255**

TYPES.—*Holotype:* ♂ with genitalia slide (JGF, 45–1001), Munda, New Georgia, Solomon Islands, from leaf axil of a very narrow-leaf pandanus or from an aroid (taro), Nov., 1943–Oct., 1944, J. G. Franclemont (USNM, 64787). *Allotype:* not designated since the sexes and stages are not definitely associated. *Paratype:* 1 ♂ (JGF, 45) with genitalia slide (560521-46), same data as holotype.

Aedes (*Finlaya*) *bougainvillensis* in part of Marks (1947:19–26); Knight and Marks (1952:543); Iyengar (1955:27); Stone, Knight, and Starcke (1959).

Aedes (*Finlaya*) *kochi* in part of Lee (1944*a*:63); Knight, Bohart, and Bohart (1944:34, 52); Stone and Bohart (1944:211–212); Stone, Knight, and Starcke (1959).

Aedes (*Finlaya*) *kochi* var. *samoana* in part of Edwards (1932:149); Insects of Samoa (1935:109).

FEMALE.—*Wing:* 2.8 mm. *Proboscis:* 1.47 mm. *Forefemur:* 1.8 mm. *Abdomen:* about 2.42 mm. In general very similar to *bougainvillensis* and particularly to *schlosseri,* differing from these chiefly in the following characters. *Head:* median longitudinal light stripe of vertex usually very broad and with numerous broad scales in addition to narrow ones; all light scaling of head dingy white or with yellowish tinge; median light ring of labium usually with some yellowish scales towards ends. *Thorax:* light scaling of mesonotum mixed dingy white and light coppery or golden; prescutellar area without conspicuous broad scales; apical dark scales of midlobe of scutellum usually numerous; *ppn* usually with numerous dark scales above; *psp* usually without scales; *pra* with a large patch of scales below bristles and several scales above. *Legs:* femora and tibiae with light scaling moderately extensive, some with yellowish tinge; subapical femoral tufts poorly developed on foreleg and practically undeveloped on midleg and hindleg; segment 1 of foretarsus with very narrow basal, a broad apical, and very narrow median light rings; segment 1 of midtarsus similar to that of foreleg except for broad basal white ring; segment 1 of hindtarsus similar but with even broader basal and apical white rings; segment 2 of foretarsus with a very small apical dorsal white patch, that of midtarsus with a somewhat larger patch; segments 2 and 3 of hindtarsus apparently with very variable apical white rings. *Wing:* very similar to *bougainvillensis;* prehumeral light spot of vein C present, generally fused with humeral; prehumeral portion of remigium usually with a small patch of light scales at base; some of the light scales of wing with yellowish tinge. *Abdomen:* dorsum of tergites essentially as in *bougainvillensis;* only sternites VI,VII with moderately developed apical tufts.

MALE.—Essentially as in the female. *Labium:* with a narrow light yellowish ring, broader dorsally; dorsal apical light patch very small. *Palpus:* essentially as in *bougainvillensis* but light scaling more restricted and with yellowish tinge. *Thorax:* dark scaling of *ppn* reduced or absent. *Abdomen:* dorsum of tergites usually extensively light-scaled.

MALE GENITALIA (fig. **254**).—As figured; diagnostic characters as in the key; in general similar to *bougainvillensis* and *schlosseri* and differing from former chiefly in the following characters. *Sidepiece:* basal tergomesal patch with slight but distinct lanceolate tips on distal mesal hairs; specialized basal mesal seta with long slender curved stem; middle of tergal surface usually with 3 rows of hairs connecting to basal tergomesal patch; inner sternal scales usually 16–20, majority projecting beyond apex of sidepiece and light in color. *Claspette:* basal angle of expanded portion of appendage usually sharp. *Clasper:* spiniform very long.

PUPA (fig. **254**).—*Abdomen:* 2.84 mm. *Trumpet:* inadequate for measurement. *Paddle:* 0.7 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *schlosseri* and *hollingsheadi,* differing from the latter in following characters and a generally lighter coloration. *Cephalothorax:* very lightly pigmented, mesonotum darker; mesonotum with 2 pairs of clear unpigmented submedian spots. *Metanotum:* darkened; with very conspicuous clear unpigmented lateral spot on each side. *Abdomen:* lightly pigmented, indefinitely darker on central portion of tergites I-III; hairs lightly pigmented. *Paddle:* essentially as in *schlosseri* except for lighter pigmentation.

LARVA (fig. **255**).—*Head:* 0.62 mm. *Siphon:* 0.66 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured, hairs moderately to lightly pigmented; diagnostic characters as in the key; very similar to *bougainvillensis;* association with male uncertain. *Head:* pigmentation a bright light brownish yellow; hair 1-C usually 3,2b; 4-C usually 6,7b, branches strongly thickened at base; 6-C usually 4,5b, branches rather stiff and straight at base, long-attenuate distally. *Segment VIII:* comb scales in middle of posterior row strongly pigmented, base of free part very long and generally with 1 pair of sharp denticles, distal part relatively short and narrow, well pigmented, with distinct thickened shaft. *Siphon:* index 4.0 or more; lightly pigmented, uniformly very densely long-spiculate. *Anal Segment:* ventrolateral spicules of saddle rather poorly developed.

MATERIAL EXAMINED.—85 specimens; 17 ♀; 25 ♂; 13 pupae; 30 larvae; no individual rearings.

SYSTEMATICS.—*A. neogeorgianus* is a very puzzling form. It was believed at first that it was a local race of *schlosseri,* but the pupa, the larva, and the male genitalia proved to be distinct from this species upon closer examination. The adults cannot be differentiated with certainty at present from those of *bougainvillensis* or *schlosseri.* In some respects *neogeorgianus* is intermediate between *bougainvillensis* and *schlosseri* in the larval stage. The pupa is essentially similar to that of *schlosseri* except for the presence of a distinct clear unpigmented spot on the metanotum. The exact taxonomic status of this form cannot be determined without individual rearings, but for the present I regard *neogeorgianus* as a distinct species.

A. neogeorgianus is known with certainty only from the New Georgia group, but some of the specimens from Bougainville which I have identified as *bougainvillensis* may prove to be *neogeorgianus* or a related species.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *neogeorgianus* have been collected apparently both in the common very narrow-leaf "screw palm" (*Pandanus* sp.) and in taro leaf axils. Unfortunately the collections from the different habitats are mixed, and the breeding site of the holotype is not definitely known. This is the only species of the group in the Solomons that has been recorded breeding commonly in taro leaf axils. The majority of the known adults have been reared and nothing is known of their bionomics or disease relations. The specimens from Roviana reported as *kochi* var. *samoana* in Insects of Samoa (1935:109) may have been taken biting, but they do not include the single female mentioned by Edwards (*in* Paine and Edwards, 1929:314–315), which is a specimen of *franclemonti.*

DISTRIBUTION (fig. 225).—*Solomon Islands:* Arundel; New Georgia; Roviana. Not known elsewhere.

18. Aedes (Finlaya) oceanicus Belkin, n. sp.

Figs. 225, 256, 257

TYPES.—*Holotype:* ♂ with associated fragment of pupal skin (Bonnet, 7-2) and genitalia slide (570527-12), Amouli, Pango Pango, Tutuila, Samoa, from leaf axil of laufala (pandanus), July 24, 1956, D. Bonnet (USNM, 64788). *Allotype:* ♀ with associated pupal skin (Bonnet, 7-1), same data as holotype. *Paratypes:* 25 larvae (Bonnet, 7-0), same data as holotype.

Aedes (*Finlaya*) *samoanus* in part of Knight, Bohart, and Bohart (1944:34–55); Stone and Bohart (1944:212); Byrd, St. Amant, *et al.* (1945); Bohart and Ingram (1946:14–15); Marks (1947:32–34); Knight and Marks (1952:545); Iyengar (1955:28); Laird (1956); Rageau (1958*a*:877); Byrd and St. Amant (1959); Stone, Knight, and Starcke (1959).

Aedes (*Finlaya*) *samoana* in part of Edwards (1935:129–130).

Aedes (*Finlaya*) *kochi* var. *samoana* in part of Edwards (1926:105; 1928*b*:44–45; 1932:149); Buxton and Hopkins (1927:95–120); Taylor (1934:17); Buxton (1935:60); Lee (1944*a*:63).

Aedes (*Finlaya*) *kochi* in part of O'Connor (1923:56–57); Buxton and Hopkins (1925:298–300).

FEMALE.—*Wing:* 2.75 mm. *Proboscis:* 1.6 mm. *Forefemur:* 1.7 mm. *Abdomen:* about 2.43 mm. In general quite similar in coloration to *fijiensis* and even more to *hollingsheadi* and markedly different from *samoanus*, with which it has been confused. *Head:* light scaling of head capsule dingy white and with yellowish tinge; median longitudinal light stripe of vertex rather broad, with narrow yellowish scales in middle and broad whitish scales laterally; erect scales all dark; median light ring of labium with pure white scales, rarely some yellowish at its ends, width of ring variable, a large apical patch or incomplete ring of pure white scales; palpus tipped with a few pure white scales. *Thorax:* integument brown to dark brown; mesonotum with indefinite pattern of pale to dark golden scales not contrasting with bronzy dark scales; prescutellar area with rather conspicuous broadened scales posteriorly; scutellar pale scales dingy white to beige, midlobe with a few dark scales apically; paratergite usually with white scales, sometimes beige; *apn* and *ppn* with light scales dingy to beige or even slightly yellowish, *ppn* with variable number of dark scales above; remainder of pleural scales usually white, sometimes beige, particularly upper *pra; psp* usually with a few scales; *pra* with scales above and below bristles. *Legs:* light scaling of femur and tibia of foreleg and midleg usually strongly yellowish, of hindleg usually largely white; subapical tufts of all femora strongly developed, largely dark; light scaling of tarsi largely white, with some yellowish on segment 1 of foretarsus; foretarsus and midtarsus with rather wide basal, median, and apical light rings on segment 1, segment 2 with dorsal apical light patch on foretarsus and rather broad apical light ring on midtarsus, segments 3 and 4 all dark, segment 5 all light; hindtarsal segment 1 with broad basal, median, and apical light rings, segments 2 and 3 with apical light ring about 0.35–0.4 of segment length, segment 4 all dark, segment 5 all light. *Wing:* predominantly dark; light scaling dingy white, beige, or very slightly yellowish on anterior portion of dorsal surface; prehumeral light spot not developed on vein C, humeral usually very small so that base of C is largely dark; accessory subcostal light area usually poorly developed on vein R_1 and never on C. *Haltere:* knob dark-scaled. *Abdomen:* dorsum of tergites with variable amount of yellowish scaling but usually in restricted basal median and submedian patches, tergite II usually with more extensive sublateral basal pale areas; only sternites VI,VII with distinct apical tufts of dark scales.

MALE.—Generally similar to the female in coloration. *Labium:* with narrow complete median ring, apical white dorsal patch or ring smaller. *Palpus:* exceeding proboscis for about entire length of segment 5; pale scaling usually pure white and restricted in extent; segment 2 with subbasal and apical white bands; segment 3 with small submedian whitish patch; segment 4 white in basal half; segment 5 white usually for more than basal half; remainder with very dark scales. *Abdomen:* dorsum of tergites with pale scaling somewhat more extensive.

MALE GENITALIA (fig. **256**).—As figured; diagnostic characters as in the key; lateral scales of sidepiece all dark; inner sternal scales and basal tergomesal and mesal hairs all very pale yellowish or golden. *Segment IX:* tergite lobe usually with 1-3 hairs. *Sidepiece:* relatively short and broad; basal tergomesal patch of hairs dense, the basal hairs rather short and straight, the distal more strongly curved and with slightly lanceolate apices; specialized basal mesal seta small but distinct, distal part flattened and bent; distal tergomesal margin with a more or less definite line of 4-6 long curved hairs; middle of mesal surface with dense clump of long straight thickened specialized hairs, sharply differentiated from adjoining hairs; inner sternal scales in a large patch of 12 or more, all broad, the more distal longer. *Claspette:* appendage pedunculate, expanded portion very broad, bladelike, and with acute basal angle. *Clasper:* moderately long, slightly widened distally; a minute subapical seta; spiniform slender, moderately curved apically, length variable. *Phallosome:* aedeagus short, only slightly widened distally, apex truncate or slightly emarginate. *Proctiger:* a few minute spicules near the single pair of cercal setae.

PUPA (fig. **256**).—*Abdomen:* 2.42 mm. *Trumpet:* 0.3 mm. *Paddle:* 0.58 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, mesonotum darker; mesonotum with 1 pair of large submedian clear unpigmented spots. *Trumpet:* uniformly darkly pigmented. *Metanotum:* darkened; with a very large lateral clear unpigmented spot on each side. *Abdomen:* moderately pigmented, tergites I-III darker middorsally but without sharp demarcation; no clear unpigmented areas on tergites; hairs lightly to moderately pigmented. *Paddle:* moderately pigmented, midrib darker and bright; apex rather strongly emarginate; external margin with very sparse short dorsal spicules.

LARVA (fig. **257**).—*Head:* 0.68 mm. *Siphon:* 0.57 mm. *Anal Saddle:* 0.18 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key. *Head:* hair 1-C usually double; 4-C not in line with 7,6-C; 4,6-C usually 2,3b (2-4b). *Abdomen:* hairs 6-III-V usually at least 4b. *Segment VIII:* comb very poorly pigmented and difficult to see; comb scales in middle of posterior row with base of free part elongate, with 1 pair of sharp lateral denticles, distal part flattened and expanded, apex usually pointed and with a few spicules. *Siphon:* index about 2.6–3.5; very lightly pigmented; spicules short and very sparse except in a few areas, particularly dorsoapically; acus rather distinct. *Anal Segment:* conspicuous fringed spicules restricted to caudolateral portion of saddle; hair 1-X usually at least 4b; gills usually broad.

MATERIAL EXAMINED.—291 specimens; 53 ♀; 30 ♂; 37 pupae; 171 larvae; 20 individual rearings (17 larval, 3 pupal).

SYSTEMATICS.—*A. oceanicus* has been confused in the past with *samoanus,* a species strikingly different in coloration and in the male genitalia. In the coloration of the adults and in the pupal ornamentation, *oceanicus* is superficially very similar to *hollingsheadi,* but the male genitalia and the larva are entirely different in the 2 species. *A. oceanicus* is the dark form of "*samoanus*" and it is quite possible that it is represented in the cotypes of *samoanus* (if they exist), since both species occur in the type locality of Apia, Upolu. However, this possibility is remote, as indicated under *samoanus,* and I have taken the precaution of restricting the latter to the pale form.

A. oceanicus has a peculiar distribution. It is the only form known from Tonga. It is the dominant form on Tutuila and apparently is found only in the coastal settlements on Upolu and Savaii in Samoa. I can find no distinct differences in any stage to separate these populations and believe that they represent a single species. This peculiar situation in a group which otherwise exhibits very strong endemism requires an explanation. First, of course, it is very possible that the Tonga and Samoa populations will prove to be specifically distinct when studied more carefully. Second, it might be possible that *oceanicus* is indigenous to both the Tonga and

Samoa groups; this appears most unlikely, since even in forms with less specialized habitats, such as the *scutellaris* group, these island groups have no indigenous species in common. I am inclined to the third view: that there is only 1 species and that its unusual present distribution is the result of dispersal by man, analogous with the dispersal of *polynesiensis* in the *scutellaris* group but much more limited because of more stringent ecological requirements of members of the *kochi* group. Before the advent of man, *oceanicus* may have utilized pandanus axils for breeding (possibly also wild aroids) either in Samoa or Tonga. The original home of *oceanicus* cannot be determined at present, for we know very little about the mosquito fauna of both groups. When the Polynesians arrived and brought with them the cultivated species of *Colocasia* and *Alocasia*, *oceanicus* (and probably *samoanus* as well) utilized these new habitats and became associated with man. Evidently only *oceanicus* has the eggs and the immature stages sufficiently resistant to withstand transport in taro over moderately long voyages. Apparently *oceanicus* did not become established in more distant areas with suitable unoccupied environments (such as the Society and Cook Islands), probably because the eggs and the immature stages could not survive such long voyages. It did not become established in Fiji, possibly because it may not have been able to compete with the native *fijiensis* in pandanus and a predator (*U. colocasiae*) in taro. Buxton and Hopkins (1927:96) explain the absence of "*samoanus*" from the Polynesian coral atolls by the absence of suitable breeding sites, since the forms of taro grown on such islands do not hold water in the axils. Only through careful collecting in all types of water-holding plants on all the Polynesian islands will it be possible to determine where *oceanicus* originated and where it has been spread by man. For the present it is considered to be originally endemic to Samoa.

I believe that there is a strong possibility that *oceanicus* is a species formed through hybridization of *samoanus* with *fijiensis*. This hybridization may have taken place in Tonga, where both *samoanus* and *fijiensis* may have been easily introduced by the Polynesians in taro from Samoa and Fiji respectively, or it may have occurred in Samoa. *A. oceanicus* appears to be an unusually vigorous dominant adaptable form and this may be owing to its hybrid origin. The morphological characters of all stages of *oceanicus* are quite compatible with this interpretation, but cytogenetic studies and experimental hybridizations are needed to resolve the problem.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *oceanicus* have been collected in taro and in pandanus on Tongatabu as well as on Tutuila. The majority of larvae presumably collected in taro at Apia, Upolu, appear to be *oceanicus* also. Laird's record (1956, 1957:342) of "*samoanus*" larvae from a step in a coconut palm trunk near Apia may also be of this species. Apparently females of *oceanicus* are not commonly collected biting; the majority of specimens I have seen were reared. It is not known if the negative data on natural infections with filarial larvae reported by Byrd, St. Amant, *et al.* (1945) and Byrd and St. Amant (1959) pertain to this species or to true *samoanus*. In view of the fact that 2 distinct species have been confused under "*samoanus*" as well as the demonstration that *fijiensis* is an efficient experimental vector and is heavily infected with filarial larvae in nature (Symes, 1955:280–281), it would be well to reëxamine the possible role of *samoanus* and *oceanicus* as vectors of human filariasis (see below under *samoanus*).

DISTRIBUTION (fig. 225).—*Samoa:* Savaii; Upolu; Tutuila. *Tonga:* Tongatabu; Vavau. ? *Horne Islands* (Hoorn, Futuna): ? Alofi. ? *Wallis Islands* (Rageau, 1958*a*:877; 1959:19). Not definitely known elsewhere; the supposed record of "*kochi*" from the Ellice Islands credited to O'Connor by Byrd and St. Amant (1959:44) is erroneous, as O'Connor (1923:56) states definitely that he did not encounter this form except in Samoa.

19. Aedes (Finlaya) samoanus (Gruenberg)

Figs. **225, 235**

1913. *Finlaya samoana* Gruenberg, Ent. Rundschau 30:130–131. TYPES: syntypes, 4 ♀, Apia, Upolu Island, Samoa, Friederichs (BERLIN, destroyed?).

Aedes (Finlaya) samoanus in part of Knight, Bohart, and Bohart (1944:34, 55); Stone and Bohart (1944:212); Byrd, St. Amant, *et al.* (1945); Bohart and

Ingram (1946:14–15); Marks (1947:32–34); Knight and Marks (1952:545); Iyengar (1955:28); Laird (1956); Byrd and St. Amant (1959); Stone, Knight, and Starcke (1959).

Aedes (*Finlaya*) *samoana* in part of Edwards (1935:129–130).

Aedes (*Finlaya*) *kochi* var. *samoana* in part of Edwards (1926:105; 1928*b*:44–45; 1932:149); Buxton and Hopkins (1927:95–120); Taylor (1934:17); Buxton (1935:60); Lee (1944*a*:63).

Aedes (*Finlaya*) *kochi* in part of O'Connor (1923:56–57); Buxton and Hopkins (1925:298–300).

FEMALE.—*Wing:* 2.87 mm. *Proboscis:* 1.58 mm. *Forefemur:* 1.93 mm. *Abdomen:* about 2.32 mm. In general quite similar in coloration to *franclemonti* and markedly different from *oceanicus,* with which it has been confused. *Head:* light scaling of head capsule dingy white, beige, or strongly yellowish; dark scaling brown to dark brown, usually restricted; median longitudinal light stripe of vertex broad, largely with very narrow scales, only a few broad scales laterad; erect scales dark except for pale golden caudolaterad; median light ring of labium with pure white scales except for yellowish ones toward ends, often some yellow, dark golden, or coppery scales in middorsal streak from white ring toward the broad apical white ring; palpus tipped with a few whitish scales. *Thorax:* integument brown to dark brown; mesonotum with indefinite pattern of whitish, beige, pale golden to coppery light scales not contrasting with rather light bronzy dark scales; prescutellar area usually with distinct caudal patches of broad light scales; scutellar scales pure white to yellowish, midlobe usually with rather large apical patch of dark scales, usually 1,2 dark scales on lateral lobes; paratergite with white scales; *apn* and *ppn* with whitish, beige, and yellowish scales, *ppn* with variable number of dark scales above; remainder of pleural scales usually white, sometimes dingy white or beige; *psp* usually with a few scales; *pra* with scales below and above bristles. *Legs:* light scaling of femur and tibia of foreleg and midleg usually strongly yellowish, of hindleg less so and usually with some scales white; subapical tufts of all femora very strongly developed, largely dark; light scaling of tarsi largely white, some yellowish usually on segment 1 of all legs; foretarsus and midtarsus with rather wide basal, variable median, and wide apical light bands and ventral surface usually completely light on segment 1, segment 2 with dorsal apical light patch, segments 3 and 4 all dark, segment 5 all light; hindtarsal segment 1 with very broad basal and apical and variable median light rings, dark scaling forming complete rings, segments 2 and 3 with apical light ring about 0.35–0.45 of segment length, segment 4 all dark, segment 5 all light. *Wing:* predominantly light; light scaling dingy white caudally, strongly yellowish anteriorly on dorsal surface; prehumeral light spot always present and fused with very large humeral spot so that base of C is predominantly light; accessory subcostal light area very strongly developed on both veins C and R_1. *Haltere:* knob largely dark-scaled, a few light scales usually present. *Abdomen:* dorsum of tergites II,III, and often IV usually almost completely light, scales largely yellowish; distal tergites with light scales usually in discrete patches; only sternites VI,VII with small dark apical scale tufts.

MALE.—Generally similar to the female in coloration. *Head:* median light stripe of vertex with broad scales predominating. *Labium:* with narrow median dingy white or yellowish ring, apical light patch reduced. *Palpus:* exceeding proboscis by less than length of segment 5; light pattern essentially as in *oceanicus* but with an additional large light band on segment 3 and all light scaling dingy white or yellowish. *Abdomen:* dorsum of tergites largely with yellowish scales.

MALE GENITALIA (fig. **235**).—As figured; diagnostic characters as in the key; lateral scales of sidepiece all yellowish at base, the distal ones mixed dark and yellowish; inner sternal scales and basal tergomesal hairs all pale yellowish or golden. *Segment IX:* tergite lobe prominent, usually with 3,4 hairs. *Sidepiece:* moderately long and broad; basal tergomesal patch of hairs very large and dense, on tergal surface broadly joined to postmedian dense patch of long bristles, on mesal surface broadly joined to postmedian central patch of long curved hairs; specialized basal mesal seta long and slender, hairlike except for slightly lanceolate or broadened apex; middle of mesal surface with dense patch of differentiated long straight hairs dorsad of inner sternal scales; inner sternal scales usually 8–12, all striated, distal longer. *Claspette:* appendage short pedunculate, expanded portion very broad, bladelike, and with an acute basal angle. *Clasper:* slender, moderately long; a minute subapical seta; spiniform rather short and heavy, straight, apex slightly spatulate. *Phallosome:* aedeagus short and broad, apex truncate. *Proctiger:* 1 pair of cercal setae.

PUPA.—Not definitely known; several specimens from Upolu may be *samoanus;* they are in too poor a condition to be figured or described in detail; in general similar to *oceanicus,* from which they appear to differ in the following; pigmentation of cephalothorax and abdomen lighter; mesonotum and metanotum without clear unpigmented spots; hair 1-C single.

LARVA.—Unknown; some of the material from

Upolu which I have provisionally identified as *oceanicus* may actually be *samoanus;* individual rearings are needed to establish correlation.

MATERIAL EXAMINED.—231 specimens; 216 ♀; 7 ♂; 8 pupae; no larvae; no individual rearings.

SYSTEMATICS.—*A. samoanus* has been confused in the past with *oceanicus,* a strikingly different species. The adults of *samoanus* superficially resemble *franclemonti,* but the male genitalia are conspicuously different and in several respects appear to be of the most generalized type in the whole group. Unfortunately the immature stages have not been identified with certainty, although it seems likely that the pupa briefly described above belongs to this species.

A. samoanus is the dominant species of the group on Savaii and Upolu and is the only one known from the interior of Upolu. In coastal areas of these islands it is joined by *oceanicus.* I have seen only 2 specimens of *samoanus* from Tutuila (P. S. Rossiter, USNM); the remainder are all *oceanicus.*

Since both *samoanus* and *oceanicus* are found in Apia, Upolu, the type locality of *samoanus,* there is a question regarding which of these species was described by Gruenberg. The types are apparently lost or destroyed, and there is nothing in the description to indicate which of the 2 forms is involved. However, Gruenberg figured the wing, and its color pattern is definitely of *samoanus* as I have interpreted it. Therefore I am hereby restricting the nominal species *samoanus* (Gruenberg) to the taxonomic form described above and illustrated by Gruenberg.

There is considerable variation in the ornamentation of the females, particularly on the labium. Since in most instances the exact source of the collections is unknown, I have not attempted to analyze this material carefully. My impression is that the same species occurs on Savaii and Upolu.

BIONOMICS AND DISEASE RELATIONS.—The breeding sites of *samoanus* are not definitely known. In the reports of Buxton and Hopkins (1927:95–101) and O'Connor (1923:56–57), *samoanus* and *oceanicus* were confused; some of the conflicting statements of these workers may be owing to this fact. None of the material collected by these investigators bears any information as to the breeding sites from which it was obtained; as a matter of fact, most of the material is labeled merely "Samoa," and some has no label at all.

Judging from the immature stages I have seen of the "*samoanus*" collected by Buxton and Hopkins, the published accounts of breeding sites (Buxton and Hopkins, 1927:95–101; O'Connor, 1923:56–57), and the definite information available on *oceanicus,* I suspect that the original breeding sites of true *samoanus* were the leaf axils of wild aroids and possibly of pandanus as well. To what extent *samoanus* breeds in taro axils cannot be determined at present, but most of the larval and pupal material collected by Buxton and Hopkins, presumably largely in cultivated aroids, appears to be *oceanicus.*

The majority of adults of *samoanus* from definite localities are females taken at night biting or at artificial lights. On the basis of the abundance of this species in native villages in the interior, I presume it is the one to which Buxton and Hopkins (1927:99) refer in the following statement: "It was probably because of the bite of this curse that the ancient Samoans used to protect themselves in a screen made of bark cloth (tapa), constructed like a rectangular mosquito net." In spite of the fact that this seems to be the most serious nocturnal pest of the native human population, no attempt has been made to control it and it has never been considered seriously as a possible vector of filariasis. O'Connor (1923:13) reports a stage of arrested development of a filaria larva in 1 of 73 wild "*samoanus*" dissected in Savaii, and Byrd, St. Amant, *et al.* (1945) and Byrd and St. Amant (1959) obtained negative results on natural infections with filarial larvae. In view of the fact that 2 distinct species have been confused under "*samoanus*" as well as the demonstration that *fijiensis* is an efficient experimental vector and is heavily infected with filarial larvae in nature (Symes, 1955:280–281), it would be well to reëxamine the possible role of *samoanus* and *oceanicus* as vectors of human filariasis. It may very well be that *samoanus* is a good vector while *oceanicus,* the form apparently most commonly studied, is refractory to filarial infection.

DISTRIBUTION (fig. 225).—*Samoa:* Savaii; Upolu; ? Tutuila. Not known elsewhere.

20. Aedes (Finlaya) schlosseri Belkin, n. sp.

Figs. **225, 258, 259**

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 740-106), Poha area, Guadalcanal, Solomon Islands, from leaf axil of broad-leaf pandanus, Nov. 15, 1944, J. N. Belkin and M. Cohen (USNM, 64789). *Allotype:* ♀ with associated larval and pupal skins (JNB, 740-120), same data as holotype (USNM). *Paratypes:* 22 ♀, 13 ♂, 36 pupae, 21 larvae (JNB, 740-2), same data as holotype, including the following: 11 ♀ with associated larval and pupal skins (JNB, 740-102-104, 109-113, 115, 118, 121), 11 ♀ (JNB, 740-1), 4 ♂ with associated larval and pupal skins (JNB, 740-107, 108, 116, 119), 9 ♂ (JNB, 740-1), 4 associated larval and pupal skins, adults lost (JNB, 740-101, 105, 114, 122), 16 pupae and 1 larva (JNB, 740-1).—This species is dedicated to Ralph J. Schlosser in recognition of his contributions to the knowledge of the mosquitoes and mosquito-borne diseases in the Solomons.

Aedes (Finlaya) bougainvillensis in part of Marks (1947:19–26); Knight and Marks (1952:543); Iyengar (1955:27); Stone, Knight, and Starcke (1959).

Aedes (Finlaya) kochi in part of Edwards (1926:105, 110; 1932:149); Taylor (1934:17); Lee (1944*a*:63); Knight, Bohart, and Bohart (1944:34, 52); Stone and Bohart (1944:211–212); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.65 mm. *Proboscis:* 1.52 mm. *Forefemur:* 1.68 mm. *Abdomen:* about 2.15 mm. In general very similar to *bougainvillensis,* from which it differs chiefly in the following characters. *Head:* median white ring of labium usually a little broader; palpus with fewer white scales, sometimes none. *Thorax:* light scaling of mesonotum not as extensive, mostly dingy white; prescutellar area usually without conspicuous broad scales; apical dark scales of midlobe of scutellum usually numerous; *ppn* usually with numerous dark scales in upper part; *psp* usually without scales; *pra* with a large patch of scales below bristles and usually only a few above. *Legs:* femora and tibiae with light scaling less extensive; segment 1 of foretarsus and midtarsus with very narrow basal light ring, broad apical light ring, and only a few light scales in middle on dorsoposterior or posterior surface, that of hindtarsus similar except for broad basal light ring. *Wing:* very similar to *bougainvillensis;* prehumeral light spot of vein C present, usually less extensive; prehumeral portion of remigium usually entirely dark or with only a few light scales at extreme base. *Abdomen:* dorsum of tergites usually less extensively light-scaled, usually with discrete median basal and 1 pair of submedian yellowish patches, basal usually with some white scales; sternites VI,VII with moderately developed apical scale tufts, V with very poorly developed tuft or none.

MALE.—Essentially as in the female and differing from *bougainvillensis* in the same characteristics except that prehumeral part of remigium is frequently extensively light at base and dark scaling of *ppn* is reduced; labium with very narrow median somewhat yellowish ring and a prominent dorsal light streak basad of it; palpus essentially as in *bougainvillensis;* dorsum of abdominal tergites with extensive dingy yellowish patches.

MALE GENITALIA (fig. **258**).—As figured; diagnostic characters as in the key; in general similar to *bougainvillensis* and *neogeorgianus* and differing from former chiefly in following characters. *Sidepiece:* basal tergomesal patch with a distal mesal line of several hairs with very broad apical bladelike expansion; middle of tergal surface usually with a single line of hairs toward basal tergomesal patch; inner sternal scales usually 14–20, majority reaching apex of sidepiece. *Claspette:* basal angle of appendage expansion usually acute. *Clasper:* usually distinctly widened.

PUPA (fig. **258**).—*Abdomen:* 2.59 mm. *Trumpet:* 0.39 mm. *Paddle:* 0.69 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general similar to *hollingsheadi* and *neogeorgianus* and differing from former chiefly in following characters and a generally lighter pigmentation. *Cephalothorax:* mesonotum with 2 pairs of submedian clear unpigmented spots. *Metanotum:* without unpigmented lateral spots. *Paddle:* pigmentation uniformly moderate except for brighter and darker midrib; apex usually not at all emarginate; marginal spicules more distinct but inconspicuous.

LARVA (fig. **259**).—*Head:* 0.7 mm. *Siphon:* 0.73 mm. *Anal Saddle:* 0.2 mm. Chaetotaxy as figured, hairs moderately pigmented; diagnostic characters as in the key; generally similar to *hollingsheadi, neogeorgianus,* and *bougainvillensis. Head:* pigmentation a bright very light brownish yellow; hair 1-C usually 2,3b; 4-C usually 6,7b, branches strongly thickened at base; 6-C usually 5,6b, branches rather stiff and straight basally. *Segment VIII:* comb scales in middle of posterior row only moderately pigmented, base of free part elongate and usually with 1 pair of sharp denticles, distal part long, usually rather poorly pigmented, without distinct thickened shaft and somewhat broader than in *hollingsheadi. Siphon:* index 4.0 or more; lightly pigmented, uniformly and sparsely short-spiculate. *Anal Segment:* ventrolateral spicules of saddle poorly developed.

MATERIAL EXAMINED.—348 specimens; 69 ♀; 61 ♂; 78 pupae; 140 larvae; 27 individual larval rearings.

SYSTEMATICS.—The adults of *schlosseri* are extremely similar to *bougainvillensis* and *neogeorgianus* and may also be confused at times with *oceanicus* and *hollingsheadi.* In the male genitalia and in the larva, *schlosseri* resembles *bougainvillensis, neogeorgianus,* and *hollingsheadi;* in the pupa, *neogeorgianus, hollingsheadi,* and *oceanicus.* However, it can be easily distinguished from all these species in all stages except females.

A. schlosseri is known definitely only from Guadalcanal, where it appears to be the dominant form of the complex, but I have seen a single female from Florida Island which may belong to this species.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *schlosseri* are commonly found in the leaf axils of pandanus species. I have also seen a single collection from taro leaf axils. All the adults in collections are reared and nothing is known of their bionomics or disease relations.

DISTRIBUTION (fig. **225**).—*Solomon Islands:* Guadalcanal; ? Florida. Not known elsewhere.

21. Aedes (Finlaya) solomonis Stone & Bohart

Figs. **225, 260, 261**

1944. *Aedes (Finlaya) solomonis* Stone and Bohart, Ent. Soc. Wash., Proc. 46:208–209. *TYPE: holotype ♂, Guadalcanal, Solomon Islands, from larva taken from "palm tree," Lechner (USNM, 56977).

Aedes (Finlaya) solomonis of Marks (1947:57–62); Knight and Marks (1952:545); Iyengar (1955:28); Stone, Knight, and Starcke (1959).

Aedes (Finlaya) flavipennis in part of Edwards (*in* Paine and Edwards, 1929:315; 1932:149); Taylor (1934:17); Knight, Bohart, and Bohart (1944:34, 52).

FEMALE.—*Wing:* 2.98 mm. *Proboscis:* 1.7 mm. *Forefemur:* 1.98 mm. *Abdomen:* about 2.6 mm. *Head:* vertex with a broad median longitudinal stripe of pure white linear decumbent scales, rarely with a few broad white scales; orbital line of similar scales; submedian decumbent scales very dark brown, usually in a broad patch with some narrow white and some broad light scales behind; erect scales largely dark brown, some lighter ones caudolaterad; labium with apical 0.67 yellow-scaled, dorsally yellow scaling usually continued to or near base, remainder dark-scaled; labella brown; palpus dark-scaled, segment 4 with numerous white scales apically, segments 2 and 3 with variable number of yellow scales dorsally; torus scales pale yellowish. *Thorax:* mesonotal ground scales dark bronzy to coppery, a conspicuous but indefinite pattern of pure white scales, some dingy white scales sometimes present; no conspicuous broad scales in prescutellar area; scutellar scaling variable, broad light scaling usually dingy white or pale yellowish, some narrow white scales usually present on base of midlobe, broad dark scales variable, always present on distal portion of all lobes, sometimes replacing light scales on lateral lobes; paratergite with pure white scales; pleural scaling largely pure white except for some dingy or yellowish scales on *ppn* and more rarely on *apn; psp* usually with a few scales; *pra* with scales only above bristles. *Legs:* femora and tibiae extensively barred and spotted with yellow and white scales, often pale scaling predominating; preapical femoral tufts strongly developed on all legs, particularly on foreleg and midleg where some of the outstanding scales are longer than width of femur shaft, some of the scales yellow; foretarsus and midtarsus predominantly yellow, a variable but small patch of white scales on base of segment 1 and fewer on apex of 1 and 2, segment 1 of midleg usually with a complete basal white ring, variable patches or individual dark scales scattered dorsally on shaft of segment 1 and on base of 2,3 and sometimes 4, segment 5 pale yellowish or beige; hindtarsus predominantly yellow, segment 1 with broad basal and apical white rings, a variable restricted number of white scales and scattered patches of dark scales in middle dorsally, lower surface entirely yellow and white, segments 2 and 3 with small basal dark ring or dorsal dark patch and apical 0.4 with white ring, segment 4 with small basal dark ring or dorsal dark patch, segment 5 entirely beige. *Wing:* dorsal scaling black, white and yellow; pattern extremely complex and variable; yellow scales most numerous on anterior portion of wing, particularly on vein C which is largely pale and with the dark "areas" of a typical wing broken by yellow; dorsal scales on vein R_{2+3} very short and broad. *Haltere:* knob largely with pale yellowish scales, some darker scales basad. *Abdomen:* tergite I with rather extensive scaling, predominantly yellowish; dorsum of tergites II-VII with variable patches of yellow and white scaling, more extensive on distal segments where pale scaling may predominate; sternites V-VII with rather strongly developed apical tufts of dark scales.

MALE.—Essentially as in the female but generally more extensively pale-scaled. *Head:* vertex more extensively pale and with larger number of broad white scales along median longitudinal light stripe. *Labium:* with basal dark scaling more extensive and some dark scaling scattered in distal portion but latter largely yellow. *Palpus:* exceeding proboscis by about length of segment 5; with extensive areas of yellow and white scales; segment 1 dark; segment 2 with median dark band, remainder pale; segment 3 extremely variable and with indefinite pattern, usually at least with as many pale as dark scales, apex white; segment 4 largely yellow and white, usually with only a few dark scales; segment 5 largely yellow and white and with small median dark ring. *Abdomen:* dorsum of tergites largely yellow, with restricted patches of dark scales and a few white scales.

MALE GENITALIA (fig. **260**).—As figured; diagnostic characters as in the key; lateral scales of sidepiece mixed dark and yellow; basal tergomesal and mesal hairs and inner sternal scales golden. *Segment IX:* tergite lobe very poorly developed, usually with 2 hairs. *Sidepiece:* moderately long; basal tergomesal area with the more basal hairs slender, moderately long and straight, the most distal and mesal thickened at base, strongly curved and with strongly expanded distal part, intermediate area with some hairs with lanceolate tips; specialized basal mesal seta strongly differentiated and with long broad expanded apical portion; distal part of tergomesal margin with a row of poorly differentiated hairs; middle of tergal surface with about 3 rows of hairs joining basal tergomesal patch; middle of mesal surface with a distinct patch of long straight hairs markedly different from the more distal and ventral hairs which are short and curved; inner sternal scales usually 12–18, all rather long, striated; apical sternal bristle moderately developed. *Claspette:* appendage pedunculate, basal angle of expanded portion usually acute. *Clasper:* moderately long, not markedly expanded; with small preapical seta; spiniform very long and slender. *Phallosome:* aedeagus with basal portion unusually broad and distal not very strongly expanded, apex rounded or slightly emarginate. *Proctiger:* 2 pairs of cercal setae.

PUPA (fig. **260**).—*Abdomen:* 2.72 mm. *Trumpet:* 0.45 mm. *Paddle:* 0.63 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key; in life yellowish in color with brownish black sharply marked middorsal pattern whose lateral margins are not even. *Cephalothorax:* pattern as figured, rather diffuse on edges on mesonotum; mesonotum with 2 pairs of large submedian clear unpigmented spots and usually 1 or more pairs of narrow clear unpigmented streaks or lines. *Trumpet:* strongly pigmented in basal 0.35–0.5, moderately distad. *Metanotum:* with 1 pair of clear unpigmented lateral spots and usually 3 or more pairs of less clearly defined smaller submedian poorly pigmented spots or streaks. *Abdomen:* pattern as figured, lateral margins uneven but sharply marked off; tergites II,III each with a pair of large submedian irregular clear unpigmented spots at caudal margin; tergite IV with more indefinite similar clear unpigmented spots, usually smaller and often broken up into several small ones on each side. *Paddle:* uniformly very lightly pigmented, midrib darker and brighter; apex distinctly emarginate; marginal spicules very small, practically invisible.

LARVA (fig. **261**).—*Head:* 0.7 mm. *Siphon:* 0.62 mm. *Anal Saddle:* 0.23 mm. Chaetotaxy as figured, hairs lightly pigmented; diagnostic characters as in the key; in life the larva is extremely pale in color, whitish with slight greenish tinge. *Head:* extremely pale except for black collar; hair 1-C usually 2b; 4-C usually 5,6b; 6-C usually 3,4b; 14-C large, stellate, multiple. *Thorax:* hair 14-M poorly developed, usually less than 6b. *Abdomen:* stellate hairs strongly developed. *Segment VIII:* comb poorly pigmented; comb scales in middle of posterior row with basal part of free portion with 1,2 pairs of sharp denticles, distal part long and broad, with slight indication of thickened shaft proximally, apex sharply pointed, fringes and spicules not apparent. *Siphon:* moderate in length, index about 2.8–3.5; extremely pale; rather uniformly and densely short-spiculate, but spicules very slender and not conspicuous except dorsoapically where they are somewhat larger. *Anal Segment:* caudal margin of saddle with spicules rather sparse, ventrolateral area with short spicules.

MATERIAL EXAMINED.—611 specimens; 118 ♀; 122 ♂; 93 pupae; 278 larvae; 31 individual larval rearings.

SYSTEMATICS.—The above diagnosis is restricted to material from Guadalcanal, the type locality of *solomonis.* I have identified tentatively as *solomonis* specimens of all stages, none of which are definitely associated through individual rearings, from the New Georgia group and from Bougainville. Some of these seem to be true *solomonis* or possibly geographical races of this species, but it appears even more likely that there is a whole complex of sibling species which show some resemblance to *solomonis, fuscipalpis,* and *fuscitarsis* but appear to be distinct in other characters. Nothing can be done to resolve the complex until more material and many individual rearings are available.

The material from Bougainville includes adults which are superficially similar to all 3 forms mentioned above but differ in details of ornamentation: the male genitalia do not have the characteristic hairs with strongly flattened tips, as found in *solomonis,* nor are they like those of *fuscipalpis* or *fuscitarsis;* the few known pupae appear similar to *solomonis* but have a narrower dark stripe; the larvae are varied—all seem to have hair 14-M large and multiple and the siphon strongly spiculate, the majority have hair 13-III,IV displaced forward to near level of hair 9, others are intermediate in this respect as compared to Guadalcanal specimens.

The material from the New Georgia group also shows a variety of characters, and the populations from different islands in the group and even on the same island do not appear to be conspecific; the male genitalia of some specimens resemble *fuscipalpis* but are definitely not this form; the few known pupae are of 2 types, one resembling material from Bougainville, the other typical specimens from Guadalcanal; the larvae are varied also, some typical, others with hair 14-M strongly developed, and still others intermediate in this character. Several larvae from Arundel Island are very similar to *fuscipalpis,* but the adults from this island are conspicuously different.

It appears, therefore, that *solomonis* in the restricted sense is a segregate of a complex composed of a number of local races or species. Evolution in this complex seems to be very active at the present. On Guadalcanal there are 2 other segregates of the *solomonis* complex, *fuscipalpis* and *fuscitarsis.* It may be that 1 of these 2 is an earlier segregate of the complex and that the other was formed through hybridization between the former and the dominant modern *solomonis.* However, it is also possible that either or both *fuscipalpis* and *fuscitarsis* are recent sympatric derivatives of *solomonis* or that 1 of them is a sympatric derivative and the other is of hybrid origin. At least 2 of these 3 forms have been collected apparently in the same pandanus but probably in separate leaf axils at different levels of the plant. No accurate field notes were made on the specific occurrence of the 3 forms; until this information is available and cytogenetic studies and experimental hybridizations are made, this interesting problem cannot be resolved. A similar situation prevails in the *bougainvillensis* complex, which includes also *hollingsheadi, neogeorgianus,* and *schlosseri.*

BIONOMICS AND DISEASE RELATIONS.—On Guadalcanal the immature stages of *solomonis* have been collected in the axils of several species of pandanus, but J. G. Franclemont records the species only from narrow-leafed pandanus in the New Georgia group.

All the known adults of *solomonis* have been reared, and nothing is known of their bionomics or disease relations.

DISTRIBUTION (fig. 225).—*Solomon Islands:* ? Bougainville; ? Arundel; ? Sasavele; ? New Georgia; Guadalcanal. Not known elsewhere.

22. Aedes (Finlaya) sp., Fiji albino form

Fig. 225

FEMALE.—*Wing:* 2.63 mm. *Proboscis:* 1.6 mm. *Forefemur:* 1.53 mm. *Abdomen:* about 2.2 mm. Scaling largely whitish on head, thorax, legs, wings, and upper surface of abdomen. *Head:* practically all scales whitish including erect occipital scales; middle of vertex with very few narrow scales; labium largely light-scaled in basal 0.6, some dark scales at and near base, a small dorsal apical patch of white scales; palpus largely dark-scaled, with light scales on apex of segment 4. *Thorax:* integument dark; mesonotum apparently with narrow whitish scales, a few darker scales in space between supraalars and prescutellars, some broader whitish scales above anterior portion of *ppn,* in supraalar area, and around posterior part of prescutellar space; scutellum with only white scales on all lobes; pleural scaling rather sparse, all white, *psp* and lower part of *pra* without scales, lower part of *mep* apparently with 3 scales. *Legs:* forefemur whitish except for apical patch of dark scales on anterior and dorsal surfaces; midfemur largely whitish, with several rather broad bands of dark scales on anterior surface and a larger apical patch of dark scales which forms a narrow complete ring; hindfemur similar to forefemur except for some scattered dark scales preapically on dorsoanterior surface; preapical scale tufts moderately developed on forefemur and midfemur only; tibiae and tarsi apparently all whitish.

Wing: dorsal scales largely white, with small patches of darker scales forming indefinite transverse bands near base, near furcation of R and near furcation of M; vein C entirely white-scaled. *Haltere:* upper part of stem and knob with white scales only. *Abdomen:* integument dark, all scales white or yellowish except for dark scales on lateral portions of tergites.

MALE, PUPA, and LARVA.—Unknown.

MATERIAL EXAMINED.—2 ♀ (UCLA).

SYSTEMATICS.—This form is strikingly different in ornamentation from all members of the group and probably represents a distinct species, although it may possibly be an albino variant of *fijiensis,* which it resembles closely in other features except for proportionally shorter forefemur and longer proboscis. Nothing approaching this degree of albinism is known in any species of the group. Since only 2 damaged females are known, this form is not named now.

BIONOMICS AND DISEASE RELATIONS.—The 2 females were taken in human-bait catches in association with *fijiensis.* The male and immature stages are unknown.

DISTRIBUTION (fig. 225).—*Fiji:* Viti Levu. Not known elsewhere.

23. Aedes (Finlaya) sp., Guadalcanal form

Fig. 225

A single female from Guadalcanal (Oct. 15, 1943, P. W. Oman; USNM) resembles *knighti* in the restricted light scaling of hindtarsal segments 2 and 3. However, the wing is extremely pale, with the subcostal and accessory subcostal pale areas fused and preapical dark area reduced; the light scaling of the labium and tarsi, particularly the hindtarsus, more strongly white; abdominal tergites and sternites more extensively pale. It is very likely that this is a distinct species, but it is not named at present since the male is unknown and the immature stages are not associated. I have seen a pupa (Sept. 28, 1943, P. W. Oman, 51; USNM) which may belong to the same species; it appears to resemble *knighti* but is in too poor condition for detailed comparison. There are also 8 larvae from Malageti on the south coast of Guadalcanal (Apr. 10, 1954, M. V. Natuna) and from Florida (B.No.2, M. V. Natuna) which may belong to this form (SYDNEY, UCLA).

24. Aedes (Finlaya) sp., Malaupaina form

Fig. 225

Aedes (Finlaya) samoana in part of Insects of Samoa (1935:109).

A single damaged female from Malaupaina Island (Three Sisters), near San Cristobal, Solomon Islands (May 10, 1934, R. A. Lever; BMNH), appears to be in general similar to *franclemonti* but differs most conspicuously in having the base of vein C largely dark-scaled, without a prehumeral light spot. Such variants have not been seen in *franclemonti,* and it appears probable that this specimen represents a related undescribed species.

Subgenus OCHLEROTATUS Lynch Arribalzaga

1891. *Ochlerotatus* Lynch Arribalzaga, La Plata U. Nac. Mus., Rev. 1:374; 2:143. TYPE SPECIES: *O. confirmatus* Lynch Arribalzaga, 1891, Argentina; the second of 2 species, selection of Coquillett (1910:577).

1891. *Taeniorhynchus* Lynch Arribalzaga, La Plata U. Nac. Mus., Rev. 1:374; 2:147. Suppressed by International Commission on Zoological Nomenclature, Opinion 550 (1959).

1903. *Gilesia* Theobald, Monog. Culicidae 3:233. *TYPE SPECIES: *G. aculeata* Theobald, 1903, Queensland; monobasic.

1904. *Culicelsa* Felt, N.Y. State Mus., B. 79:391*b*. TYPE SPECIES: *Culex taeniorhynchus* Wiedemann, 1821, Mexico; original designation.

1911. *Andersonia* Strickland, Entomologist 44:250. *TYPE SPECIES: *A. tasmaniensis* Strickland, 1911, Tasmania; monobasic.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—*Head:* eyes usually more or less separated above antennae; frons with or without scales; decumbent scales of vertex largely narrow; erect scales numerous; palpus 0.15–0.4 proboscis, 5-segmented, segment 5 minute; antenna varied in length, longer or shorter than proboscis. *Thorax:* mesonotal scaling varied, usually narrow; acrostichals and dorsocentrals present, varied in development; scutellum with narrow scales only; paratergite usually scaled, sometimes bare; pleural scaling varied; pleural bristles varied; lower *mep* bristles present or absent. *Legs:* tarsal scaling varied; claws varied, usually toothed at least on foreleg and midleg. *Wing:* remigium usually with conspicuous bristles; alula with extensive marginal fringe of long hairs or hairlike scales. *Abdomen:* scaling varied on tergite I and laterotergite. *Genitalia:* segment VIII usually narrow and completely retractile; cercus usually long and narrow; 3 spermathecae.

MALES.—Essentially as in the females. *Palpus:* as long as or longer than proboscis; 5-segmented, segments 4 and 5 subequal, downturned and hairy. *Antenna:* distinctly shorter than proboscis, flagellar segments 12 and 13 elongate, flagellar whorls long and dense. *Legs:* claws of foreleg and midleg enlarged. *Abdomen:* lateral hairs numerous and long; scaling reduced.

MALE GENITALIA.—Usually prominent. *Segment VIII:* usually narrowed at base. *Segment IX:* varied in development; tergite usually with a pair of more or less distinct lobes bearing hairs; sternite with a few hairs. *Sidepiece:* usually elongate; with more or less strongly developed basal tergomesal lobe, sometimes with apical tergomesal lobe; mesal membrane from base to apex. *Claspette:* strongly developed; with elongate stem and a single apical seta usually specialized as a bladelike, sicklelike, or variously modified long appendage. *Clasper:* simple; spiniform apical, usually long. *Phallosome:* aedeagus simple; ventral paramere usually long. *Proctiger:* strongly developed; basolateral sclerotization strong; paraproct with strong apical spine which is usually simple; cercal setae present.

PUPAE.—*Cephalothorax:* hair 8-C widely separated from hair 9, usually at level of trumpet bases. *Trumpet:* short, broad; tracheoid indistinct. *Abdomen:* hairs 2,3-I usually approximated; 2-III-VII varied in position; 9-VI small, similar to 9-II-V. *Terminal Segments:* female cercus strongly projecting. *Paddle:* margins without or with short spicules; hair 1-P single or branched.

LARVAE.—*Head:* broad; inner mouthbrush filaments pectinate or simple; hair 4-C usually small, varied in position; 5,6-C caudad of antennal bases. *Antenna:* simple; short to quite long; usually distinctly spiculate; hair 1-A varied, usually inserted near middle. *Thorax:* hair 13-P not developed. *Abdomen:* hair 12-I present; 6-I,II always strongly developed; 6-III-VI at least moderately developed; 7-I strongly developed. *Segment VIII:* comb in a large patch of several rows or in a single row; comb scales varied. *Siphon:* varied in length; acus always present, attached; pecten varied, teeth evenly spaced or distal widely separated; hair 1-S strongly developed, within or beyond pecten; valves small; trachea usually strongly developed. *Anal Segment:* saddle complete or incomplete; acus present or absent; marginal spicules small or absent; hair 1-X usually on saddle; 2-X multiple; 3-X single; ventral brush strongly developed, usually with at least 7 pairs of hairs on grid and usually with 2 or more detached hairs proximad of grid; gills varied.

SYSTEMATICS.—As currently interpreted, *Ochlerotatus* is 1 of the 2 largest subgenera of *Aedes*, with about 160 described species and subspecies. It is a heterogeneous complex of several different types which appear to have in common some rather basic structures in the male genitalia, suggesting affinities with *Finlaya, Mucidus,* and *Levua.* The female genitalia and the adult ornamentation, on the other hand, are superficially quite similar to those of *Aedimorphus.* The larvae are also suggestive of *Aedimorphus* and related subgenera but seem to be distinct in that hair 12 on abdominal segment I is nearly always developed. It seems probable that the subgenus as now understood is a polyphyletic assemblage and that it will be split up into several subgenera when the numerous species are revised. The groups recognized by Edwards (1932:136–137) are based in general on very superficial characters, and several of them include completely unrelated forms.

Ochlerotatus is very poorly represented in the Old World tropics, where it appears to have been replaced largely by *Aedimorphus, Verrallina,* and related subgenera. In the South Pacific it is represented by 6 forms, 2 of which are very poorly known. These fall into 3 of the sections recognized by Marks (1957*b*), as follows: (1) the *vigilax* section, represented by *antipodeus, edgari, vigilax,* and possibly *subalbirostris,* (2) the *aculeatus* section, represented by *mcdonaldi,* and (3) the *burpengaryensis* section, probably represented by sp. 6, New Caledonia form. All the species, except possibly *mcdonaldi,* appear to be relicts or very ancient forms.

BIONOMICS AND DISEASE RELATIONS.—The typical species of *Ochlerotatus* are breeders in various types of temporary ground pools. However, several annectent types provisionally placed in the subgenus are known from rockholes and treeholes. Females of many species are vicious biters and are often very troublesome pests, particularly in the north temperate regions. The majority of species bite in the daytime, particularly early in the morning and late in the afternoon, but several are also nocturnal feeders. The flight range of several species is reported to be very extensive. Experimental and natural infections with viruses, bird plasmodia, and filarial worms have been reported for several species (see Horsfall, 1955). In the South Pacific *vigilax* is apparently the vector of nonperiodic filariasis on New Caledonia.

DISTRIBUTION (fig. 262).—*Ochlerotatus* is best known by the numerous Holarctic species, but these belong to relatively few modern types. The subgenus is very strongly represented and has a greater variety of types in the Australian and Neotropical regions. Only a few forms are known from the Oriental, Indomalayan, Papuan, Ethiopian, and Malagasy regions. In the South Pacific *Ochlerotatus* is widely distributed from the Solomons, New Caledonia, and New Zealand to Tahiti but forms a conspicuous element of the mosquito fauna only in New Zealand and New Caledonia.

KEYS TO SPECIES

(Keys to tribe Aedini, pp. 318–321)

ADULTS

1. Lower mesepimeral bristles present; tarsi without distinct basal white rings or dorsal bands 2

Lower mesepimeral bristles absent; some of the tarsal segments with distinct basal light rings or dorsal bands 3

2(1). Abdomen without distinct transverse basal pale bands; *ppn* with broad scales predominating .... 5. *mcdonaldi*

Abdomen with distinct transverse basal pale bands; *ppn* with narrow scales only .... 6. New Caledonia form

3(1). Subspiracular area with 2 scale patches; female palpus over 0.3 of proboscis .... 4. *subalbirostris*

Subspiracular area without scales; female palpus less than 0.2 of proboscis 4

4(3). Labium entirely dark; mesonotum with narrow longitudinal lines of pale golden scales .... 1. *antipodeus*

Labium with median pale ring or with ventral pale scaling on median third or more; mesonotum without longitudinal pale golden lines 5

5(4). Postspiracular area at most with 1,2 narrow golden scales; paratergite, *apn,* and *ppl* without scales .... 2. *edgari*

Postspiracular area with large patch of broad whitish scales; paratergite, *apn,* and *ppl* with scales .... 3. *vigilax*

MALE GENITALIA

(4. *subalbirostris* and sp. 6 not included)

1. Claspette filament broad, with crest of branched spicules; sternomesal margin of sidepiece with very numerous long bristles from near base to apex . . . . 5. *mcdonaldi*
   Claspette filament slender, without crest of branched spicules; sternomesal margin of sidepiece without long bristles except a few near apex 2

2(1). Basal tergomesal lobe in form of long pedunculate process; appendage of claspette very long, slightly expanded apically . . . . 2. *edgari*
   Basal tergomesal lobe short, sessile; appendage of claspette moderately long, an attenuate spiniform 3

3(2). Tergal surface of sidepiece with only a few longish hairs proximad of basal tergomesal lobe; tergomesal subapical area with 2 heavy differentiated setae . . . . 3. *vigilax*
   Tergal surface of sidepiece with large patch of very short hairs proximad of basal tergomesal lobe; tergomesal subapical area without heavy differentiated setae . . 1. *antipodeus*

PUPAE

(4. *subalbirostris* and sp. 6 not included)

1. Hair 3-I closer to 4,5-I than to 2-I; 5-IV weak, only slightly more than 0.5 of tergite V . . . . 5. *mcdonaldi*
   Hair 3-I closer to 2-I than to 4,5-I; 5-IV strong, about as long as tergite V or longer 2

2(1). Hair 2-III-VII heavy, spiniform, near middle of segment or slightly caudad; hair 5-IV-VI usually single . . . . 1. *antipodeus*
   Hair 2-III-VII relatively weak, not markedly spiniform, in distal 0.3 of segments; hair 5-IV-VI usually branched 3

3(2). Hair of paddle single . . . . 2. *edgari*
   Hair of paddle branched . . . . 3. *vigilax*

LARVAE

(4. *subalbirostris* and sp. 6 not included)

1. Anal segment completely ringed by saddle which is pierced by precratal hairs of ventral brush; integument strongly spiculate throughout; hair 4-C large . . . . 5. *mcdonaldi*
   Anal saddle incomplete; integument smooth; hair 4-C small 2

2(1). Hair 4-C near level of 5-C; 11,12-C large; 9-P multiple; dorsal and ventral abdominal hairs large . . . . 1. *antipodeus*
   Hair 4-C nearer level of 6-C than 5-C; 11,12-C small; 9-P usually single; dorsal and ventral abdominal hairs small 3

3(2). Siphon index more than 2.0; hair 5-C usually 3-5b; 5-P usually single . . . . 2. *edgari*
   Siphon index less than 2.0; hair 5-C usually 1,2b; 5-P usually double . . . . 3. *vigilax*

1. Aedes (Ochlerotatus) antipodeus (Edwards)

Figs. **263-265**

1920. *Ochlerotatus antipodeus* Edwards, B. Ent. Res. 10:132. *TYPE: holotype ♀, marked as type by Edwards, Mt. Albert or Kari Kari Bay, New Zealand, no date, A. E. Brooks (BMNH).

Aedes (*Ochlerotatus*) *antipodeus* of Edwards (1924:376; 1932:137); Taylor (1934:15); Graham (1939:212–213); Miller (1950:42); Miller and Phillipps (1952:16–17); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 5.16 mm. *Proboscis:* 3.33 mm. *Forefemur:* 2.25 mm. *Abdomen:* about 3.5 mm. *Head:* decumbent scales of vertex light golden except for a pair of anterior submedian patches of dark bronzy scales just caudad of orbital line; erect scales largely dark; light lateral broad scales largely pale beige or whitish; labium and palpus dark-scaled, segments 2,3 of palpus with very scanty scaling; antennal torus with a few very small dark scales, segment 1 of flagellum with small patch of small broad dark scales at base. *Thorax:* integument dark; mesonotal scales all narrow, predominantly very dark bronzy but with a conspicuous contrasting pattern of pale golden scales largely in narrow lines and in patches as follows, (1) a complete acrostichal line dividing into prescutellar lines, (2) a pair of dorsocentral lines, scales mesad of bristles in anterior portion and laterad of bristles in posterior, (3) a pair of broken lateral prescutal lines of rather broad patches to supraalar area, each connected to dorsocentral line caudad of scutal angle by a caudolaterally oriented broad diagonal posterior fossal line; scutellum with broad median longitudinal stripe of pale golden scales, remaining scales dark bronzy, scanty on all lobes; paratergite bare, rarely with 1 scale; *apn* with small elongate outstanding broad whitish or pale beige scales; upper part of *ppn* with small decumbent broad scales, largely dark, a few pale particularly along upper border, 3–5 dark bristles; *ppl* with large patch of whitish broad scales below bristles; *psp* with a few whitish broad scales, usually about 4 dark bristles and several short light hairs; *stp* with usual large upper and lower scale patches, scales broad, whitish, lower bristles in a patch; *pra* with large lower patch of broad whitish scales; *mep* with large patch of broad whitish scales from very numerous pale upper *mep* bristles to lower third, lower *mep* bristles not developed; scales absent on other sclerites. *Legs:* forecoxa largely with dark scales, some pale at base and apex; midcoxa largely with pale scales; hindcoxa apparently without scales; femora dark-scaled above, light-scaled below and on variable portion of anterior and posterior surfaces, more on hindleg; tibiae dark-scaled, paler ventrally; tarsi dark-scaled except for basal white rings on segments 1–4, narrowest on foreleg, broadest on hind; both claws of foreleg and midleg toothed. *Wing:* dorsal wing scales all dark; bristles of remigium numerous and conspicuous. *Haltere:* knob with dark scales above, light below. *Abdomen:* tergites dark-scaled except for narrow basal transverse bands of whitish or yellowish scales, bands somewhat expanded laterad; laterotergite with large patch of whitish or pale beige scales; sternites pale-scaled laterally, dark-scaled median triangular area with broad base apical.

MALE.—Essentially similar to the female in ornamentation. *Palpus:* slightly shorter than proboscis; scaling scanty; segments 4,5 directed ventrally, with long hairs on mesal side. *Legs:* claws not studied.

MALE GENITALIA (fig. **264**).—As figured; diagnostic characters as in the key. *Segment IX:* tergal lobe small but distinct, with about 4 hairs; sternite with lateral sclerotization continued as the basal sclerotized part of lateral portion of segment distally supporting inner sternal process of sidepiece; middle portion of sternite with 5 hairs. *Sidepiece:* moderately long and broad; with distinct basal tergomesal lobe and indistinct broad apical tergomesal expansion; scales and long bristles restricted to lateral and ventral surfaces, dorsal surface with extremely short fine hairs; basal tergomesal lobe prominent, strongly projecting sternomesad, its tergal surface densely covered with short very fine hairs which are longer mesad; apical tergomesal expansion very broad, not distinctly lobelike, sparsely covered with very fine hairs which are longer than elsewhere on tergal surface; apicosternal area with 3 or more very long heavy differentiated subapical bristles. *Claspette:* stem slender; appendage a slender tapered curved spiniform. *Clasper:* long; apparently flattened; strongly widened in middle on inner surface; with 2,3 very short subapical setae; spiniform short and slender, apical. *Phallosome:* aedeagus very short and broad, swollen distally. *Proctiger:* 2 cercal setae on each side.

PUPA (fig. **264**).—*Abdomen:* 3.4 mm. *Trumpet:* 0.54 mm. *Paddle:* 0.96 mm. Not definitely associated with adults; cephalothorax badly folded in all specimens, hairs 1-3-C may be incorrectly homologized; chaetotaxy as figured, hairs moderately to very strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately to lightly pigmented, ends of appendage cases blackened; larger hairs with dendritic branching or heavy barbs. *Trumpet:* narrowed subapically; uniformly very darkly pigmented except for blackened apex. *Abdomen:* lightly to moderately pigmented, hair 2 spiniform on all segments; hairs 6-I,II,7-I very long and thickened. *Paddle:* uniformly lightly pigmented; midrib strongly developed; marginal spicules small but distinct.

LARVA (fig. **265**).—*Head:* 0.97 mm. *Siphon:* 1.37 mm. *Anal Saddle:* 0.39 mm. Not definitely associated with adults; chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately to strongly pigmented except for dark areas behind ocular areas and around foramen magnum, particularly ventrally, collar dark; mental plate as figured; inner mouthbrushes finely pectinate apically; hair 1-C heavy and very long; hair 4-C very fine, at or caudad of level of 5-C. *Antenna:* long and slender; uniformly pigmented, shaft with strong spicules. *Thorax* and *Abdomen:* integument without distinct spicules; hair strongly to moderately pigmented. *Segment VIII:* comb in a triangular patch, in 4,5 rows in middle; comb scale of middle of posterior row with a strongly spatulate rounded fringed apex on long smooth basal shaft; outer scales, particularly ventrally, long, pointed, spinelike, with fringe near base only. *Siphon:* index about 3.0–3.5, moderately to strongly pigmented, darkened on basal ring; sculpturing indistinct; acus small, joined by a very long and slender stem; about 20 pecten teeth, very darkly pigmented, progressively longer distally, evenly and closely spaced, those in middle with 1 heavy denticle and 2 or more slender denticles anteriorly on enlarged base, base less enlarged and denticles smaller on distal teeth; hair 1-S distal to pecten. *Anal Segment:* saddle incomplete, small; moderately to strongly pigmented, darkened at base and dorsoapically, lighter caudolaterally, dorsocaudal area with long patch of short broad apically fringed spicules; small detached acus present; ventral brush with 7 pairs of hairs on grid and 2–4 unpaired hairs proximad; gills short, subequal.

MATERIAL EXAMINED.—99 specimens; 60 ♀; 11 ♂; 5 pupae; 23 larvae; no individual rearings.

SYSTEMATICS.—As pointed out by Edwards (1924:376), *antipodeus* bears a superficial resemblance to some species of *Finlaya* in the adult ornamentation. It is very likely that *antipodeus* is one of the most generalized *Ochlerotatus* in existence, and it is to be expected that it would show some similarities with *Finlaya.* Marks placed *antipodeus* in the *vigilax* section on the basis of similarities in the male genitalia and larval siphon and comb.

The association of immature stages with the adults of *antipodeus* is presumptive only. Although it appears to be correct, it should be checked with individual rearings.

There is considerable variation in all stages, but the available material is too scanty and in too poor a condition for study. The majority of adults in collections are partially denuded and the striking mesonotal pattern is obscured.

BIONOMICS AND DISEASE RELATIONS.—Very little specific information is available on the bionomics of *antipodeus* other than that the immature stages are found in ground pools and that the adults attack man. This species is said to be a cold-weather form; the larvae are most active in cold water and their development is retarded by high temperatures (Graham, 1939:213; Miller and Phillipps, 1952:17).

DISTRIBUTION (fig. **263**).—*New Zealand:* North Island (Auckland, Wellington); South Island (Canterbury). Not known elsewhere.

2. Aedes (Ochlerotatus) edgari Stone & Rosen

Figs. **263, 266, 267**

1952. *Aedes* (*Ochlerotatus*) *edgari* Stone and Rosen, Hawaii. Ent. Soc., Proc. 14:425–427. *TYPE: holotype ♂ with genitalia slide, Punaauia, Tahiti, Dec. 4, 1950, L. Rosen (USNM, 61305).

Aedes (*Ochlerotatus*) *edgari* of Iyengar (1955:27); Rageau (1958*a*:877); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.83 mm. *Proboscis:* 2.83 mm. *Forefemur:* 2.17 mm. *Abdomen:* about 3.0 mm. Related to *vigilax* but differing strikingly in ornamentation as follows. *Head:* integument darker, dark scaling with purplish gloss; light decumbent narrow scales yellowish in color, less numerous but forming orbital lines and a median stripe and predominating caudally; dark lateral broad scales more numerous, occupying an extensive area below the light yellowish upper spot of broad scales; labium with median third yellowish ventrally, usually expanded dorsad in distal portion to form complete ring; palpus a little longer. *Thorax:* integument darker; mesonotal scaling less dense, light scales largely golden, contrasting more with the dark scales, prescutellar scales less numerous, scutellar scales golden; pleural scaling much more restricted, light scales beige to yellowish; *apn* and *ppl* without scales; *ppn* scales all dark, largely narrow, some moderately broadened; *psp* with only 1,2 narrow golden scales; *stp* with small upper and lower patches of broad pale scales; *pra* with small patch of broad pale scales below knob; *mep* with smaller upper patch of broad scales. *Legs:* pale scaling of coxae and femora pale yellowish; hindcoxa without scales; femora dark-scaled above and in front, without speckling of light scales, pale at base, lower or posterior surfaces with usual pale-scaled areas, but with some dark scales; tibiae all dark; foretarsus and midtarsus with white basal bands very narrow on segments 1 and 2 and a trace on 3; hindtarsus with white scaling as in *vigilax* but more extensive, segment 5 nearly all white. *Wing:* all dorsal scales dark; bristles of remigium fewer, less conspicuous, usually 2. *Haltere:* knob largely dark-scaled. *Abdomen:* tergites without basal white bands but usually with a few indistinct pale scales in area, particularly on midline, no apical light scales on distal segment, lateral white patches small but conspicuous on II-VII; sternites largely dark-scaled.

MALE.—Essentially as in the female; scaling even less extensive. *Labium:* light ring narrower but complete. *Palpus:* distinctly shorter than proboscis, with pale basal bands on segments 3–5 as in *vigilax. Legs:* larger claw of foreleg and smaller of midleg toothed, others simple. *Abdomen:* tergites with conspicuous basal whitish bands widened laterally on distal segments.

MALE GENITALIA (fig. **266**).—As figured; diagnostic characters as in the key; basically as in *vigilax* but differing markedly in details. *Segment VII:* narrowed, greatly elongate. *Segment VIII:* narrowed, tergite lobe with 2 pairs of strong thickened lateral bristles. *Segment IX:* tergite lobe small but prominent, usually with 3-5 hairs. *Sidepiece:* moderately long and slender, basal tergomesal lobe very strongly developed as a pedunculate process, apicotergal lobe slightly developed; scales and long bristles restricted to lateral and ventral surfaces; dorsal surface with very short slender hairs at base of basal tergomesal lobe and somewhat longer hairs in distal half; basal tergomesal lobe developed as a long slender stem curving ventrad then dorsad and expanded apically into a capitulum with dense covering of hairs which project dorsally; apicotergal lobe small but distinctly indicated as an angular process bearing a small thickened bristle; apicosternal area with several very long heavy bristles. *Claspette:* small; stem very slender; appendage a very long slender spiniform bristle. *Clasper:* essentially as in *vigilax;* long, slender, not markedly widened in the middle; several rather long, slender, subapical hairs; spiniform moderately long, shallowly inserted. *Phallosome:* aedeagus very poorly sclerotized, essentially as in *vigilax* but smaller. *Proctiger:* paraproct with 2,3 denticles; usually about 5 rather long cercal setae on each side.

PUPA (fig. **266**).—*Abdomen:* 2.75 mm. *Trumpet:* 0.46 mm. *Paddle:* 0.84 mm. Chaetotaxy as figured; diagnostic characters as in the key; essentially similar to *vigilax,* from which it differs most conspicuously in the weak, branched hair of the paddle, differently shaped paddle, and generally somewhat darker coloration; paddle somewhat infuscated near apex of midrib.

LARVA (fig. **267**).—*Head:* 0.87 mm. *Siphon:* 0.89 mm. *Anal Saddle:* 0.45 mm. Chaetotaxy as figured, larger hairs strongly pigmented; diagnostic characters as in the key; resembling *vigilax* in basic features but differing markedly in the following details; hair 5-C usually 3-5b; antenna somewhat longer, more uniformly pigmented; hair 5-P single; 6-I,II,7-I single; comb scales more numerous; siphon longer, index about 2.5–3.0, pecten teeth more numerous; saddle with dorsoapical spicules more prominent; gills longer than saddle; larger branched hairs of segment VIII, siphon, and anal segment with branches more numerous, base usually flattened.

MATERIAL EXAMINED.—155 specimens; 25 ♀; 16 ♂; 57 pupae; 57 larvae; 4 individual larval rearings.

SYSTEMATICS.—*A. edgari* is a very interesting species, closely related to *vigilax* in spite of the unique monstrous development of the male genitalia. In all fundamental characters it is an aberrant development of the *vigilax* type, and in all probability it originated from a very small population of *vigilax* or a species ancestral to the latter. The nearest known present population of *vigilax* is in Fiji, some 2,000 miles away, and there is no large land mass within 1,500 miles of Tahiti where populations of ancestral *vigilax* may have existed in the recent past. There is a possibility that *vigilax* and similar species do not disperse only through the adult stage. The eggs of such species are remarkably resistant and may remain in diapause for years; they could be transported by air currents during tropical storms and could conceivably be dumped by pure chance on a suitable dot of land such as Tahiti. However, I believe that no such dispersal took place but rather that *edgari* arrived in Tahiti in the remote past by way of large intermediate land masses that are no longer in existence, that it has been isolated for a very long time, and that it is, in fact, a relict and not a modern derivative of the *vigilax* stock. Other possibilities seem more remote but cannot be completely disregarded: transport of eggs by water birds and even transport of eggs in soil or with plants by man within historical times. In any event, it is clear that only a single small population of the *vigilax* type gave rise to *edgari.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *edgari* have been collected in shallow temporary ground pools of fresh water; only once have they been found in a pool near the sea, but the water was apparently fresh. Females have been observed feeding on man at night in nature. This species seems to be uncommon. Rosen (*in* Stone and Rosen, 1952:428) has shown *edgari* to be an efficient laboratory host for the Tahitian strain of *Wuchereria bancrofti.*

DISTRIBUTION (fig. **263**).—*Society Islands:* Tahiti. Not known elsewhere.

3. Aedes (Ochlerotatus) vigilax (Skuse)

Figs. **263, 268, 269**

1850. *Culex albirostris* Macquart, Soc. des Sci. de Lille, Mem. (1849):314; Dipteres Exotiques (separate), Sup. 4:10. TYPE: lectotype ♀, New South Wales, 4·9·47, J. Verreaux; selection of Klein and Marks, 1960:112–115 (PARIS).—Klein and Marks (1960:115) are submitting an application to the International Commission on Zoological Nomenclature for the rejection of this nominal species and the validation of *vigilax* (Skuse, 1889); see also *subalbirostris* Klein & Marks, 1960.

1889. *Culex vigilax* Skuse, Linn. Soc. N.S. Wales, Proc. (2)3:1731–1732. TYPES: syntypes, ♀, New South Wales and Queensland (MACL).

1901. *Culex marinus* Theobald, Monog. Culicidae 1:396–399. *TYPE: lectotype ♂, marked as ♂ type by Theobald, South Queensland, July 24, 1899, T. L. Bancroft, 71; by present selection (BMNH).—Synonymy with *vigilax* by Edwards (1922*a*:99).

1903. *Culex annulifera* Ludlow, N.Y. Ent. Soc., J. 11:141–142. *TYPE: lectotype ♀, Mangarin, Mindoro, Philippines, Feb., F. Suggs; selection of Knight and Hull, 1951:226 (USNM).—Synonymy with *vigilax* by Edwards (1929*a*:99); preoccupied by *Culex annuliferus* E. Blanchard, 1852.

1905. *Culex ludlowae* R. Blanchard, Les Moustiques, p. 630.—Substitute name for *C. annulifera* Ludlow, 1903 not *C. annuliferus* E. Blanchard, 1852; synonymy with *vigilax* by Edwards (1922*a*:99); specific name corrected from *Ludlowi.*

1907. *Culicelsa pseudovigilax* Theobald, Monog. Culicidae 4:382.—New name for *C. vigilax* of Theobald, 1901 not *C. vigilax* Skuse, 1889, but in reality they are the same; synonymy with *vigilax* by Edwards (1922*a*:99).

1911. *Culicelsa uniformis* Strickland, Entomologist 44:131–132. *TYPE: lectotype ♀, marked as type by Theobald, Perth, Western Australia, Mar. 28, 1907; present selection (BMNH).—Synonymy with *vigilax* by Edwards (1924:375).

Aedes (*Ochlerotatus*) *vigilax* of Edwards (1922*a*:99; 1922*b*:466; 1924:375; 1932:138); Taylor (1934:17); Lever (*in* Paine, 1943:24–25); Lee (1944*a*:53); Knight, Bohart, and Bohart (1944:34, 56); Perry (1946:18); Laird (1955*a*:287; 1956); Iyengar (1955:27); Rageau (1958*a*:877; 1958*b*:3); Rageau and Vervent (1958:15–16); Stone, Knight, and Starcke (1959).

Aedes (*Ochlerotatus*) *nocturnus* and *nocturnus niger* of Edwards (1922*a*:99).

Culex albirostris of Theobald (1903:162).

Culex procax of Theobald (1901*a*:415).

FEMALE.—*Wing:* 3.5 mm. *Proboscis:* 2.58 mm. *Forefemur:* 1.65 mm. *Abdomen:* about 3.17 mm. *Head:* narrow decumbent scales variable in coloration, whitish caudally and sometimes in the middle, dark anteriorly; erect scales dark; lateral and ventral broad scales largely light, with a subdorsal patch of dark ones; labium dark-scaled at extreme base and in apical 0.4 or less, remainder with extremely variable amount of whitish to yellowish or light golden scaling, more extensive on ventral surface, sometimes confined to small ventral area or forming a complete large ring, frequently with scattered dark scales dorsally; palpus 5-segmented, segment 5 extremely minute, largely dark-scaled, segment 4 with restricted apical light scaling; torus of antenna with a few very small dark scales in addition to hairs, flagellar segment 1 with a few longer dark scales. *Thorax:* mesonotal integument dark brown; mesonotal scales all narrow, variable in color, largely dark bronzy in front, a variable number of light coppery to pale golden or beige scales chiefly posteriorly; posterior portion of prescutellar area with beige scales; scutellum with narrow beige scales on all lobes; paratergite with a patch of small broad whitish scales near middle; *apn* scaling variable, both narrow and broad and light and dark scales may be present, scales usually dark above, light below; *ppn* scaling extremely variable, broad dark scales predominating in central portion of patch, several broad light scales in posterior lower corner, narrow dark scales along mesonotal margin and in front, frequently narrow scales more numerous and mixed or predominating in central portion, sometimes light scaling more extensive; remaining scales of pleuron all broad and dingy white, distributed in broad patches on *ppl, psp,* upper and posteroventral *stp,* and upper anterior *mep,* absent elsewhere; lower *mep* bristles absent. *Legs:* forecoxa largely dark-scaled, usually with large patch of pale scales at base externally and speckled with light scales apically in front; scales of midcoxa and hindcoxa largely pale; femora and tibiae largely dark-scaled, more or less extensively speckled with light scales, particularly ventrally and on hindleg; tarsi largely dark-scaled, with variable basal rings or dorsal basal patches of white scales, foretarsus with white markings usually only on segments 1–3, midtarsus on 1–3 or 1–4, hindtarsus on 1–5. *Wing:* dorsal scales largely dark, a variable number of pale, whitish to coppery, scales chiefly on anterior portion and at base of veins C and R, sometimes pale scales more numerous and present on middle portion of wing; remigium bristles strongly developed. *Haltere:* knob largely pale-scaled. *Abdomen:* tergites largely dark-scaled, with whitish to creamy light markings; tergite I with small basal light patch; laterotergite light-scaled; tergites II-VI with conspicuous straight basal dorsal light bands and lateral light patches which are basal on II and subcentral on III-VI; apex of tergites V and VI with some pale scales; tergite VII with light scaling chiefly apical; sternites predominantly light-scaled, with more or less extensive apicolateral dark-scaled areas.

MALE.—Essentially as in the female. *Labium:* pale scaling more restricted. *Palpus:* approximately as long as proboscis or slightly shorter, with basal light bands on segments 3–5. *Thorax:* scaling scantier; mesonotum with more numerous pale coppery scales; *ppn* scales scantier, narrower, and paler. *Legs:* larger claw of foreleg toothed; larger claw of midleg with submedian swelling, smaller toothed, others simple. *Abdomen:* basal light bands of tergites variably prolonged caudad laterally, no separate lateral light patches.

MALE GENITALIA (fig. **268**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe usually prominent, usually with 3–5 hairs distally and 1 or more at base. *Sidepiece:* moderately long and broad; with well-developed basal tergomesal lobe but no apical tergal lobe; scales and long bristles restricted to lateral and ventral surfaces; dorsal surface with moderately short thin hairs in a small patch near base and longer scattered hairs in distal half; basal tergomesal lobe prominent, sessile, extending sternally, densely covered with moderately long, thin hairs on mesal surface; apicotergal area with 2 heavy hairs; apicosternal area with several long heavy bristles. *Claspette:* short; appendage a slender spiniform, more or less attenuate and curved apically. *Clasper:* long, slender, not markedly widened in middle; several rather long, slender subapical hairs; spiniform moderately long, deeply inserted. *Phallosome:* aedeagus long, slightly widened in middle, apex slightly produced. *Proctiger:* paraproct ending in a single tooth; about 6 rather long, very slender cercal setae on each side.

PUPA (fig. **268**).—*Abdomen:* 3.12 mm. *Trumpet:* 0.48 mm. *Paddle:* 0.81 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, darker on mesonotum. *Trumpet:* uniformly rather strongly pigmented. *Metanotum:* darkened. *Abdomen:* moderately pigmented, a little darker anteriorly and in intersegmental areas. *Paddle:* rather lightly pigmented, midrib and external buttress darkened; minute spicules on dorsal surface externally; hair 1-P single, heavy and rather long.

LARVA (fig. **269**).—*Head:* 0.83 mm. *Siphon:* 0.72 mm. *Anal Saddle:* 0.4 mm. Chaetotaxy as figured, larger hairs strongly pigmented; diagnostic characters as in the key. *Head:* uniformly strongly pigmented except for lighter ocular areas and black collar; mental plate as figured; inner mouthbrushes pectinate apically; hair 1-C heavy, long; 4-C very fine, nearer 6-C than 5-C. *Antenna:* moderately long and slender; dark on basal ring, remainder light proximally, darker apically; spicules small, sharply pointed, variable in number. *Thorax* and *Abdomen:* integumentary spiculation indistinct. *Segment VIII:* comb in an irregular triangular patch; scales small, strongly fringed, and usually with a differentiated apical spicule. *Siphon:* index about 1.5–2.0; moderately to strongly pigmented, basal ring black; sculpturing indistinct; acus well developed, broadly joined; 8–12 pecten teeth, evenly and closely spaced; hair 1-S within or beyond pecten. *Anal Segment:* saddle poorly to moderately pigmented, extensive but incomplete; a few short dorsoapical spicules; small detached acus present; ventral brush with 6–7 pairs of hairs on grid and 2–4 detached unpaired hairs, 1 of which may be on grid; gills short.

MATERIAL EXAMINED.—668 specimens; 360 ♀; 110 ♂; 13 pupae; 185 larvae; no individual rearings.

SYSTEMATICS.—*A. vigilax* is an extremely variable species, particularly in the amount of the light scaling on the labium, femora, and wing and the type and color of the light scaling on the posterior pronotum. Most specimens have a distinct patch of scales on the paratergite, but I have seen several in which these are apparently completely absent. I have not examined enough material of *vigilax* from various portions of its range to reach a definite decision as to the taxonomic status of *ludlowae,* which is treated as a subspecies of *vigilax* by Knight and Hull (1951:226–229). However, it seems to me that it is not worthy of recognition as a subspecies. I find that the characters which supposedly differentiate this form are quite commonly found in typical *vigilax* from Australia as well as the South Pacific. I believe that essentially the same situation prevails in *vigilax* and in *taeniorhynchus* (Wiedemann, 1821) from the New World. These distantly related species of ancient origin have persisted to this day through their adaptability and plasticity; although primarily brackish water-breeders, they develop successfully in fresh water; both are strong fliers, and it is very likely that the various isolated populations are frequently intermixed. Therefore it is very unlikely that distinct segregates are found except on islands now or in the past so isolated that local populations could become genetically distinct. In *vigilax* several such segregates are evident at present, the strongly differentiated *edgari* from Tahiti and the less strongly differentiated forms in the Western Indian Ocean, *vansomerenae* Mattingly, 1955, *fryeri* (Theobald, 1912), and *dufouri* Hamon, 1953.

The populations of *vigilax* in the South Pacific are not extensive except on New Caledonia and possibly the Loyalties. On the other islands suitable habitats are very restricted and the populations remain small. In spite of this, they have not become differentiated to any great degree. Therefore I consider that they are probably replenished from time to time from more extensive populations, probably from the east coast of Australia.

In the South Pacific the association of the immature stage with the adults is presumptive only since no individual rearings have been carried out, but it appears to be correct.

BIONOMICS AND DISEASE RELATIONS.—*A. vigilax* is primarily a brackish water-breeder in mangrove swamps and salt marshes, but it is also found in rockholes and freshwater ground pools. Where the populations are large, the females are very aggressive and attack man as well as domestic animals. The smaller populations in unfavorable areas are frequently missed because, under these conditions, the females seldom attack man except in the immediate vicinity of the breeding sites. *A. vigilax* is said to bite at all times of the day and night, with a peak about sunset. This species is reported to be a powerful flier and may be found considerable distances from the coast.

A. vigilax is potentially an important vector of pathogens to man. It has been shown to be the principal vector of nonperiodic filariasis in New Caledonia and probably also in the Loyalty Islands (Iyengar, 1954*b*:43).

DISTRIBUTION (fig. **263**).—*Solomon Islands:* Guadalcanal. *New Hebrides:* Espiritu Santo; Aessi. *New Caledonia:* widespread along the coasts; Art (Belep); Ile des Pins. *Loyalty Islands:* Ouvea; Lifu; Mare. *Fiji:* Viti Levu. Also reported from *New Guinea, Australia, Indonesia, Philippines, Thailand, Indochina,* and *Formosa.*

4. Aedes (Ochlerotatus) subalbirostris Klein & Marks, 1960

Fig. **263**

1960. *Aedes* (*Ochlerotatus*) *subalbirostris* Klein and Marks, Linn. Soc. N.S. Wales, Proc. 85:115–116. *TYPE: holotype ♀, Invercargill (Otago), New Zealand, 23·XI·86, W. Wesche (BMNH).

Aedes (*Ochlerotatus*) *albirostris* of Edwards (1925:376; 1932:137); Taylor (1934:17); Miller (1950:42); Stone, Knight, and Starcke (1959).

FEMALE.—*Head:* middle of vertex and occiput with narrow curved decumbent scales, light golden in the middle, darker toward sides anteriorly, becoming bronzy and sparse near the broad lateral scales; erect scales numerous, scattered, moderately long, light in color; broad lateral scales white on sides but a few dark ones toward anterior end near darker narrow scales; orbital border densely covered with narrow yellowish scales; labium dark on apical 0.25 or more, largely light in middle, somewhat darker at base, a few dark scales mixed with light in middle; palpus narrowly white at apex of segments 2–4. *Thorax:* integument reddish brown, darker above; mesonotum without distinct scale pattern, all scales narrow, reddish brown in middle, lighter on sides, some whitish particularly in supraalar area; scutellum with fine narrow curved light golden scales; paratergite with large patch of broad whitish scales; *apn* with numerous light bristles and hairs, scales white, narrow anteriorly, broad posteriorly and below; *ppn* with narrow curved whitish scales above and with broad scales below, mixed white and dark in front, dark in middle and light behind, 8–10 golden bristles; *ppl* with numerous light hairs and broad white scales; *psp* with about 10 light golden hairs and a large patch of broad whitish scales; *ssp* extensively covered with broad whitish scales in lower part, one patch against *ppn*, the other against *stp* border; *stp* with usual crescent of bristles, 5 above and 3 caudally, within this area a patch of broad whitish scales from almost anterior border to posterior, lower part with 3 large bristles and 6–8 whitish hairs and a large patch of broad whitish scales extending to level of middle of coxa; *pra* with about 20 light golden bristles and a large patch of broad white scales below them; *mep* with 20–25 light golden upper bristles, no lower bristles, middle and upper part to upper bristles covered with broad decumbent white scales, a few broad erect white scales among bristles. *Legs:* femora speckled, light scales predominating, except dorsally; tibiae somewhat speckled, dark scales predominating; light scales dingy white or yellowish on both femora and tibiae; yellowish knee spots; tarsi dark-scaled except for narrow whitish bands at base of segment 2 of foreleg (possibly also segment 1), segments 1–3 of midleg, and segments 1–4 of hindleg, ventral surface lighter; all claws toothed. *Wing:* vein scales uniformly dark. *Haltere:* stem whitish, knob darker; small white scales on upper part of stem and base of knob, dark scales on inner side and upper part of knob. *Abdomen:* tergites dark-scaled, with narrow white-scaled bands which are mainly basal but spread on to apical margins of segments IV-VII; sternites largely light-scaled, darker at base.

MALE, PUPA, and LARVA.—Unknown.

MATERIAL EXAMINED.—1 ♀.

SYSTEMATICS.—*A. subalbirostris* is known only by the holotype female which was considered by Edwards (1924:376) to be conspecific with *albirostris* (Macquart, 1850) despite a number of discrepancies. Klein and Marks (1960:112–115) find that the syntypes of *albirostris* are conspecific with *vigilax* (Skuse, 1889) and that they were collected in New South Wales rather than in New Zealand, as stated by Macquart. The unique specimen from New Zealand is an entirely different species, for which Klein and Marks propose the name *subalbirostris.*

The taxonomic position of *subalbirostris* cannot be properly evaluated until the male and immature stages are studied.

BIONOMICS AND DISEASE RELATIONS.—Nothing is known of the bionomics of *subalbirostris.* The Invercargill specimen was taken in a hotel.

DISTRIBUTION (fig. **263**).—*New Zealand:* South Island (Otago). Not known elsewhere.

5. Aedes (Ochlerotatus) mcdonaldi Belkin, n. sp.

Figs. **263**, **270**, **271**

TYPES.—*Holotype:* ♂ (JNB, 693-1), West Poha swamp, Guadalcanal, Solomon Islands, from temporary pool, Oct. 24, 1944, J. N. Belkin (USNM, 64790). *Allotype:* ♀ (JNB, 693-13) with associated larval and pupal skins, same data as holotype (USNM). *Paratypes:* 14 ♀, 15 ♂, 17 pupae, 169 larvae (JNB, 693-1), same data as holotype, including 8 ♀ with associated larval and pupal skins (JNB, 693-11, 12, 14-19).—This species is dedicated to William A. McDonald in recognition of his contributions towards the completion of this study.

Aedes (*Ochlerotatus*) sp. near *sagax* of wartime collections in the Solomons.

FEMALE.—*Wing:* 4.41 mm. *Proboscis:* 2.5 mm. *Forefemur:* 2.17 mm. *Abdomen:* about 3.67 mm. Dark scaling with strong purplish violet gloss, particularly on legs and abdominal tergites; light scaling whitish or slightly yellowish, scales small and widely separated producing a pepper and salt effect against dark integument. *Head:* vertex dorsally with decumbent scales all lanceolate and whitish; erect scales all whitish and short, the anterior very slender and inconspicuous but extending to orbital bristles; lateral appressed scales broad, whitish, gradually merging into narrow dorsal scales, not extending on ventral surface of head capsule; a frontal tuft of narrow white scales to antennal base; clypeus very dark; labium entirely dark-scaled; palpus long, about 0.4 of proboscis, segment 5 minute, 4 very long, integument light, scales all dark; antenna slightly longer than proboscis, torus and base of flagellar segment 1 light, both without distinct scales. *Thorax:* integument dark brown; mesonotal scales sparse, largely whitish, narrow, and straight; lateral prescutal area with broader light yellowish scales; supraalar area with broader whitish scales; a more or less extensive area cephalad of prescutellar space with narrower dark bronzy scales; acrostichals and dorsocentrals numerous but very short, other bristles all short except posterior prescutellars and posterior supraalars; scutellum with sparse vestiture of narrow whitish scales on midlobe, only a few similar scales on lateral lobes; paratergite with scattered broad whitish scales and light hairs on lower portion; pleural scaling extensive but sparse, scales small, largely broad and whitish or slightly yellowish; *apn* scales largely erect; *ppn* with whitish scaling except in lower third, a patch or scattered narrower dark scales in upper portion, where light scales are more yellowish; *ppl* scales extending to anterior surface; *psp* with only a few scales; an extensive *ssp* scale patch against *stp* and *ppn; stp* with large continuous scale patch in posterior half or less and a few scales near anterior angle; *pra* with large scale patch below bristles and a few scales among latter; *mep* scales largely in upper anterior quarter; a line of 5 or more anterior *mep* light bristles sometimes extending to lower third of sclerite; *ppn* with numerous bristles and hairs, majority in upper caudal area but some scattered. *Legs:* forecoxal scales whitish at base and inner margin, dark elsewhere, midcoxal scales apparently all whitish; hindcoxa apparently without scales; femora largely dark-scaled except for usual pale areas and more or less extensive light speckling of anterior surfaces, light scaling slightly yellowish; tibiae and tarsi dark-scaled, without distinct markings; all claws with large submedian tooth. *Wing:* dorsal scales all dark; plume scales rather short; remigium with 1,2 very short thin inconspicuous hairs. *Haltere:* knob dark-scaled above, light-scaled below. *Abdomen:* tergites largely dark-scaled; tergite I with very small median caudal scale patch; laterotergite without scales; tergites II-VII with more or less extensive basal lateral patches of whitish or slightly yellowish scales, sometimes almost reaching apex of segment, and more or less prolonged dorsad at base, particularly on II,III, sometimes a few scattered pale scales dorsally on base of segments; sternite II usually bare, III-VII with extensive basal white scaling, remainder dark-scaled. *Genitalia:* segment VIII completely retractile; cercus long but broad.

MALE.—Essentially as in the female except for conspicuously different ornamentation. *Head:* scaling of vertex sparse. *Palpus:* exceeding proboscis by more than half of segment 5; apex of segment 3 and base of 4 with very long hairs. *Thorax:* mesonotum with very small narrow dark bronzy scales except along sides where there are widely scattered broad whitish or slightly yellowish scales; all scutellar scales narrow, dark bronzy; pleural scales less numerous, very scattered but occupying same areas as in female. *Legs:* femora darker, very sparsely light-speckled; claws of foreleg and midleg enlarged, anterior of each pair with basal and submedian long slender teeth, posterior with only subbasal tooth; claws of hindleg small, subequal, simple. *Abdomen:* almost devoid of scaling; tergites with dark scales in middle and a few light scales laterally; sternites with light scales basally, dark distally.

MALE GENITALIA (fig. 270).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe small, prominent, usually with 5,6 hairs; sternite with about 5 hairs in the middle. *Sidepiece:* long and slender; with distinct basal tergomesal lobe but no apical lobe; all scales and majority of large thin bristles on lateral and sternal surfaces; dorsal surface with short thin hairs in basal half, some at base of lobe, and longer hairs and some thin bristles in distal half; basal tergomesal lobe shifted to mesal surface, with discrete sternal patch of thickened, rather straight hairs; apicotergal area with 1 short differentiated bristle; mesal sternal border with several rows of close-set hairs and long thin bristles. *Claspette:* strongly developed; stem elongate, a short premedian mesal process bearing a thin hair; appendage bladelike, short-pedunculate, a crest of large dendritic spicules, apex curved and sharply pointed. *Clasper:* long; slender in tergal aspect, widened in basal half in lateral aspect; distal portion slender and with several long thin hairs on outer surface; spiniform moderately long and slender, rather deeply inserted on apex. *Phallosome:* aedeagus long, widened at about middle, apex narrowed and rounded. *Proctiger:* paraproct with single apical tooth; 2,3 cercal setae on each side near paraproct tooth.

PUPA (fig. 270).—*Abdomen:* 3.56 mm. *Trumpet:* 0.61 mm. *Paddle:* 1.23 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly moderately pigmented; hairs moderately to strongly pigmented. *Trumpet:* uniformly darkly pigmented. *Abdomen:* uniformly moderately pigmented, intersegmental areas dark; hairs small, moderately pigmented; hair 9-VIII small. *Paddle:* uniformly moderately pigmented except for dark midrib and external buttress; spicules indistinct; hair 1-P poorly developed, branched.

LARVA (fig. 271).—*Head:* 1.05 mm. *Siphon:* 1.23 mm. *Anal Saddle:* 0.42 mm. Chaetotaxy as figured, hairs strongly to moderately pigmented; diagnostic characters as in the key. *Head:* uniformly darkly pigmented except for lighter ocular areas and black collar; very conspicuous short blunt or rounded spicules of various sizes throughout; mental plate as figured; inner mouthbrushes not pectinate; hair 1-C rather short and slender; 4-C a strong multiple tuft. *Antenna:* moderately long, slender; pigmentation uniform; spicules heavy, conspicuous, and numerous. *Thorax* and *Abdomen:* integument with very conspicuous uniform dense tubercle-like spicules throughout; tubercles of large hairs very darkly pigmented. *Segment VIII:* 8–14 comb scales in a single, more or less regular row, a partial double or even triple row, middle scales with long median spine and heavy basal spicules; a conspicuous rounded small sclerite caudomesad of hair 2-VIII. *Siphon:* index about 2.3–3.2; uniformly darkly to very darkly pigmented, lighter specimens darkened on basal ring; integument conspicuously spiculate; acus slender, attached; usually more than 20 evenly spaced, close-set black pecten teeth, usually with large basal denticles on both sides; hair 1-S beyond pecten. *Anal Segment:* saddle forming complete ring pierced ventrally by detached hairs of ventral brush; darkly to very darkly pigmented, integument indistinctly sculptured, marginal spicules strong, long dorsally; distinct attached acus present; ventral brush with about 8 pairs of hairs on grid and usually 8 unpaired detached hairs, the majority of which pierce the saddle, latter emarginate caudoventrally; lateral sclerotization of grid joining saddle; gills long, pointed.

MATERIAL EXAMINED.—509 specimens; 68 ♀; 71 ♂; 86 pupae; 284 larvae; 9 individual larval rearings.

SYSTEMATICS.—*A. mcdonaldi* is very similar in all stages to *aculeatus* (Theobald, 1903) from Queensland and New South Wales (Marks, 1949:2–11) but is easily distinguished, as follows: the adults have the tarsi unbanded, the light scales of the vertex narrow, the lateral broad scales of mesonotum less numerous and a line of lower anterior mesepimeral hairs; the male genitalia have a more conspicuous mesal process on the claspette stem; the pupa has hair 1-V-VII strongly branched; in the larva hair 1-S is multiple and the ventral brush appears to have more detached basal hairs. In several respects *mcdonaldi* appears to be more primitive than *aculeatus.*

The various known populations of *mcdonaldi* show considerable differences, but the samples are so small that it is impossible to determine if more than 1 species or subspecies is involved. This mosquito is extremely localized and seldom collected, as it does not seem to attack man.

The *aculeatus* section of Marks (1949:2–11; 1957*b*:73) is of great interest since at least 2 of the included species show several characters which are inconsistent with the current definition of *Ochlerotatus.*

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *mcdonaldi* have been collected on Guadalcanal in shallow temporary pools in a densely shaded but open area near a swamp. The larvae are very difficult to rear individually in the laboratory but pupate readily in mass rearings, as do many other ground pool *Aedes.* All the known adults are reared, and nothing is known of their bionomics and disease relations. In the laboratory the adults were very sluggish and clumsy and could not be induced to bite.

DISTRIBUTION (fig. **263**).—*Solomon Islands:* Bougainville; Roviana; Guadalcanal. Not known elsewhere.

6. Aedes (Ochlerotatus) sp., New Caledonia form

Fig. **263**

A single damaged female from La Foa, New Caledonia (Mar., 1945, Pletsch and Remington; USNM), probably represents an undescribed species superficially somewhat similar to *sagax* (Skuse, 1889) from New South Wales, which falls into the *burpengaryensis* section of Marks (1957*b*:71–83). This seems to be an authentic record from New Caledonia since the specimen is mounted in the same manner and bears the same data and labels as specimens of *vigilax* undoubtedly mounted in the field in New Caledonia.

Subgenus LEVUA Stone & Bohart

1944. *Levua* Stone and Bohart, Ent. Soc. Wash., Proc. 46:214. *TYPE SPECIES: *Aedes* (*L.*) *suvae* Stone and Bohart, 1944, Fiji; original designation.—As subgenus of *Aedes.*

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Aedes (Levua) suvae Stone & Bohart

Figs. **272-274**

1944. *Aedes* (*Levua*) *suvae* Stone and Bohart, Ent. Soc. Wash., Proc. 46:214–215, Nov. 21. *TYPE: holotype ♂ with genitalia slide, Suva, Fiji, S. T. Helms (USNM, 56980).

Aedes (*Levua*) *suvae* of Iyengar (1955:28).

Aedes Geoskusea of Amos (1944:32, 33, Aug. 15).—I consider the description of Amos not to be a valid one and believe that he did not propose the name *Geoskusea* as a specific epithet but rather made an error similar to those occurring in other nontechnical publications. Since some nomenclaturists may object to this interpretation, this matter will be submitted for action by the International Commission on Zoological Nomenclature.

Aedes (*Levua*) *geoskusea* of Laird (1956:82); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.08 mm. *Proboscis:* 2.0 mm. *Forefemur:* 1.83 mm. *Abdomen:* about 2.33 mm. Dark species, without obvious ornamentation. *Head:* scales largely dark; decumbent scales of vertex largely narrow, curved, dark coppery except for some darker broad scales laterally in front extending from lateral area of head capsule where scales are broad, flat, and largely dark but a few usually pale; erect scales dark, very numerous, extending over most of vertex; labium and palpus with dark scales only; palpus less than 0.15 of proboscis, with several strong bristles, 5-segmented, segment 5 minute; antenna distinctly longer than proboscis; flagellar segment 1 about 1.4 of segment 2; torus and flagellar segment 1 with a few very small, inconspicuous scales. *Thorax:* mesonotal integument dark; all mesonotal scales narrow, curved, dark bronzy; acrostichals and dorsocentrals strongly developed; all scutellar lobes with narrow curved dark bronzy scales, very scanty on lateral lobe; paratergite broadened, without scales; pleuron brown, membranous area lighter, scales confined to *ppn* and *stp; ppn* scales bronzy to dark bronzy, narrow above, moderately broad and decumbent in most of patch which is restricted to upper portion of sclerite; *stp* scales translucent, iridescent light brown, all broad and decumbent, difficult to see, in an upper and a lower posterior patch; possibly an occasional scale may be developed elsewhere; lower *mep* bristles not developed. *Legs:* dark-scaled throughout except for somewhat lighter coxae, trochanters, base of femora, and lower surface of hindfemur; claws all small, subequal, and simple. *Wing:* dorsal scales all dark; plume scales long and narrow; remigium with 1,2 rather long, thin bristles. *Haltere:* knob dark-scaled. *Abdomen:* tergites largely dark-scaled; tergite I with some scales laterally; laterotergite with light brown translucent scales; sternites largely with light brown translucent scales. *Genitalia:* segment VIII completely retracted; cercus long but flattened and broad, ovoid.

MALE.—Essentially similar to the female. *Palpus:* distinctly longer but only about 0.20–0.25 of proboscis, without conspicuous long bristles, similar in segmentation to female. *Antenna:* slightly shorter than in female but still distinctly longer than proboscis; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg and midleg enlarged, anterior foreclaw toothed, others simple.

MALE GENITALIA (fig. 273).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe prominent, very strongly developed, rounded, with numerous hairs on dorsal and ventral surfaces; sternite with a patch of 8–10 hairs near the middle. *Sidepiece:* relatively short and broad; with distinct basal tergomesal lobe but no apical lobe; scales confined to lateral and ventral surfaces; dorsal surface with long hairs and bristles and a group of 5–7 short broadened bristles along mesal margin at level of basal tergomesal lobe; apicosternal area with 3 long, broadened bristles; basal tergomesal lobe shifted to mesal surface but connected by indistinct basal sclerotization to tergal surface, expanded portion facing mesad, densely covered with moderately long hairs, the sternal border with strong tubercles at bases of hairs. *Claspette:* essentially as in *A.* (*Ochlerotatus*) *vigilax:* stem slender, appendage a slender tapered spiniform hair. *Clasper:* short and heavy, slightly curved, gradually narrowed to apex; an outer row of several hairs subapically; spiniform short, black, swollen, and bifid from base, inserted under a hood. *Phallosome:* aedeagus large, broadened beyond base, rounded apically, simple. *Proctiger:* paraproct with an extremely long apical spine bifid for about half its length; a patch of 8–10 short cercal setae on a distinct lightly sclerotized area on each side.

PUPA (fig. 273).—*Abdomen:* 1.7 mm. *Trumpet:* 0.56 mm. *Paddle:* 0.75 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, unevenly blotched with darker pigmentation; hairs strongly pigmented. *Trumpet:* moderately widened apically; uniformly strongly pigmented; integumentary spicules strong. *Abdomen:* moderately pigmented, unevenly darkened anteriorly; hairs moderately to strongly pigmented, larger hairs variable in development, often abnormally branched. *Paddle:* lightly pigmented except for black midrib and darkened areas around base, external buttress, and midrib; dorsal marginal spicules very small, inconspicuous; hair 1-P strong, very long.

LARVA (fig. 274).—*Head:* 0.68 mm. *Siphon:* 0.69 mm. *Anal Saddle:* 0.32 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; in general quite similar to the *vigilax* group of *Ochlerotatus;* diagnostic characters as in the key. *Head:* uniformly moderately pigmented, darkened on postocular areas, collar black; mental plate as figured; inner mouthbrushes simple, not pectinate; hair 1-C heavy, long; 4-C very small and thin, nearer 5-C than 6-C. *Antenna:* long, slender; uniformly pigmented; spicules very few, difficult to see. *Thorax* and *Abdomen:* integumentary spiculation indistinct. *Segment VIII:* comb a very large patch of very numerous long scales with slender basal free part and spatulate fringed apex. *Siphon:* index about 2.75–3.2; moderately to strongly pigmented, basal ring darkened; sculpturing indistinct; acus attached by a very long stem; pecten of 14–20 or more slender, evenly and closely spaced teeth each with long basal denticle; hair 1-S distad of pecten. *Anal Segment:* saddle indistinct, reduced to a poorly sclerotized largely unpigmented dorsal plaque not bearing hair 1; no acus; ventral brush with 5,6 pairs of hairs on grid and 2-4 detached unpaired hairs, 1 of which may be on grid; gills very short.

MATERIAL EXAMINED.—82 specimens; 30 ♀; 15 ♂; 17 pupae; 20 larvae; no individual rearings.

SYSTEMATICS.—*Levua* is undoubtedly an ancient derivative of *Ochlerotatus,* specialized as a breeder in crabholes. It differs from *Ochlerotatus* chiefly in the short palpus of the male and the simple claws of the female. Stone and Bohart stressed the resemblance of *Levua* to *Geoskusea;* this is evident in the above-mentioned departures from *Ochlerotatus* and in the general body conformation of the adults. There is a possibility that *suvae* originated as a hybrid between an *Ochlerotatus* and a *Geoskusea,* with the characters of the former predominating.

BIONOMICS AND DISEASE RELATIONS.—*A. suvae* breeds in crabholes; these are said to be actually made by lobsters, according to Amos (1947:23). I have not been able to find any information on the bionomics of the adults, and apparently the females do not attack man.

DISTRIBUTION (fig. 272).—*Fiji:* Viti Levu. Not known elsewhere.

Subgenus MUCIDUS Theobald

1901. *Mucidus* Theobald, J. Trop. Med. 4:235, no included species, July 15; Liverpool Sch. Trop. Med., Mem. 4, App. p. II, one species included, Sept.; Monog. Culicidae 1:268–269, Nov. 23. *TYPE SPECIES: *Culex alternans* Westwood, 1835, Australia, is currently accepted as type species, following Neveu-Lemaire (1902:219) and Brunetti (1914:66); this usage must be validated by the International Commission on Zoological Nomenclature since, according to the rules, the type species should be *M. africanus* Theobald, Sept., 1901, the first included species (this is a homonym in *Aedes* of *Stegomyia africanus* Theobald, Sept., 1901, an important economic species, and Edwards (1932:134, fn.), as first reviser, wisely selected *S. africanus* as the senior homonym).

1907. *Pardomyia* Theobald, Monog. Culicidae 4:280. *TYPE SPECIES: *P. aurantia* Theobald, 1907, Sarawak; monobasic.

1908. *Ekrinomyia* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):65, 71. *TYPE SPECIES: *E. aureostriata* Leicester, 1908, Malaya; monobasic.

FEMALES.—*Head:* eyes narrowly separated above antennae; frons with scales; decumbent scales of central part of vertex largely narrow; erect scales very numerous; palpus from 0.25 to 0.6 of proboscis, distinctly 5-segmented, segment 5 large; antenna slightly shorter than proboscis. *Thorax:* mesonotal scales narrow; acrostichals and dorsocentrals present; scutellum with narrow scales; paratergite with or without scales; pleural scaling varied; pleural bristles numerous; *mep* with anterior median bristles. *Legs:* tarsi banded; claws toothed on at least foreleg and midleg. *Wing:* membrane infuscated at base of Rs and across furcation of Rs to *m-cu;* remigial bristles short and inconspicuous; alula with complete marginal fringe. *Abdomen:* scaling of tergite I and laterotergite restricted. *Genitalia:* segment VIII completely retractile or protruding for 0.5 or more of its length; cercus long, slender; 3 spermathecae, one enlarged

MALES.—Essentially as in the females. *Palpus:* longer than proboscis; segments 4 and 5 subequal. *Antenna:* flagellar whorls very long and numerous; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg and midleg enlarged, teeth varied. *Abdomen:* lateral hairs numerous but rather short.

MALE GENITALIA.—*Segment VIII:* strongly developed, narrowed at base. *Segment IX:* tergite poorly sclerotized; tergal lobe poorly differentiated but with hairs; sternite large, with group of hairs. *Sidepiece:* varied in width; with distinct basal tergomesal lobe bearing small differentiated setae; mesal surface with membrane from base to apex. *Claspette:* strongly differentiated; with slender stem and an apical seta in form of long appendage. *Clasper:* long, simple; with subapical setae; spiniform apical, slender. *Phallosome:* aedeagus simple, without teeth; ventral paramere long. *Proctiger:* strongly developed; basolateral sclerotization strong; paraproct with strong apical spine; cercal setae present.

PUPAE.—*Cephalothorax:* hairs 2,3-C closely approximated, removed from caudal border of sclerite; 8-C caudad of level of trumpets. *Trumpet:* elongate; tracheoid strongly developed at base. *Abdomen:* hairs 2,3-I approximated; 1-II single, very close to midline; 9-VI small, similar to 9-II-V; 2-VI,VII laterad of hair 1. *Terminal Segments:* female cercus only slightly projecting beyond lobe. *Paddle:* marginal spicules indistinct.

LARVAE.—Predaceous. *Head:* labrum very wide and large; maxillary sutures divergent caudad; labial plate long; mouthbrushes on prominent lateral lobes in a compact group, each filament rather short, curved, and with strong apical pectinations; hair 1-C strongly displaced laterad; 0,3-C close together, 4-C cephalad of antennal base, long; 5-7-C strongly caudad of antennal base, 6-C short, others long; 0-8-C single; 12-15-C strongly displaced cephalad. *Antenna:* spiculate. *Thorax:* hair 13-P absent; 6-M single. *Abdomen:* hair 12-I present; 6-I-VI long, usually single or double; 7-I,II large, multiple; 1-III-V strongly developed. *Segment VIII:* comb a large patch of small spatulate fringed scales; hairs 1,2-VIII on small common basal plate. *Siphon:* long; acus strongly developed, attached; pecten varied in length; hair 1-S large; valves small; trachea large. *Anal Segment:* elongate; saddle incomplete; marginal spicules present or absent; hairs 1-X single, on saddle; acus not developed; 2,3-X both single; ventral brush very strongly developed, with 13,14 pairs of hairs extending nearly the entire length of segment, the more distal on an enclosed grid or boss; gills short.

SYSTEMATICS.—*Mucidus* appears to be closely related to *Ochlerotatus;* if it were not for the distinctive larva and pupa, it could readily be included as a group of the latter. There is a very striking similarity in the larval head capsule of *Mucidus* and the nominate subgenus of *Psorophora,* but many other features in the larval stage are very different in the 2 groups.

Two very clearly marked groups are recognized in *Mucidus:* the *Mucidus* group, represented by *alternans* in the South Pacific, and the *Pardomyia* group, represented by *painei.*

BIONOMICS AND DISEASE RELATIONS.—The larvae of *Mucidus* are predaceous on other mosquito larvae and are found in temporary ground pools. Females of several species of the nominate group are reported to attack man at least occasionally, chiefly at night. Nothing is known of the disease relations of members of the subgenus.

DISTRIBUTION (fig. 275).—The subgenus is confined to the Old World. The *Mucidus* group is widespread in the Old World tropics; it has been reported from the Ethiopian, Oriental, Indomalayan, and Australasian regions; in the South Pacific it is represented by *alternans* in New Caledonia and the Loyalty Islands. The *Pardomyia* group occurs in the Indomalayan and Australasian regions only; in the South Pacific it is represented by *painei* in the Solomon Islands.

KEYS TO SPECIES

(Keys to tribe Aedini, pp. 318–321)

ADULTS

1. Wing very densely scaled, brown, pale yellowish and white; mesonotum with tufts of twisted erect pale scales; vestiture of legs more or less shaggy .... 1. *alternans*

Wing very sparsely scaled, chiefly dark; mesonotum without tufts of twisted erect pale scales; vestiture of legs smooth .... 2. *painei*

MALE GENITALIA

1. Sidepiece broad, mesal portion of dorsal surface with short hairs from base; lobe of tergite IX not defined, represented by group of about 6 hairs .... 1. *alternans*

Sidepiece narrow, mesal portion of dorsal surface with short hairs apically only; lobe of tergite IX small, rather prominent, with about 4 hairs .... 2. *painei*

PUPAE

1. Trumpet length about 5.0 median width, tracheoid in basal 0.25 or less .... 1. *alternans*

Trumpet length about 12.0 median width, tracheoid in basal 0.35 or more .... 2. *painei*

LARVAE

1. Hair 1-C long, slender; hair 9-M,T single .... 1. *alternans*

Hair 1-C short, spiniform; hair 9-M,T multiple .... 2. *painei*

1. Aedes (Mucidus) alternans (Westwood)

Figs. 275-277

1835. *Culex alternans* Westwood, Soc. Ent. de France, Ann. 4:681. *TYPE: holotype ♀, marked as type, Australia (New Holland) (BMNH).

1856. *Culex commovens* Walker, Insecta Saundersiana Diptera 1:432. *TYPE: holotype ♀, "identified as the type by E. A. Waterhouse," parts mounted on 2 pins, Australia (New Holland), Saunders 68-4 (BMNH).—Synonymy with *alternans* by Theobald (1901*a*:269).

1889. *Culex hispidosus* Skuse, Linn. Soc. N. S. Wales, Proc. (2)3:1726–1728. TYPES: syntypes, ♀, Hexham swamps (near Newcastle), Richmond, Mt. Kembla, Illawara, New South Wales, F. A. A. Skuse and A. G. Hamilton (MACL).—Synonymy with *alternans* by Theobald (1901*a*:269).

1901. *Culex kermorganti* Laveran, Soc. de Biol., Compt. Rend. 53:568. TYPE: holotype ♀, dissected and mounted on 2 slides, Noumea, New Caledonia (PASTEUR).—Synonymy by Rageau and Hammon (1957).

Aedes (*Mucidus*) *alternans* of Edwards (1932:134); Taylor (1934:15); Lee (1944*a*:50); Knight, Bohart, and Bohart (1944:33, 50); Knight (1947:321–322); Iyengar (1955:26); Laird (1956); Rageau (1958*a*:877; 1958*b*:2); Stone, Knight, and Starcke (1959).

Aedes (*Mucidus*) *kermorganti* of Edwards (1932:134); Taylor (1934:15); Knight, Bohart, and Bohart (1944:33, 52); Knight (1947:322); Iyengar (1955:27); Laird (1956); Rageau (1958*a*:877).

Mucidus alternans of Theobald (1901*a*:269–272); Edwards (1922*b*:450; 1924:367).

Mucidus kermorganti of Edwards (1922*a*:99; 1922*b*:450; 1924:367).

FEMALE.—*Wing:* 6.67 mm. *Proboscis:* 3.67 mm. *Forefemur:* 3.33 mm. *Abdomen:* about 5.25 mm. A very large speckled, yellow, light brown, and white mosquito with shaggy palpus, legs, and abdomen. *Head:* integument light to dark brown; central portion of vertex largely with narrow scales, brownish yellow laterally, a median longitudinal stripe of pure white scales, scales small and decumbent in front, long and erect caudad; a conspicuous orbital line of small broad scales continued as complete frontal line; sides of vertex with some broad brownish yellow scales followed by broad white scales; erect scales very numerous and long, largely pale brownish yellow except for posterior part of median white stripe, where they are white and lanceolate, a few similar as well as shorter semierect white scales laterally caudad; sides and venter with broad scales, largely white except for an upper patch of deep yellow and brown scales at level of *apn;* orbital bristles very numerous; labium thick, scaling largely yellowish or brownish yellow, shaggy in basal 0.4 where most of the scales are yellowish at base and tipped with brown, from 0.4 to about 0.9 with smooth yellow scaling, distal 0.1 or less largely brown dorsally; palpus about 0.6 of proboscis, 5-segmented, segments 1 and 2 very small, others long, particularly 4, scaling shaggy particularly on segment 5, scales elongate, largely yellow with brown tips, a few completely dark brown scales, white scales predominating on segment 5, base of 4, scattered on dorsum and apex of 3; antenna only slightly shorter than proboscis, light brownish yellow; torus with conspicuous patch of small broad white scales, flagellar whorls short, flagellar segment 1 about 1.6 or more of segment 2 and with small patch of broad white scales. *Thorax:* integument light greyish to yellowish brown; mesonotum predominantly with light brownish yellow narrow scales, variable patches of narrow decumbent and long twisted erect or semierect white scales (1) in front, (2) over and among supraalars, (3) on a pair of median dorsocentral spots, (4) in a posterior acrostichal spot, and (5) in the posterior prescutellar area; acrostichals short, very numerous, in about 3 rows, dorsocentrals short, very numerous; fossa with numerous short bristles blending in with anterior dorsocentrals; scutellum with numerous white scales on all lobes, some scales short and decumbent, majority long, erect, and twisted; paratergite with broad white scales above and below; pleuron with numerous broad white scales, many semierect, distributed on *apn, ppn, ppl, psp, ssp,* hypostygial area, *stp, pra, mep;* pleural bristles golden or very pale, *ppn* and *psp* numerous, lower *mep* in a patch of about 10 near the middle of front half of sclerite, *stp* bristles in patches along posterior border but not in distinct upper longitudinal row. *Legs:* coxae with white scales, forecoxa with yellow scales in middle, others sometimes with scattered yellowish scales; trochanters with whitish and yellowish scales; femora and particularly tibiae with erect or semierect elongate scales, largely yellow and yellow with brown tips, with 2 more or less distinct white-scaled bars, premedian and postmedian on femora, median and preapical on tibiae, some white scales at base of femora and tibiae and some on apex of femora; tarsi with scales largely yellow tipped with brown or light brown, and with conspicuous white or whitish rings, basal and median on segment 1 and basal on 2–5, light rings indefinite or sometimes absent on 4–5 on foreleg and midleg, very conspicuous, white, and occupying most of the segments on hindleg; all claws with heavy submedian tooth. *Wing:* dorsal scaling all broad, very dense, brown, pale yellowish, and pure white; fringe with conspicuous white areas between veins; alula with dense marginal fringe of long hairs and scales; remigial bristles short; wing membrane distinctly clouded at base and furcation of Rs and on crossveins *r-m* and *m-cu*. *Haltere:* with whitish and yellowish scales. *Abdomen:* scaling of tergites yellow with white markings, many scales elongate and erect or semierect; tergite I with restricted median caudal patch of white or whitish scales; laterotergite with white scales; tergites II-VII largely yellow, with variable basal lateral and basal median patches of white scales, sometimes connected by narrow transverse basal white bands, frequently an apical transverse line of white scaling also present; sternites largely white or whitish, distal ones with yellow or brownish apical lateral patches. *Genitalia:* segment VIII completely retracted.

MALE.—Essentially as in the female. *Palpus:* exceeding proboscis by about length of segment 5; segment 2 with broad subbasal white band; segments 3–5 with broad basal white bands, remainder largely yellowish; apex of segment 3 and all of 4 with very long and numerous hairs, segment 5 with hairs numerous but less conspicuous. *Legs:* scaling more shaggy and less dense, conspicuous erect scales particularly on tibiae and tarsal segment 1 on all legs; claws of foreleg and midleg enlarged, unequal, anterior member of pair with basal and premedian tooth, posterior with basal only, claws of hindleg as in female. *Abdomen:* less densely scaled; with numerous moderately long hairs.

MALE GENITALIA (fig. **276**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite emarginate in the middle of posterior border, without distinct lateral tergal lobes, but with about 6 bristles in a group on each side; sternite large, with a median caudal patch of 10–12 bristles. *Sidepiece:* rather short and broad; large bristles and scales restricted to lateral and ventral surfaces; dorsal surface with short thin hairs from near base; a small prominent hairy basal tergomesal lobe separated distally by membrane, bearing several thickened setae, 1 of which is at tergal base of lobe; a poorly defined apical tergal projection with 1,2 thickened hairs and several other hairs longer than elsewhere on dorsal mesal surface. *Claspette:* strongly developed; stem elongate; appendage only slightly wider than stem, slightly hooked apically. *Clasper:* long, narrow, slightly tapered distally; several subapical setae; spiniform rather short, slender, deeply inserted. *Phallosome:* aedeagus small and simple; swollen and rounded apically. *Proctiger:* lateral sclerotization strongly developed; paraproct with simple dorsal spine; a patch of about 8 cercal setae on each side.

PUPA (fig. **276**).—*Abdomen:* 6.25 mm. *Trumpet:* 1.38 mm. *Paddle:* 1.53 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately to strongly pigmented; middorsal ridge strongly developed; all hairs short. *Trumpet:* moderately long; distinctly tracheoid at base; uniformly moderately to strongly pigmented, darker than general integument. *Abdomen:* moderately to strongly unevenly pigmented, with darker blotches; hairs weakly developed; hair 1-I (float hair) weak, with a few dendritic branches; 1-II weak; 5-IV-VI branched. *Paddle:* moderately to rather strongly pigmented, lighter around midrib; marginal spicules inconspicuous.

LARVA (fig. **277**).—*Head:* 1.21 mm. *Siphon:* 1.76 mm. *Anal Saddle:* 0.73 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, caudal portion darker and with integumentary sculpturing more distinct; hairs strongly to moderately pigmented; mental plate as figured; hair 1-C moderately long. *Antenna:* short and slender, moderately pigmented, distal portion darker; spicules small, rough at base; hair 1-A usually double. *Thorax:* integument without distinct spiculation; hairs and tubercles strongly pigmented; hair 9-M,T long and single. *Abdomen:* integument without distinct spiculation; hair 13-III-V long and single. *Segment VIII:* comb in an irregular patch of about 5,6 rows of short scales which are broadened and fringed apically. *Siphon:* index about 3.75–4.5; moderately to strongly pigmented, black on basal ring, darkened apically; integumentary sculpturing distinct; acus large; pecten of about 20 or more slender teeth, rather evenly spaced, the basal very short, the distal longer, each usually with strong subbasal denticle; hair 1-S beyond pecten. *Anal Segment:* saddle moderately large, incomplete; pigmentation moderate to strong; sculpturing distinct; marginal spicules short and heavy, developed chiefly dorsally; hair 1-X on saddle, single; 2,3-X both single, on a prominent process with strong ventral sclerotization; ventral brush with about 13,14 pairs of hairs extending the greater part of the midventral line of segment, all with a more or less strongly developed basal lateral bar, the 7,8 caudal pairs on a raised boss; gills short, pointed.

MATERIAL EXAMINED.—206 specimens; 49 ♀; 39 ♂; 21 pupae; 97 larvae; no individual rearings.

SYSTEMATICS.—*A. alternans* is an extremely variable species, particularly in the ornamentation of the adults; in some individuals the mesonotal scaling is predominantly light brownish yellow, in others white; the number of erect scales is extremely variable on all parts of the body. Apparently only 1 species is involved, but since the material is very scanty and no individual rearings are available, it is really not possible to analyze the variations. Females from New Caledonia as a rule appear to have more dark scales on palpal segment 5 than is usual in Australian specimens. Should the New Caledonia populations prove to be distinct, the nominal taxon *kermorganti* is available for them. It appears to be based on aberrant individuals with the erect scaling poorly developed.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *alternans* have been reported from swamps or swampy pools, either brackish or fresh, on the coast or inland (Cooling, 1924:17; Mackerras, 1926; Woodhill and Pasfield, 1941:210). Females are reported to be anthropophilic but are rarely aggressive on New Caledonia (Rageau, 1958*b*:2). Nothing is known of the disease relations of *alternans*.

DISTRIBUTION (fig. **275**).—*New Caledonia:*

widely distributed on main island. *Loyalty Islands:* Ouvea (Rageau, 1958*a*:877; 1958*b*:2). Also widely distributed in *Australia* and *New Guinea* and reported from *Timor.*

2. Aedes (Mucidus) painei Knight

Figs. 275, 278, 279

1929. *Pardomyia aurantia* var. *nigrescens* Edwards *in* Paine and Edwards, B. Ent. Res. 20:314. *TYPE: lectotype ♀, marked as type by Edwards, Lady Lever plantation, Kolombangara, Solomon Islands, from muddy ditch, Oct. 3, 1928, R. W. Paine; by present selection (BMNH).—Preoccupied in *Aedes* by *Aedes nigrescens* Theobald, 1907.

1948. *Aedes* (*Mucidus*) *aurantius painei* Knight, Ent. Soc. Wash., Proc. 50:68.—New name for *nigrescens* Edwards, 1929 not *nigrescens* Theobald, 1907.

Aedes (*Mucidus*) *aurantius painei* of Iyengar (1955:27); Stone, Knight, and Starcke (1959).

Aedes (*Mucidus*) *aurantius nigrescens* of Knight, Bohart, and Bohart (1944:33, 50); Knight (1947:324); Belkin (1952:123).

Aedes (*Mucidus*) *aurantius* var. *nigrescens* of Edwards (1932:135); Taylor (1934:15).

FEMALE.—*Wing:* 5.0 mm. *Proboscis:* 3.25 mm. *Forefemur:* 2.53 mm. *Abdomen:* about 3.78 mm. A very large dark brown mosquito with golden markings, scaling smooth, wings with conspicuous small clouded areas and very scanty scaling. *Head:* integument light brownish orange; scales of vertex all golden yellow; decumbent scales all very narrow and appressed, very dense along orbital border, a few about halfway down the frons; erect scales very dense, with orange tint, slightly darkened toward apices; side and lower surface with broad scales, mostly golden yellow, a small upper anterior patch of dark scales; orbital bristles short, not numerous; labium moderately slender, largely with yellow scales, with some patches of brown scales; palpus slightly more than 0.25 of proboscis, segment 5 small, scaling largely deep golden yellow, segment 5 and apex and inner surface of segment 4 with brown scales, some brown scales scattered elsewhere, segment 3 with long outstanding scales; antenna slightly shorter than proboscis; torus orange yellow to light brownish orange, with a few inconspicuous broad orange yellow scales and hairs; flagellar segment 1 with a few small elongate broad yellow scales. *Thorax:* integument brown to dark brown with rusty tinge; mesonotal scaling extremely variable but dark scaling usually predominating, from dark bronzy brown to dark coppery, variable patches of golden yellow scales on anterior promontory, lateral prescutal area, and supraalar area where these scales are elongate and outstanding, and in prescutellar area, particularly caudad, scattered scales or patches of golden yellow scales on disc as well; bristles of mesonotal disc much as in *alternans* but less numerous, posterior acrostichals very few, inconspicuous; scutellum with long narrow curved golden yellow scales on all lobes; paratergite bare or with 1 to several bristles, usually no scales; pleural scaling variable but restricted, largely deep golden yellow; *apn* with narrow scales in lower half; *ppn* with a very small patch of narrow scales, usually restricted to middle of extreme upper portion; *ppl* with narrow scales, sometimes with some darker broader scales below; *stp* with a small upper patch of moderately broad to broad scales and a lower patch of narrower curved scales; *pra* with 1 to several broad scales below knob; *mep* with a variable number of largely broad scales, from only 3,4 to small patch between upper and anterior bristles; pleural bristles dark, *ppn* numerous but largely in 1,2 rows, *psp* numerous, *stp* in more or less regular upper transverse and caudal rows, upper *mep* very numerous, a patch of 5–7 anterior median *mep*. *Legs:* coxal scaling largely golden yellow, forecoxa with brown scales in middle; trochanters largely with golden yellow scales; femora with deep golden yellow scales at base, remainder dark brown with variable yellow bars or spots, yellow scaling more extensive on forefemur and predominating on posterior surfaces of midfemur and hindfemur; tibiae predominantly dark-scaled, with variable amount of brownish yellow at base, in flecks on foretibia and midtibia and spots or blotches on hindtibia; foretarsus and midtarsus with poorly defined pale bands of yellow to light brown scales, broad at base and narrow on apex of segment 1, broad at base of segment 2, indefinite and variable on segments 3 and 4 but sometimes with distinct basal pale scales, segment 5 variable, dark to yellowish; hindtarsus with progressively narrower and paler basal bands of yellow scales on segments 1–4, segment

5 completely white or whitish; both claws of foreleg and midleg with large subbasal tooth, those of hindleg simple. *Wing:* veins very scantily clad dorsally with short broad scales, particularly in posterior portion, dark scaling predominating; a variable number of yellow scales, chiefly on C, R, and R_1; more densely scaled on remigium and base of C; remigial bristles short and inconspicuous, usually 1,2; alula with rather short marginal hairs or slender scales; wing membrane clouded in area of crossvein *h* across base of veins, around crossvein *sc* which is incomplete, at origin of Rs, and most conspicuously and extensively around furcation of Rs and crossveins *r-m* and *m-cu*. *Haltere:* knob dark-scaled. *Abdomen:* scaling of tergites variable; tergite I with rather large median caudal patch of dark scales, bristles long and numerous; laterotergite with rather large patch of yellow scales; tergites II-IV predominantly dark, with variable, usually discrete bands, spots, or blotches of yellow scales at base, submedially, apically, and laterally, some scattered yellow scales as well; tergites V-VII extremely variable, sometimes as II-IV or predominantly yellow-scaled; sternite II with a few apicolateral yellow scales; sternites III-VII variable, usually dark caudally and laterally, yellow basally and in the middle. *Genitalia:* segment VIII exposed for 0.5 or more of its length.

MALE.—Essentially as in the female. *Palpus:* exceeding proboscis usually by less than 0.5 of segment 5; coloration variable, segments 2–4 predominantly yellow, segment 2 with basal and apical dark scales, segments 3 and 4 with apical dark scales, more numerous on 4; segment 5 predominantly dark; apex of segment 3 and sides of 4 with rather sparse long hairs. *Legs:* claws of foreleg and midleg enlarged, uneven, larger (anterior) with strong premedian tooth, smaller (posterior) simple; claws of hindleg small, simple. *Abdomen:* tergites with variable scaling, usually with yellow more extensive and diffuse; bristles rather numerous but short.

MALE GENITALIA (fig. 278).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with small prominent lobes, each with 3,4 hairs; sternite with about 8,9 hairs. *Sidepiece:* moderately long and slender; large bristles and scales largely on lateral and ventral surfaces; dorsal surface with rather long hairs scattered chiefly on external portion, shorter thinner hairs apically toward mesal surface; a small prominent basal tergomesal hairy lobe, with several thickened short bristles with sharply bent slender apex; apical tergomesal lobe not developed, area with 1 thickened hair and rather numerous short thin hairs. *Claspette:* stem slender, with several conspicuous hairs arising from short angular projections; appendage rather slender, sickle-shaped, only slightly widened in middle. *Phallosome:* aedeagus moderate in size, narrowed subapically then swollen. *Proctiger:* lateral sclerotization poorly developed; paraproct with simple dorsal spine; a patch of about 5–8 cercal setae on each side.

PUPA (fig. 278).—*Abdomen:* 4.9 mm. *Trumpet:* 1.59 mm. *Paddle:* 1.46 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately to strongly unevenly pigmented, mouthparts and wing cases dark; hairs moderately long; 8-C long, double, branches uneven. *Trumpet:* very long and slender; tracheoid dark, extending to about 0.4; remainder moderately pigmented. *Metanotum:* with lateral dark spot. *Abdomen:* moderately pigmented, with basolateral dark blotches on sternites; laterally with distinct integumentary sculpturing; hair 1-I with numerous sparsely dendritic branches; 1-II long, heavy, very close to midline; 5-IV-VI long, usually single. *Paddle:* moderately uniformly pigmented, midrib and external buttress darkened; marginal spicules short, indistinct.

LARVA (fig. 279).—*Head:* 1.22 mm. *Siphon:* 1.58 mm. *Anal Saddle:* 0.72 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly lightly to moderately pigmented except for lighter ocular areas and black collar; integumentary sculpturing prominent, particularly caudally; hair 1-C short, spiniform. *Antenna:* short and slender, uniformly moderately pigmented; spicules short and stout; hair 1-A usually 4,5b. *Thorax:* integument without distinct spiculation; hairs and tubercles strongly pigmented; hairs 9-P,M,T multiple. *Abdomen:* integument without distinct spiculation; hair 13-III-V moderate, branched. *Segment VIII:* comb in a patch of about 50–60 densely packed short scales which are widened and fringed apically; hairs 1,2-VIII on common basal plate, 2-VIII usually double. *Siphon:* index about 3.25-4.0; moderately pigmented, black on basal ring, darkened apically; integumentary sculpturing moderate; acus large, broadly joined; pecten of about 25 or more teeth, each usually with 3 or more denticles, the distal teeth more widely spaced; hair 1-S large, usually 10-12b, within or near end of pecten. *Anal Segment:* saddle large, rather narrowly incomplete; pigmentation moderate, base darkened; integumentary sculpturing distinct; marginal spicules not developed; hair 1-X on saddle, single; hairs 2,3-X both single, on a moderately prominent tubercle; ventral brush of about 13,14 pairs of hairs, all with a more or less developed basal lateral bar, caudal 10 pairs joined to longitudinal bar on a more or less distinct boss; gills short, pointed.

MATERIAL EXAMINED.—140 specimens; 36 ♀; 23 ♂; 41 pupae; 40 larvae; 9 individual larval rearings.

SYSTEMATICS.—*A. painei* is a member of the very interesting *aurantius* complex. Five nominal taxa have been proposed in this complex. Knight (1947) reduced these to 2 species, *quadripunctis* (Ludlow, 1910) from the Philippines and *aurantius* (Theobald, 1907) (= *aureostriatus* [Leicester, 1908]) from the Oriental and Australasian regions, and recognized 3 subspecies of the latter, *aurantius* from the Australasian and Oriental regions, *chrysogaster* (Taylor, 1927) from Australia, and *painei* (as *nigrescens*) from the Solomon Islands. The characters of adult ornamentation used by Knight are extremely variable even in a single population, and the larval characters do not hold for *aurantius* from Queensland, while *painei* has a larva very similar to *quadripunctis*. I have seen specimens of so-called *aurantius* from Queensland which agree in all essentials with *painei* both in the adult stage and in the larva.

I have made no attempt to study the entire complex but suspect from a superficial examination that there are 3 and possibly 4 forms involved: *quadripunctis* from the Philippines; *aurantius* from Borneo, Indonesia, and Malaya; *painei* and related forms from the Solomons, New Guinea, and Australia; and possibly *chrysogaster* from Australia. The larva of typical *aurantius* supposedly has only about 20 comb scales and hair 2-VIII single. However, there is a possibility that this is in error, since Edwards (1929*a*:314) found another error in the shape of the scales as originally described by Edwards and Given (1928:342), which was probably owing to the folding of the eighth segment so that the scales were observed in side view.

For the present I am treating *painei* as a distinct species. The samples of the various populations now available are extremely small, and there are very few individual rearings. In the Solomons there is a tremendous amount of individual variation within a single collection, and almost every collection is markedly different in adult ornamentation. This may be owing to a large extent to variations in amount of larval food.

The Solomons populations appear to be distinct from every other population of the complex that I have seen in the great reduction of the golden scaling on the pleuron and particularly on the posterior pronotum. In other respects they exhibit, at least sporadically, features found in other populations and therefore have been identified as *painei* (= *nigrescens*), *aurantius*, and *chrysogaster*. I believe that in the Solomons there is only one extremely variable form, and for the present I consider that *painei* is probably endemic to the Solomons.

BIONOMICS AND DISEASE RELATIONS.—*A. painei* is an uncommon species. The immature stages have been collected a few times in temporary pools in forested areas as well as in coconut plantations. Females rarely attempt to bite and are seldom seen in the field.

DISTRIBUTION (fig. 275).—*Solomon Islands:* Bougainville; Kolombangara; New Georgia; Banika (Russell); Guadalcanal. A very similar form has been identified as *aurantius* or *aurantius* variety in New Guinea and Australia.

Subgenus EDWARDSAEDES Belkin, n. subg.

TYPE SPECIES.—**Culex imprimens* Walker, 1861, Amboina. INCLUDED SPECIES.—*A.* (*E.*) *imprimens* and the following nominal species here considered to be synonyms of *imprimens: Culex auratus* Leicester, 1908 (preoccupied in *Aedes* by *auratus* Grabham, 1906), from Malaya, and **Aedes* (*Banksinella*) *brugi* Edwards, 1924, from New Guinea.

Aedes (*Neomelaniconion*) in part of Stone, Knight, and Starcke (1959).
Aedes (*Banksinella*) in part of Edwards (1932:171–172).

FEMALE.—In general similar to *Aedimorphus* and *Neomelaniconion. Head:* eyes narrowly separated; decumbent scales of vertex largely narrow; erect scales very numerous and extending to orbital bristles; palpus slender, about 0.20–0.25 of proboscis, segment 5 small but distinct, segments 1 and 2 ankylosed. *Thorax:* mesonotum and scutellum with narrow scales only; acrostichal and dorsocentral rows complete, bristles short; paratergite bare; *apn* and *ppn* largely with narrow scales; *pra* without scales; lower *mep* bristles absent. *Legs:* pale knee spots present; tibiae and tarsi with basal pale markings; both claws of all legs toothed. *Abdomen:* tergite I and laterotergite extensively scaled; tergites II-VII with lateral pale markings, tergites II-V or VI with basal transverse pale bands. *Genitalia:* segment VIII completely retracted; cercus long and slender, exerted; 3 spermathecae, unequal.

MALE.—In general similar to the female but conspicuously distinct in reduction of scales on *ppl* and *psp* and in development of broad scales on *apn* and *ppn. Palpus:* 4-segmented, segment 4 upturned and with numerous lateral hairs. *Legs:* pale scaling of tarsi reduced; claws of foreleg and midleg enlarged and unequal; all claws with subbasal tooth. *Abdomen:* with long lateral hairs; tergal lateral pale markings reduced.

MALE GENITALIA.—Short, inconspicuous, deeply retracted. *Segment IX:* tergite divided in middle, with conspicuous projecting lobes. *Sidepiece:* very short and broad, with large basal sternomesal lobe; basal tergomesal lobe not developed. *Claspette:* not developed. *Clasper:* with large mesal lobe; spiniform not developed. *Phallosome:* aedeagus relatively simple, slender, apex sagittate; ventral paramere with long mesal arm. *Proctiger:* basolateral sclerotization with sternal arm; paraproct with very strongly developed apical spine; cercal setae not developed.

PUPA.—*Cephalothorax:* hair 8-C cephalad of trumpet base. *Trumpet:* short, only slightly widened distally, tracheoid not developed. *Metanotum:* hair 10-C caudad and laterad of 11-C. *Abdomen:* hairs 2,3-I widely separated. *Terminal Segments:* female cercal lobe prominent, long.

LARVA.—*Head:* hair 4-C far cephalad of 6-C; 5,6-C approximated; 8-C short; 12,13-C approximated, removed from cephalic border. *Antenna:* long, slender; strongly spiculate; hair 1-A multiple, in basal half. *Thorax:* hairs 9-12-M,T on very large basal tubercles. *Abdomen:* hair 6-I-VI relatively short; 6-I-IV, 7-I usually at least 3b; hair 12-I absent. *Segment VIII:* comb in irregular patch of double row of scales, latter fringed basally and with long distal spine; hairs 1,2-VIII on small common basal plate. *Siphon:* relatively long; acus strongly developed; pecten of numerous teeth, the distal thickened and widely spaced; hair 1-S distal to pecten. *Anal Segment:* saddle complete; without acus; caudal margin with short heavy spicules dorsally; hair 1-X single; 2,3-X both branched; ventral brush with 5 pairs of hairs on poorly developed grid and 6 unpaired hairs proximad and piercing the saddle.

SYSTEMATICS.—*Edwardsaedes* is erected for *A. imprimens*, which in the past has been placed in *Aedimorphus* on the basis of adult ornamentation and in *Neomelaniconion* (as *Banksinella*) on the structure of the male palpus. This species has several unique features, as noted in the diagnosis, and in addition shows a number of similarities with *Verrallina.* Its natural affinities cannot be determined, since all these subgenera are very poorly known at present and appear to be very heterogeneous assemblages of species having in common only superficial characters. The male genitalia, the pupa, and the larva of *imprimens* are so strikingly different from all the known species in these subgenera that I believe it is advisable to recognize a distinct subgenus for this form.

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Aedes (Edwardsaedes) imprimens (Walker)

Figs. 280-282

1861. *Culex imprimens* Walker, Linn. Soc. London, J. Proc. 5:144. *TYPE: holotype ♀, Amboina, identified as the type by E. A. Waterhouse (BMNH).

1908. *Culex auratus* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):153–154. TYPES: syntypes, ♀, Malaya (apparently lost, not in BMNH).—Preoccupied by *Aedes auratus* Grabham, 1906; questionable synonymy with *imprimens* by Edwards (1913:228).

1924. *Aedes* (*Banksinella*) *brugi* Edwards, B. Ent. Res. 14:371–372. *TYPE: holotype ♂ with attached genitalia mount, Merauke, New Guinea, 1922, S. L. Brug (BMNH).—NEW SYNONYMY, suspected by Edwards (1929*a*:314); Knight and Hull (1953:468); Stone, Knight, and Starcke (1959).

Aedes (*Neomelaniconion*) *imprimens* of Stone, Knight, and Starcke (1959).
Aedes (*Banksinella*) *imprimens* of Hsiao and Bohart (1946:22); Knight and Hull (1953:465–468); Iyengar (1955:30).
Aedes (*Aedimorphus*) *imprimens* of Paine and Edwards (1929:306, 314); Edwards (1932:170); Taylor (1934:20); Knight, Bohart, and Bohart (1944:35, 52); Bohart (1945:63); Laird (1956).
Aedes (*Ochlerotatus*) *imprimens* of Edwards (1924:377; 1925:257).
Aedes (*Ecculex*) *imprimens* in part of Edwards (1922*b*:467).
Ochlerotatus imprimens of Edwards (1913:228).
Aedes (*Neomelaniconion*) *brugi* of Stone, Knight, and Starcke (1959).
Aedes (*Banksinella*) *brugi* of Edwards (1932:170); Taylor (1934:20); Knight, Bohart, and Bohart (1944:35, 51); Knight and Hull (1953:468); Iyengar (1955:30).

FEMALE.—*Wing:* 4.67 mm. *Proboscis:* 3.25 mm. *Forefemur:* 2.53 mm. *Abdomen:* about 3.67 mm. *Head:* eyes narrowly separated above antennae; decumbent scales of vertex linear except laterally, light golden except for dark bronzy ones in a narrow median longitudinal stripe; a patch of dark broad scales laterally; orbital lines with light golden linear scales extending on frons to level of lower margin of eyes; erect scales light golden anteriorly and in center, dark posteriorly and laterally; sides with broad scales below dark patch, largely whitish, some darkened; labium largely dark-scaled, some scattered pale scales near base, chiefly ventrally; palpus largely dark-scaled, a few scattered pale scales; antenna about as long as proboscis; torus with a few small broad scales in addition to hairs; flagellar segment 1 with a few small broad scales. *Thorax:* integument reddish brown to light brown on membranous areas; mesonotum with indefinite and variable pattern of light golden and dark bronzy scales, pale scales chiefly along sides anteriorly, in supraalar and prescutellar areas, dorsocentral lines, and curved posterior fossal line from scutal angle mesad; scutellar scales all pale golden; *apn* and *ppn* scales largely narrow and pale golden, some broadened, pale scales toward lower parts, a variable number of narrow dark bronzy scales on upper middle part of *ppn;* broad whitish or beige scales in large patches on *ppl* and *psp,* a narrow line on *ssp* against *stp,* large patches on upper and caudal portions of *stp,* and a large median patch on *mep. Legs:* forecoxa dark-scaled in middle, light on base and apex; midcoxa with light scales; hindcoxa largely bare; trochanters largely pale-scaled; forefemur largely dark-scaled on anterior surface except at base and apex and a sprinkling of a few pale yellowish scales, posterior surface with pale yellowish scales extending on ventral and dorsal surfaces; midfemur dark-scaled on anterior surface except at base, apex, and a ventral line not reaching apex and a sprinkling of a few pale yellowish scales, posterior surface with pale yellowish scales except dorsally and apically, ventral surface pale-scaled, dorsal surface dark-scaled except at base and apex and with sprinkling of a few pale scales; hindfemur largely pale yellowish except for dorsal dark line represented near base as scattered dark scales and expanding to a more or less broad preapical dark ring; tibiae dark-scaled except for pale yellowish or whitish basal ring on all legs and a more or less extensive pale streak on posterior surfaces of foreleg and midleg, a few pale scales sometimes present elsewhere; all tarsal segments of all legs with whitish or pale basal rings or patches, most strongly developed on hindleg, frequently reduced or even absent on 1 or more apical segments of foreleg and midleg; both claws of all legs with 1 strong subbasal tooth. *Wing:* dorsal scales largely dark except for a small yellowish spot on base of C, sometimes a few paler scales on Sc; squame scales small; plume scales rather short and broad; remigial hairs thin and rather long; alula with extensive marginal fringe of short narrow scales. *Haltere:* knob largely pale-scaled, some dark scales on inner surface. *Abdomen:* tergite I extensively scaled, scales largely dark, a variable number of pale scales at sides and in middle; laterotergite with large dense patch of whitish scales; tergites II-VII largely dark-scaled, with long basolateral rectangular patches of whitish scales often extending entire length of segment on VII; tergites II-V or II-VI with variable dorsal basal transverse pale yellowish bands, some pale scales in variable dorsal submedian patches on V-VII, usually some pale scales scattered elsewhere; sternites largely with pale yellowish scales, variable apical transverse bands or patches of dark scales on III-VI; cercus without scales.

MALE.—Essentially as in the female but strikingly different in the following characters. *Head:* all decumbent scales pale; narrow scales distinctly wider, broad scales more numerous; erect scales predominantly pale. *Labium:* usually without pale scales. *Palpus:* exceeding proboscis by more than 0.8 of segment 4; apical half of segment 3 with numerous long lateral hairs; pale scales usually not developed. *Thorax:* mesonotum predominantly pale-scaled; *apn* and *ppn* usually with numerous broad scales, *ppn* without dark scales; *ppl* usually without any scales at all; *psp* usually with only a few scales. *Legs:* claws of foreleg and midleg enlarged, unequal, all with large subbasal tooth; claws of hindleg as in female. *Abdomen:* lateral whitish markings of tergites II-VII greatly reduced, usually represented by only a few scales, sometimes apparently completely absent.

MALE GENITALIA (fig. 281).—As figured; diagnostic characters as for subgenus.

PUPA (fig. 281).—*Abdomen:* 4.19 mm. *Trumpet:* 0.74 mm. *Paddle:* 1.28 mm. Chaetotaxy as figured; diagnostic characters as for subgenus; pigmentation a rather uniform moderate yellowish brown; trumpet uniformly dark; hairs moderately pigmented except for dark large single hairs; hairs with slender branches; abdominal integument with conspicuous sculpturing. *Paddle:* pigmentation moderate, base, midrib, and external buttress darker and brighter; dorsal marginal spicules small, indistinct; hair 1-P small, spiniform.

LARVA (fig. 282).—*Head:* 1.07 mm. *Siphon:* 1.96 mm. *Anal Saddle:* 0.61 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as for subgenus. *Head:* uniformly moderately pigmented, except for light ocular areas and dark collar; integumentary sculpturing conspicuous; mental plate as figured; inner mouthbrushes without distinct pectinations; hair 1-C slender. *Antenna:* uniformly moderately pigmented; spicules short and heavy. *Thorax* and *Abdomen:* integument with rather distinct spiculation particularly ventrally. *Siphon:* index about 4.0–4.5; uniformly moderately to rather strongly pigmented, darkened on basal ring; densely covered with small broad spicules; pecten teeth usually more than 20. *Anal Segment:* saddle uniformly moderately to strongly pigmented, darkened at base, densely covered with short broad spicules which are longer caudad.

MATERIAL EXAMINED.—728 specimens; 543 ♀; 46 ♂; 42 pupae; 97 larvae; 6 individual larval rearings.

SYSTEMATICS.—*A. imprimens* is a very clearly marked species showing a great deal of variation in all stages, particularly in the ornamentation of the adults. It appears that only 1 species is involved, but the material available from most areas is too scanty for an analysis of geographical variation.

There is a marked sexual dimorphism in *imprimens,* very similar to the type found in some species of *Verrallina.* A single individual rearing of a male from Guadalcanal definitely associates the sexes through the immature stages.

The holotype of *imprimens* is in poor condition, but it shows most of the diagnostic characters of the species as currently understood. The holotype of *brugi* is, in my opinion, a small specimen of *imprimens,* which in general shows a great deal of variation in size, particularly in the male.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *imprimens* have been collected only a few times. They have been found in temporary pools and in flowing water in flooded areas, in deep or partial shade. My impression is that immature stages of *imprimens,* in common with some *Verrallina* species, undergo development in pools which are intermittently flooded for short periods and that they can survive for comparatively long periods of time out of water. The eggs are laid singly and are not cemented to objects.

Females of *imprimens* attack man very readily in the daytime in and around forested areas, are capable of biting through dense and thick clothing, and inflict a very painful bite. They are powerful and agile flyers and are difficult to capture. During the rainy season they appear to be very abundant, but I believe that their numbers are actually seldom very large and that their persistent attacks lead one to overestimate their abundance. On Guadalcanal *imprimens* is one of the major pest mosquitoes in foothill areas.

Nothing is known of the disease relations of *imprimens*. On Guadalcanal a few random dissections for larval filariae were all negative.

DISTRIBUTION (fig. 280).—*Solomon Islands:* Bougainville; New Georgia; Guadalcanal. Also recorded from *New Britain, New Guinea, Amboina* (type locality), *Ceram, Java, Sumatra, Malaya, Thailand, Borneo, Philippines,* and *Japan.*

Subgenus VERRALLINA Theobald

1903. *Verrallina* Theobald, Monog. Culicidae 3:295. *TYPE SPECIES: *Aedes butleri* Theobald, 1901, Malaya; the first of 3 included species, selection of Blanchard (1905:417).

1907. *Neomacleaya* Theobald, Monog. Culicidae 4:238. *TYPE SPECIES: *N. indica* Theobald, 1907, India; monobasic.—Synonymy with *Verrallina* uncertain.

1908. *Aioretomyia* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):185. *TYPE SPECIES: *A. varietas* Leicester, 1908, Malaya; the first of 6 new species, selection of Brunetti (1914:55).—Synonymy with *Verrallina* uncertain.

Aedes (*Aedes*) of Edwards (1913:229; 1922*b*:468; 1924:387; 1932:174; all in part); Laffoon (1946); King and Hoogstraal (1947*b*); Stone, Knight, and Starcke (1959); and all authors treating South Pacific species.

FEMALES.—*Head:* eyes distinctly separated above antennae, sometimes relatively widely; frons with or without scales; decumbent scales of vertex largely broad, narrow scales sometimes developed anteriorly on midline and along orbital lines; erect scales few, restricted to occiput, where a few narrow decumbent scales may be present; clypeus bare; proboscis usually longer than forefemur; palpus usually less than 0.15 of proboscis, 4-segmented, segments 1 and 2 ankylosed; antenna from about 0.8 to 1.2 of proboscis. *Thorax:* mesonotal scales all narrow; acrostichals and dorsocentrals strongly developed; scutellum with narrow scales on all lobes; paratergite bare; pleural scaling reduced; *psp* without scales; *ppl, stp,* and *mep* with small broad scales; *apn* and *ppn* with or without scales; central part of *mep* with short hairs posteriorly near scale patch. *Legs:* tibiae and tarsi entirely dark-scaled; claws varied. *Wing:* dorsal scales all dark; squame scales dense, plume scales rather broad; remigial hairs short; alula with short marginal hairs or narrow scales. *Abdomen:* tergite I extensively scaled; laterotergite with whitish scales. *Genitalia:* segment VIII only partially retracted; cercus conical; 3 spremathecae, all different in size.

MALES.—Essentially as in the females. *Palpus:* shorter than in females. *Antenna:* with varied number of long bristles in flagellar whorls. *Legs:* claws varied. *Abdomen:* with rather short lateral hairs.

MALE GENITALIA.—Very short and inconspicuous. *Segment VIII:* strongly developed, apex of tergite truncate or emarginate. *Segment IX:* tergite without distinct lobes or hairs; sternite with subapical line or patch of hairs. *Sidepiece:* usually very short and broad; mesal surface membranous; simple or with conspicuous lobes; never with differentiated hairy basal tergomesal area. *Claspette:* not developed. *Clasper:* varied in place of insertion; irregular in shape; usually with long hairs but without spiniform. *Phallosome:* aedeagus varied in development but relatively simple, without lateral teeth. *Proctiger:* varied in development; without cercal setae.

PUPAE (South Pacific species only).—*Cephalothorax:* hairs rather short; 1-C close to margin of sclerite; 2,3-C rather close together, 3-C very close to margin of sclerite; 8-C far cephalad; 9-C very close to wing base. *Trumpet:* short; sculpturing very prominent; tracheoid distinct at base. *Metanotum:* hair 10-C caudomesad of 11-C. *Abdomen:* float hair (1-I) strongly developed; 2,3-I widely separated; 2-III-VII mesad of hair 1 and removed from caudal border, usually more or less spiniform. *Terminal Segments:* female cercus prominent, conical; male genital lobe very short and broad. *Paddle:* midrib strongly developed; dorsal marginal spicules short and broad, usually not conspicuous; hair 1-P thickened, simple, barbed or rarely with brush tip.

LARVAE (South Pacific species only).—*Head:* hairs 5,6-C widely separated, usually well behind level of antennae; 4-C at level of 6-C or cephalad; 8-C single; strongly developed; 11-C small, multiple; 12,13-C close together, removed from cephalic border. *Antenna:* moderately long, slender; spicules more or less distinct; hair 1-A branched. *Thorax:* hair 1-P single; 9,10,12-P single; 14-M,13-T small, multiple; 13-P absent. *Abdomen:* hair 1-I usually single; 2-III-V strongly mesad of hair 1; 6-I usually double or triple, 6-II double or single, 6-III-VI long and single; 7-I usually single; 12-I absent; 13-III-V mesal, 13-VI cephalic and dendritic. *Segment VIII:* comb in a single to triple row, scales small and fringed apically; hairs 1,2-VIII without basal tubercles, poorly to moderately developed; 3,5-VIII strongly developed. *Siphon:* index moderate; acus well developed; pecten with enlarged widely spaced teeth distally, or majority of teeth widely spaced; hair 1-S distad of or within pecten. *Anal Segment:* saddle incomplete; small attached acus sometimes developed; caudal margin with short spicules dorsally; hair 1-X single; 2-X branched or single; 3-X single; ventral brush with 5 pairs of hairs on grid and 2 unpaired hairs basad; gills varied, long to very long.

SYSTEMATICS.—The South Pacific species formerly placed in the subgenus *Aedes* have little in common with the type species of this subgenus (*cinereus* Meigen, 1818, described from Europe), but they appear to be in general quite similar to *butleri,* the type species of *Verrallina.* I am placing them in the latter subgenus only provisionally, pending a thorough revision of the subgenera of *Aedes.* It may be necessary to recognize a distinct subgenus for the South Pacific species, together with other Australasian forms formerly placed in the subgenus *Aedes,* but since the immature stages of the entire complex are largely unknown, it would be premature to do it now. The Australasian and South Pacific *Verrallina* are most strikingly characterized by the development of a peculiar structure around the aedeagus of the male genitalia, apparently derived from basal sternal arms of the proctiger.

In spite of the fact that several species of *Verrallina* are very common and serious pest mosquitoes, this group is very poorly known. Outside Guadalcanal very few forms have been reared individually, and even there the number of rearings is very small. The ornamentation of the adults and the male genitalia are extremely variable in this complex, and it is most difficult to differentiate between individual, ecological, or geographical variation and specific differences without associated characters in the immature stages. An additional complication is found in the rather strong sexual dimorphism in the adults. It seems that in this complex there are several widely distributed, variable, adaptable dominant species and a number of localized specialized segregates. It is very probable that there are several unrecognized species in the Solomons in addition to the forms differentiated below.

All the South Pacific species of *Verrallina* appear to be endemic except *lineatus. A. carmenti* has been reported outside the area, but, as indicated below, I question the validity of these records pending a thorough study of the immature stages.

BIONOMICS AND DISEASE RELATIONS.—The breeding sites of species of *Verrallina* are very poorly known even in the common forms attacking man. As far as is known, the immature stages are found in temporary ground pools. Some species seem to be adapted to breeding in jungle pools which are frequently flushed, as in the instance of *carmenti* and probably *mccormicki,* while others, such as *lineatus,* breed in more open coastal pools not subjected to frequent flushing. *A. cuccioi* has been collected only in stream bed pools and in ground level treeholes in stream beds. The eggs of *carmenti* are apparently laid in a ribbonlike gelatinous string which is attached to various objects in a favorable environment out of water.

The females of several species of *Verrallina* attack man very readily, chiefly during the day and largely in the shade or in the vicinity of forested areas. In the South Pacific *carmenti* and *lineatus* are serious pests of man. The latter seems to be a semidomestic species and may have been spread through human agency.

Nothing is known of the disease relations of species of *Verrallina.* Random dissections of *carmenti* and *lineatus* on Guadalcanal failed to show natural infection with larval filariae.

DISTRIBUTION (fig. 283).—*Verrallina* is confined to the Oriental, Indomalayan, and Australasian regions. In the South Pacific it is found only in the Solomons, the Santa Cruz group, and the New Hebrides.

KEYS TO SPECIES

(Keys to tribe Aedini, pp. 318–321)

ADULTS

1. Vertex of head with orbital line of narrow pale scales; erect occipital scales pale; *apn* with scales . . . . 3. *lineatus*
Vertex of head without orbital line of narrow pale scales; erect occipital scales dark; *apn* without scales 2

2(1). *Male:* claws of foreleg and midleg equal, small, neither enlarged; *female:* claws of foreleg and midleg simple . . . . 4. *mccormicki*
Male: claws of foreleg and midleg unequal, an-

terior strongly enlarged; *female:* claws of foreleg and midleg toothed 3

3(2) *Male:* anterior claw of foreleg and midleg toothed; *female:* upper anterior part of *ppn* with numerous narrow scales . . . . 2. *carmenti*

Male: anterior claw of foreleg and midleg simple; *female:* upper anterior part of *ppn* without scales . . . . 1. *cuccioi*

MALE GENITALIA

1\. Tergite VIII with 1,2 thickened, apically truncate specialized setae; apicosternal area of sidepiece with 1,2 broad, striated foliforms with acute subapical or apical process . . . . 1. *cuccioi*

Tergite VIII without specialized setae; apicosternal area of sidepiece with 1,2 spiniforms, sometimes somewhat broadened but without acute subapical or apical process 2

2(1). Sidepiece with a distinct prominent small mesal lobe bearing several hairs; clasper setae restricted to 2 patches at base . . . . 2. *carmenti*

Sidepiece without such a mesal lobe; clasper setae scattered, usually some distally . . . 3

3(2). Apicosternal area of sidepiece with 1,2 large flattened spiniforms and 1,2 thickened hairs; middle of dorsal surface of sidepiece without specialized bristles . . . . 3. *lineatus*

Apicosternal area of sidepiece with only 1 small spiniform and 1 thickened hair; middle of dorsal surface of sidepiece with 3 or more differentiated bristles . . . . . 4. *mccormicki*

PUPAE

1\. Hair 5-IV-VI usually single and distinctly longer than tergite following . . . 1. *cuccioi*

Hair 5-IV-VI usually 2,3b and shorter than or about equal to tergite following 2

2(1). Hair 1-II usually with less than 10 branches . . . . 4. *mccormicki*

Hair 1-II with at least 10 branches 3

3(2). Marginal spicules of paddle indistinct; pigmentation a bright yellowish brown . . . . 2. *carmenti*

Marginal spicules of paddle relatively strong; pigmentation a pale blackish brown . . . . 3. *lineatus*

LARVAE

1\. Comb scales in a patch or irregular double or triple row; pecten teeth evenly and widely spaced, extending to 0.9 of siphon; hair 8-P minute . . . . 1. *cuccioi*

Comb scales in a single curved row; pecten teeth restricted to basal 0.6 of siphon, distal more widely spaced than proximal; hair 8-P strong 2

2(1). Siphonal tuft (1-S) distinctly ventral to pecten teeth . . . . 4. *mccormicki*

Siphonal tuft (1-S) more or less in line with pecten teeth 3

3(2). Hair 2-X usually 2,3b; siphon index usually over 3.5; antenna uniformly light . . . . 2. *carmenti*

Hair 2-X usually at least 6b; siphon index usually under 3.0; antenna darkened distally . . . . 3. *lineatus*

1. Aedes (Verrallina) cuccioi Belkin, n. sp.

Figs. 284-286

TYPES.—*Holotype:* ♂ with associated larval and pupal skins and genitalia slide (JNB, 776-102), Matanikau valley, Guadalcanal, Solomon Islands, from small ground level treehole in stream bed, Dec. 9, 1944, J. N. Belkin *et al.* (USNM, 64791). *Allotype:* ♀ with associated larval and pupal skins and genitalia slide (JNB, 776–101), same data as holotype (USNM). *Paratypes:* 1♀ (JNB, 776-106), 2♂ (JNB, 776-103, 104) with associated larval and pupal skins, 2 sets of associated larval skins and pupae, no adults (JNB, 776-105, 107), all with same data as holotype.—This species is dedicated to J. Cuccio, a member of the 20th Malaria Survey Unit on Guadalcanal.

Aedes (*Aedes*) *funereus* in part of Iyengar (1955:30); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.46 mm. *Proboscis:* 1.4 mm. *Forefemur:* 1.27 mm. *Abdomen:* about 1.97 mm. Superficially very similar to *carmenti* but smaller and differing chiefly in the following characters. *Head:* erect scales longer and more numerous, extending on vertex; palpus about 0.2 of proboscis; antenna distinctly longer than proboscis. *Thorax: ppn* without narrow scales above, short hairs less numerous, broad scales variable. *Legs:* hindfemur with light scaling less extensive. *Abdomen:* lateral light patches of tergites more basal and less conspicuous.

MALE.—Essentially as in the female and differing from *carmenti* in same characters except as follows. *Head:* erect scales short and few; antenna about as long as proboscis. *Thorax:* pleural scaling reduced; *ppn* and upper *stp* with very short hairs, usually no scales. *Legs:* claws of foreleg and midleg enlarged, unequal, all simple.

MALE GENITALIA (fig. 285).—As figured; diagnostic characters as in the key; very small, largely hidden. *Segment VIII:* very strongly developed; tergite slightly emarginate on caudal border, with 1,2 long specialized setae on a tubercle on each side as figured, sometimes with additional thickened and apically truncate setae. *Segment IX:* tergite poorly sclerotized, ribbonlike; sternite moderately long, with about 10 hairs toward apex, usually in irregular row. *Sidepiece:* very short and broad; a few scales restricted to basal half laterally and ventrally, several long curved bristles distally on the side; dorsal surface with thin hairs from base to apex; mesal surface membranous from base to apex and with a sternomesal sclerotized area with short hairs; sternoapical area with a foliform with twisted sharp apex and a more distal, variable, flattened spiniform or foliform. *Clasper:* irregular in shape; inserted near apex of sidepiece; expanded and with several tergal hairs in basal half; distal part without hairs, strongly curved and with sharp apex. *Phallosome* and *Proctiger:* essentially as in *carmenti* but differing in details as figured.

PUPA (fig. 285).—*Abdomen:* 2.3 mm. *Trumpet:* 0.36 mm. *Paddle:* 0.64 mm. Chaetotaxy as figured, hairs moderately to lightly pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly pigmented. *Trumpet:* strongly uniformly pigmented; integumentary sculpturing very prominent; tracheoid indicated at base. *Abdomen:* lightly pigmented; hair 5-IV-VI very long, usually single or rarely 2-forked; 9-VIII heavy, usually double; 2-I-VII spiniform. *Paddle:* lightly pigmented, midrib brighter; marginal spicules differentiated but poorly pigmented; hairs 1-P spiniform.

LARVA (fig. 286).—*Head:* 0.53 mm. *Siphon:* 0.67 mm. *Anal Saddle:* 0.26 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly lightly to moderately pigmented; mental plate as figured; inner mouthbrushes with pectinate tips; hairs 5,6-C with heavy stiff branches. *Antenna:* short and slender; lightly pigmented, slightly darkened at base; spicules very small. *Thorax* and *Abdomen:* integument without distinct spiculation; hairs moderately to strongly pigmented; hair 1-P long; 3,8-P very short. *Segment VIII:* comb in 2 rows of about 12–15 short fringed scales. *Siphon:* index about 4.0–5.0; acus large; lightly to moderately pigmented, darkened at base and apex; integumentary sculpturing indistinct; pecten of about 6–10 simple teeth, mostly large and evenly spaced to beyond 0.75, more proximal smaller; trachea narrow. *Anal Segment:* saddle narrowly incomplete; moderately pigmented, darkened at base; sculpturing light; marginal spicules very small, arising from imbrications; acus absent; hairs 2,3-X both long and single; ventral brush essentially as in *carmenti;* gills extremely long, narrow, sausage-shaped.

MATERIAL EXAMINED.—64 specimens; 18♀; 20♂; 11 pupae; 15 larvae; 6 individual larval rearings.

SYSTEMATICS.—*A. cuccioi* is strikingly different in the immature stages from the other South Pacific species of the subgenus, but the adults are in general quite similar to *carmenti.* The male genitalia resemble those of *milnensis* King & Hoogstraal, 1947 and *bifoliatus* King & Hoogstraal, 1947 from New Guinea in the development of stiff blunt-ended, specialized setae on tergite VIII but are easily differentiated from both by the presence of only simple hairs on the dorsal surface of the sidepiece.

There is a great deal of variation in all stages of *cuccioi,* but the same variations appear within populations from the same island. In the male genitalia of specimens from New Georgia, there may be additional specialized setae on tergite VIII and somewhat thickened hairs on the dorsal surface of the sidepieces, but both of these are poorly differentiated. The more apical of the 2 sternal foliforms of the sidepiece also varies a great deal in development. There is not enough material available to determine whether or not more than 1 form is involved in this complex; for the present, I consider all the known populations as part of a single variable species.

BIONOMICS AND DISEASE RELATIONS.—Guadalcanal specimens of *cuccioi* were reared from larvae collected in a rot hole at base of a tree growing in a stream bed (JNB, 776), in rock pools and potholes in a stream bed (JNB, 512), and in a flooded stream (JNB, 168). On Bougainville the immature stages have been found in a small clear swampland stream (ABG, 323) and on New Georgia in a flooded area along a creek (JGF, 35). A single male was collected on Guadalcanal resting near a sandy pool in a stream bed (JNB, 1292). No females have been collected in nature.

DISTRIBUTION (fig. 284).—*Solomon Islands:* Bougainville; New Georgia; Guadalcanal. Not known elsewhere.

2. Aedes (Verrallina) carmenti Edwards

Figs. 284, 287, 288

1924. *Aedes* (*Aedes*) *carmenti* Edwards, B. Ent. Res. 14:388–389. *TYPE: lectotype ♀, marked as type by Edwards, Maravovo, Guadalcanal, Solomon Islands, taken in bush or native house, June, 1923, A. G. Carment; by present selection (BMNH).

Aedes (*Aedes*) *carmenti* of Edwards (1924:388–389; 1932:175; both in part); Paine and Edwards (1929:307); Knight, Bohart, and Bohart (1944:27, 51, in part); Iyengar (1955:30, in part); Stone, Knight, and Starcke (1959, in part).

FEMALE.—*Wing:* 3.67 mm. *Proboscis:* 2.92 mm. *Forefemur:* 1.92 mm. *Abdomen:* about 2.73 mm. *Head:* eyes distinctly separated above antennae; no scales or bristles on frons; all scales of vertex dark except for small lateral patch of dingy whitish scales; decumbent scales all broad, dark bronzy, except for a few narrow on occiput; erect scales short, brown, restricted to occiput; labium dark-scaled; palpus a little less than 0.15 of proboscis, dark-scaled, 4-segmented, segments 1 and 2 ankylosed, segment 5 not differentiated; antenna about 0.8 of proboscis; torus with a few small broad dark scales in addition to hairs; flagellar segment 1 a little more than 1.5 of segment 2, with a few small broad dark scales; flagellar whorls with a few moderately long hairs. *Thorax:* integument bronzy brown; mesonotum with slender narrow bronzy or dark coppery scales throughout, lighter on sides, particularly in supraalar areas; acrostichals and dorsocentrals well developed; scutellum with slender narrow bronzy scales on all lobes; paratergite bare; *apn* without scales; *ppn* vestiture variable, upper middle portion with narrow bronzy scales, posterior with some translucent broad bronzy scales, a variable number of small thin hairs in upper posterior half, 6 or more bristles in posterior arcuate row, sometimes 2 or more additional short bristles in upper posterior corner; *ppl* with patch of translucent silvery broad scales extending on anterior surface along with bristles; *psp* and *pra* without scales; upper part of *stp* with large patch of small broad translucent bronzy scales, some silvery toward upper end and rather numerous small dark hairs toward anterior and caudal ends, middle posterior part of *stp* with rather extensive patch of translucent silvery broad scales and variable number of short slender hairs, *stp* bristles in usual transverse and posterior row; *mep* with a median patch of translucent silver broad scales followed by numerous hairs particularly toward lower end but not reaching lower third; upper *mep* bristles numerous, other pleural sclerites without scales. *Legs:* forecoxa with dark scales except for some light translucent silvery ones at base and apex, midcoxa with light and dark scales, hindcoxa largely bare; forefemur and midfemur dark-scaled except for largely pale posterior surface; hindfemur largely pale-scaled, apex and dorsal surface dark, hairs numerous; remainder of legs dark-scaled; both anterior and posterior claws of foreleg and midleg with subbasal tooth, hind claws simple. *Wing:* dorsal vein scales all dark, squame scales rather large and dense, plume scales moderately broad; dorsal remigial hairs short; alula with marginal fringe of short slender scales. *Haltere:* knob with pale metallic scales above, dark scales below. *Abdomen:* tergites largely dark-scaled; tergite I extensively scaled in distal half, hairs numerous; laterotergite with whitish scales; tergites II-VII largely dark-scaled, with subbasal lateral patches of dingy white scales; sternites II-VII largely dark-scaled, with basolateral pale-scaled patches or bands, more conspicuous on proximal segments. *Genitalia:* segment VIII exerted, strongly scaled; cercus prominent, conical, without scales; postgenital plate small but prominent; 3 spermathecae, all markedly different in size.

MALE.—Essentially as in the female. *Palpus:* shorter than in female, about 0.11–0.12 of proboscis. *Antenna:* strongly long-plumose; flagellar segments 12 and 13 elongate. *Thorax:* scaling reduced; pleural scaling largely replaced by short hairs on *ppn* and upper *stp*. *Legs:* claws of foreleg and midleg enlarged, unequal, both members of pair with subbasal tooth. *Abdomen:* with dense vestiture of rather short hairs below and distally; scaling rather scanty.

MALE GENITALIA (fig. 287).—As figured; diagnostic characters as in the key; inconspicuous, short, broad, and deeply retracted in segment VIII. *Segment*

VIII: strongly developed; tergite slightly emarginate in middle of caudal border, without specialized setae. *Segment IX:* broad; tergite short, poorly sclerotized, deeply emarginate in the middle of caudal margin, without hairs; sternite rather long, broadly separating sidepieces, with apical row of long hairs or weak bristles. *Sidepiece:* very short and broad; scales restricted to lateral and ventral surfaces; distal portion with several very long, strongly curved bristles; dorsal surface with hairs from near base, progressively longer distad; mesal surface membranous from base to apex, with small, poorly defined but projecting hairy basal mesal lobe; apicosternal angle slightly produced, with 1 heavy spiniform. *Clasper:* irregular in shape, nearly apical in insertion; basal part with large tergomesal expansion bearing several long hairs mesally and several shorter thinner hairs laterally; distal part slender, strongly and irregularly curved, with acute apex and without hairs. *Phallosome:* aedeagus rather large, triangular in outline in dorsal aspect, with strong subbasal sternal bridge, tergal surface with conspicuous median unpaired process; ventral paramere rather small. *Proctiger:* apparently divided into tergal and sternal portions; tergal portion membranous except for weak basolateral sclerotization; no sclerotized paraproct; cercal setae not developed; sternal portion with pair of lateral sclerotizations articulating at base with paramere and basal piece and joined by transverse sclerotized bar, extended vertically as collar dorsad and laterad of aedeagus and with distal edge ridged and apparently folded, entire collarlike structure and bars may be developed from sternal extension of basal lateral sclerotization, as developed in *A. alboscutellatus* and *Armigeres* species, but homology not established.

PUPA (fig. 287).—*Abdomen:* 2.62 mm. *Trumpet:* 0.44 mm. *Paddle:* 0.87 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly pigmented a bright yellowish brown, darkened on mesonotum and wing cases. *Trumpet:* uniformly darkly pigmented; integumentary sculpturing strong; tracheoid slightly indicated at base. *Metanotum:* darkened. *Abdomen:* lightly pigmented a bright yellowish brown, darkened on intersegmental areas. *Paddle:* very lightly pigmented, base, midrib, and external buttress slightly darker; marginal spicules rather large but very poorly differentiated, not conspicuous.

LARVA (fig. 288).—*Head:* 0.77 mm. *Siphon:* 1.1 mm. *Anal Saddle:* 0.39 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, ocular areas light; integumentary sculpturing indistinct; mental plate as figured; inner mouthbrushes thickened but not pectinate; hair 1-C very long, slender. *Antenna:* long, slender; uniformly very light except for a very inconspicuous darkening at extreme base; spicules small, numerous on ventral surface. *Thorax* and *Abdomen:* integument without distinct spiculation; hair 8-P strongly developed, single or double. *Segment VIII:* comb of about 10–15 fringed scales in a rather even curved row, 1,2 scales sometimes detached. *Siphon:* index about 3.5–4.5; strongly pigmented, darkened at base, lighter apically; integumentary sculpturing strong on basal portion; acus large; pecten of about 12–15 long, slender teeth, the outer 2–4 widely spaced and simple, the proximal smaller and with slender subbasal denticles; hair 1-S more or less in line with pecten. *Anal Segment:* saddle large but incomplete; moderately to strongly pigmented, darkened on base, lighter ventrally; integumentary sculpturing rather weak; marginal spicules very short, only slightly indicated even dorsally; hair 2-X with few branches; ventral brush with 5 pairs of hairs and 2 hairs not distinctly paired, all on grid or 1,2 of the latter detached basad; gills variable, slender, pointed, usually very long.

MATERIAL EXAMINED.—2,804 specimens; 1,244 ♀; 217 ♂; 190 pupae; 433 larvae; 16 individual larval rearings.

SYSTEMATICS.—*A. carmenti* is superficially very similar to the other South Pacific species of the subgenus but is easily differentiated by the characters given in the keys. It seems to be a variable species, and it may be possible that local geographic forms exist or that 2 or more species are confused. Unfortunately very little individually reared material is available at present. King and Hoogstraal (1947*b*:115–117) synonymize *ceramensis* Brug, 1934 with *carmenti* and questionably refer to the latter records of "*funereus*" from Amboina. Published figures of both these forms differ considerably from true *carmenti* from the Solomons, and I believe that they are distinct species (Brug, 1932:80, 1934:512). The male genitalia from Hollandia, New Guinea, figured by King and Hoogstraal (1947*b*:116) resemble *carmenti* from Guadalcanal, but since in several species in this group the male genitalia are distinguishable in slight details only, the identity of the New Guinea form cannot be definitely determined until the immature stages are described thoroughly. I have seen a larva and a pupal skin from Northern Queensland, determined as *carmenti* by E. N. Marks; although they resemble this species, there are a number of differences which may be indicative of specific distinctness.

BIONOMICS AND DISEASE RELATIONS.—Although *carmenti* is one of the most serious pest mosquitoes in the Solomons, its immature stages have been collected only a few times. This species is apparently adapted to breeding in shallow, heavily shaded temporary jungle pools which are frequently flushed. In the laboratory, eggs were laid in a ribbonlike row on the sides of test tubes, cemented so thoroughly to the glass that they could not be dislodged except with a scalpel. In nature mature larvae and pupae were collected on several occasions on Guadalcanal in very shallow pools less than a day after the pools, previously dry, had been filled by a rain. My impression is that the immature stages develop rather slowly during periods when such pools are filled and that they survive periods of partial desiccation of these pools between rains. It is also possible that they are washed down from breeding sites farther away from the coast.

Females of *carmenti* attack man voraciously in forested areas during the daytime but very seldom bite in the open or after dark. Nothing else is known of their habits or of their disease relations. Random specimens were dissected on Guadalcanal but none were found to harbor filarial larvae.

DISTRIBUTION (fig. 284).—*Solomon Islands:* Bougainville; Treasury; Santa Isabel; Kolombangara; New Georgia; Sasavele; Russell; Florida; Guadalcanal; San Cristobal. Not known definitely elsewhere; *carmenti* has been reported also from Ceram, Amboina, New Guinea, Queensland, and Nissan (Laird, 1952:153), but, as indicated above under Systematics, I regard all these records as questionable.

3. Aedes (Verrallina) lineatus (Taylor)

Figs. 283, 284, 289, 290

1905. *Skusea funerea* var. *ornata* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:79–80. TYPE: holotype ♀ (*fide* Stone, 1957*a*:171), described from series of 8♀, Sattelberg, Huon Gulf, 1899, and Friederich-Wilhelmshafen, 1900, Biro (BUDA).—Preoccupied by *Culex ornatus* Meigen, 1818 (= *Aedes geniculatus* (Olivier, 1791), according to Edwards, 1921*b*:319).

1914. *Lepidotomyia lineatus* Taylor, Roy. Ent. Soc. London, Trans. 1914(62):191–193. TYPE: syntypes, ♀, Lakekamu Gold Field and Mekeo District, New Guinea (Papua), Giblin and Breinl (SYDN).

Aedes (*Aedes*) *lineatus* of King and Hoogstraal (1947*b*:118–119); Iyengar (1955:30); Laird (1956); Rageau (1958*a*:877); Rageau and Vervent (1958:18–19); Stone, Knight, and Starcke (1959).

Aedes (*Aedes*) *funereus ornatus* of Knight, Bohart, and Bohart (1944:25, 52); Perry (1946:16); and authors and wartime collections in the South Pacific.

Aedes (*Aedes*) *funereus* var. *ornatus* of Edwards (1924:387; 1926:110; 1932:176); Buxton and Hopkins (1927:101); Paine and Edwards (1929:307); Taylor (1934:21); Lee (1944*a*:77); and authors.

Skusea pseudomediofasciata (?) of Taylor (1919:838–839).

FEMALE.—*Wing:* 3.16 mm. *Proboscis:* 2.28 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.5 mm. Extremely variable in coloration; superficially somewhat similar to *carmenti,* differing from it chiefly in the following characters. *Head:* eyes narrowly separated above antennae, frons with pale yellowish narrow scales; orbital line with pale yellowish narrow scales, width of line extremely variable; a variable middorsal patch of light scales on vertex, sometimes reduced to small area near erect scales, sometimes reaching frons and with some narrow scales anteriorly; erect scales all pale; lateral light-scaled patch of head usually very large and conspicuous; palpus about 0.14 of proboscis; antenna about 0.9 of proboscis; torus light yellowish. *Thorax:* integument brown to light brown; mesonotal vestiture variable, usually with more or less distinct pattern of light golden scaling contrasting with darker bronzy scales, light scales along acrostichal line to prescutellar area and around the latter, along lateral prescutal margin to supraalar area and to posterior dorsocentral line, and in supraalar area, sometimes pattern completely absent; scutellar scales usually light golden; *apn* with narrow dingy white scales throughout and several broad whitish scales in front; *ppn* with narrow scales in upper posterior portion, dark above and lighter below; broad pale scales of *ppl, stp,* and *mep* rather small, very dense, not translucent, variable in color from pure dull white to yellowish white; upper *stp* patch very large, small hairs usually not developed, rarely a few present; thin hairs behind *mep* scale patch just reaching lower third of sclerite. *Legs:* forecoxa with extensive pale scaling at base and apex; claws of foreleg and midleg subequal, all with minute subbasal tooth or simple. *Wing:* remigial bristles stronger. *Abdomen:* lateral light-scaled markings very strongly developed and arcuate, extending to dorsum of tergites where they are joined by transverse complete or incomplete dingy white bands as follows, (1) tergites III,IV with transverse pale bands postmedian laterally, angled basad mesally to join a large premedian patch, (2) tergite V with straighter postmedian band, (3) tergite VI with subapical band, (4) tergite II with median basal light patch; light scaling extremely variable in extent.

MALE.—Essentially as in the female and differing from *carmenti* in same characters except as follows. *Palpus:* less than 0.1 of proboscis. *Antenna:* less densely plumose than in *carmenti*. *Thorax:* all *apn* scales broad; all *ppn* scales light, some broad ones present caudally. *Legs:* claws of foreleg and midleg simple. *Abdomen:* tergal bands less distinct than in female.

MALE GENITALIA (fig. **289**).—As figured; diagnostic characters as in the key; variable; very similar to *mccormicki* and differing chiefly in the following characters. *Sidepiece:* without strongly differentiated dorsal setae; sternoapical angle with a much broader, larger foliform and 1 more distal spiniform which is sometimes developed as a foliform. *Clasper:* distal portion more slender and more strongly angled.

PUPA (fig. **289**).—*Abdomen:* 2.48 mm. *Trumpet:* 0.29 mm. *Paddle:* 0.75 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately and unevenly pigmented, darkened on mesonotum and appendage and wing cases. *Trumpet:* uniformly dark; integumentary sculpturing very strong; tracheoid indicated at base. *Metanotum:* darkened. *Abdomen:* moderately pigmented, darkened on proximal segments and intersegmental areas; hair 5-IV-VI usually double; 1-II usually with 12 or more branches; 2-I-VII more or less spiniform. *Paddle:* moderately pigmented, strongly darkened on midrib and external margin; marginal spicules variable, sometimes strongly developed; hair 1-P thickened, sometimes barbed or with brush tip.

LARVA (fig. **290**).—*Head:* 0.79 mm. *Siphon:* 0.95 mm. *Anal Saddle:* 0.35 mm. Chaetotaxy as figured, hairs and tubercles strongly pigmented; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, light on ocular areas, strongly darkened caudally; integumentary sculpturing indistinct; mental plate as figured; inner mouthbrushes thickened, indistinctly pectinate. *Antenna:* long, slender; moderately to lightly pigmented in basal half, usually strongly darkened in distal; spicules strong. *Thorax* and *Abdomen:* integument without distinct spiculation. *Segment VIII:* comb usually with 10–12 small fringed scales. *Siphon:* index about 2.5–3.0; moderately to strongly pigmented, darkened on basal ring; integumentary sculpturing distinct; acus strongly developed; pecten usually with 12–16 teeth, the distal 2,3 long, simple, and widely spaced, the proximal shorter, closely and evenly spaced, and with large subbasal tooth; hair 1-S more or less in line with pecten. *Anal Segment:* saddle narrowly to rather broadly incomplete; moderately pigmented, darkened dorsally at base and apex; sculpturing indistinct; marginal spicules short, distinct dorsally only; acus not developed; hair 2-X usually at least 6b; ventral brush essentially as in *carmenti;* gills longer than saddle.

MATERIAL EXAMINED.—2,852 specimens; 1,932 ♀; 349 ♂; 123 pupae; 448 larvae; 9 individual larval rearings.

SYSTEMATICS.—*A. lineatus* is an extremely variable species, particularly in the ornamentation of the adults. It is possible that more than 1 species is confused under this name, but it seems to me that we are dealing here with a highly plastic dominant form whose distribution is at least partially owing to human agency. Although some of the populations seem to be strikingly different, the features characterizing them appear sporadically in other populations. Nothing can be done to resolve the complex until numerous individual rearings are made throughout the entire range.

BIONOMICS AND DISEASE RELATIONS.—*A. lineatus* appears to be a semidomestic species. The immature stages are most frequently found in temporary ground pools in cleared and partially shaded areas in association with man; they occur less frequently in undisturbed jungle areas. Females attack man very readily in the daytime, particularly in shaded areas. Although this is one of the commonest mosquitoes attacking man wherever it occurs, it has never been suspected of being involved in disease transmission and practically nothing is known of its bionomics.

The presence of *lineatus* on such outlying islands as Ontong Java is of considerable interest. It seems very unlikely that *lineatus* adults can cross such wide expanses of water; it would appear, therefore, that this species reached such islands in the egg stage, either through aerial transport or through human agency. *A. lineatus* is frequently common around taro grounds, and it is very probable that its eggs are transported with these cultivated aroids.

DISTRIBUTION (figs. **283, 284**).—*Solomon Islands:* Bougainville; Treasury; Vella Lavella; Kolombangara; Gizo; New Georgia; Rendova; Russell; Florida; Guadalcanal; Malaita; San Cristobal; Ontong Java; Sikiana. *Santa Cruz Islands:* Vanikoro. *Banks Islands:* Pakea. *New Hebrides:* Espiritu Santo; Aore; Aoba; Malekula; Epi; Emae; Efate. Also reported from *Australia* (Queensland), *Bismarck Archipelago, Admiralty Islands, Emirau, New Guinea, Ceram,* and *Sumba.*

4. Aedes (Verrallina) mccormicki Belkin, n. sp.

Figs. 284, 291, 292

TYPES.—*Holotype:* ♂ with genitalia slide (JNB, 874-2001), Lunga area, Guadalcanal, Solomon Islands, from temporary pool near swamp, Feb. 19, 1945, E. J. McCormick, Jr. and F. B. Wysocki (USNM, 64792). *Allotype:* ♀ with associated larval and pupal skins (JNB, 874-25), same data as holotype (USNM). *Paratypes:* 2 ♀ with associated larval and pupal skins (JNB, 874-21, 22), 1 associated larval skin and pupa (JNB, 874-23), 2 ♀, 18 ♂, 29 pupae, 87 larvae (JNB, 874-2), all same data as holotype.—This species is dedicated to E. J. McCormick, Jr., a member of the 20th Malaria Survey Unit on Guadalcanal.

Aedes (Aedes) funereus in part of Iyengar (1955:30); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.16 mm. *Proboscis:* 2.25 mm. *Forefemur:* 1.92 mm. *Abdomen:* about 2.33 mm. Posably 2 or more species confused; superficially similar to *carmenti,* from which it differs chiefly in the smaller size and the following characters; general coloration a lighter brown. *Head:* eyes more widely separated above antennae; erect scales of occiput larger; palpus about 0.13 of proboscis; antenna as long as or slightly longer than proboscis. *Thorax: ppn* usually bare except for posterior bristles (4–7), rarely 1,2 scales or short hairs; upper *stp* scales all dingy silvery, the posterior longer and in erect patch, small hairs absent or rarely a few present; *mep* scales longer, erect, median hairs longer and fewer. *Legs:* femora less extensively pale; all claws simple. *Abdomen:* weaker and smaller specimens with complete or incomplete subbasal transverse light bands on tergites III-V and tergites VI,VII with larger lateral light patches; larger specimens without transverse light bands.

MALE.—Differing from *carmenti* in same characters as the female except as follows. *Head:* eyes even more widely separated. *Palpus:* less than 0.1 of proboscis. *Antenna:* slightly shorter than proboscis; bristles in flagellar whorls very long but very few. *Legs:* tarsal segment 4 of foreleg and midleg not shortened, more than 2.0 length of segment 5; claws of foreleg and midleg minute, equal, simple. *Abdomen:* tergites III-VII always with more or less broad transverse light bands, nearly basal on III,IV, premedian on V,VI, sometimes barely indicated on VI,VII; lateral hairs of abdominal segments fewer.

MALE GENITALIA (fig. 291).—As figured; diagnostic characters as in the key. *Segment VIII:* strongly developed; tergite truncate on caudal border, without specialized setae. *Segment IX:* tergite sinuate on caudal border, without hairs; sternite with about 6 hairs toward caudal border. *Sidepiece:* very short and broad; a few scales on lateral and ventral surfaces; dorsal surface with 3 or more thickened curved rather short bristles near middle in addition to weaker hairs and bristles; mesal surface membranous from base to apex; a small sternomesal lobe, somewhat projecting distally and bearing a long thickened straight seta which is inserted on a tubercle, shorter hairs basad; sternoapical angle slightly produced, with 1 rather weak spiniform and several hairs on sternal face. *Clasper:* inserted near apex; irregular in shape; basal part with strong inner angle but not greatly expanded; distal part rather broad, strongly curved dorsad; tergal surface with about 10 long hairs, chiefly in basal half but 1 about halfway on distal. *Phallosome* and *Proctiger:* in general as in *carmenti.*

PUPA (fig. 291).—*Abdomen:* 2.18 mm. *Trumpet:* 0.26 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly to moderately pigmented, darkened on mesonotum and base of wing case. *Trumpet:* short, only slightly diagonally truncate; uniformly darkly pigmented; integumentary sculpturing very prominent; tracheoid indicated at base. *Metanotum:* darkened. *Abdomen:* uniformly lightly to moderately pigmented, darkened on anterior intersegmental areas; hair 1-II with 10 or less branches; 2-I-VI slightly spiniform; 5-IV-VI usually double. *Paddle:* lightly to moderately pigmented, midrib a little brighter; marginal spicules coarse but indistinct.

LARVA (fig. 292).—*Head:* 0.71 mm. *Siphon:* 0.79 mm. *Anal Saddle:* 0.34 mm. Chaetotaxy as figured, hairs strongly to moderately pigmented; diagnostic characters as in the key. *Head:* moderately pigmented, light on ocular areas, darkened caudally; integumentary sculpturing indistinct; mental plate as figured; inner mouthbrushes thickened, very minutely pectinate. *Antenna:* long, slender, curved; uniformly lightly pigmented except for darkened basal ring; spicules very small, sparse. *Thorax* and *Abdomen:* integumentary spiculation indistinct. *Segment VIII:* comb of about 15 or more small fringed scales in a long arcuate row. *Siphon:* index usually 2.75–3.2; moderately pigmented, darkened on basal ring; integumentary sculpturing light; acus strongly developed; pecten of about 12 or more teeth, the distal 2–5 long, simple, widely spaced, the proximal shorter, closely set, with large subbasal denticle and sometimes a few spicules; hair 1-S within and distinctly ventrad of pecten teeth. *Anal Segment:* saddle narrowly incomplete; moderately to lightly pigmented, darkened at base; marginal spicules small, distinct middorsally; hair 2-X usually with 2 or more branches; ventral brush essentially as in *carmenti.*

MATERIAL EXAMINED.—562 specimens; 136♀; 82♂; 111 pupae; 233 larvae; 4 individual larval rearings.

SYSTEMATICS.—Adults of *mccormicki* appear to be quite similar to *similis* (Theobald, 1910) from Queensland and resemble particularly type B *parasimilis* King & Hoogstraal, 1947 from New Guinea (King and Hoogstraal, 1947*b*:126); the larva is of the same type as the *parasimilis* figured by King and Hoogstraal. However, the male genitalia of *mccormicki* are conspicuously different from those of *parasimilis* in the development of specialized dorsal bristles on the sidepiece. Therefore it is almost certain that *mccormicki* is distinct from any previously described species.

It seems very possible that more than 1 species is confused under *mccormicki.* On Guadalcanal all females show some pale transverse banding on the dorsum of the abdominal tergites, but the larger specimens have it considerably reduced. On the other hand, all females from New Georgia lack the banding completely, and all are considerably larger than the Guadalcanal specimens. The 2 known females from Bougainville are intermediate in size and show incomplete premedian bands on tergites III-V. In other respects, all the adult material conforms quite well to the diagnostic characters given above; particularly characteristic is the unusually wide frons separating the eyes above the antennae. It is possible that only 1 extremely variable species is involved. The larval material is also variable; unfortunately, only a few individual rearings are available from Guadalcanal and none from elsewhere.

BIONOMICS AND DISEASE RELATIONS.—*A. mccormicki* is apparently a general breeder in temporary ground pools, both in deeply shaded jungle in association with *carmenti* and in partially open areas in association with *lineatus.* It is probably a much more common species than the few collections would indicate, since the larvae are easily mistaken for *lineatus* in the field and females do not normally attack man. Only 3 adults were collected in nature on Guadalcanal, one female resting on a tree trunk, a male flying, and a second female in a night hand catch.

DISTRIBUTION (fig. 284).—*Solomon Islands:* Bougainville; New Georgia; Guadalcanal. Not known elsewhere.

AEDES, subgenus undetermined

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Aedes (subgenus?) sp., Bougainville form

Figs. 293, 294

FEMALE, MALE, and PUPA.—Unknown.

LARVA (fig. 294).—*Head:* 0.9 mm. *Siphon:* 1.07 mm. *Anal Saddle:* 0.39 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key; superficially similar to some species of *Verrallina* and *Aedimorphus. Head:* strongly pigmented, ocular areas lighter; integumentary sculpturing weak; mental plate as figured; all mouthbrush filaments thickened and hooked apically, weakly pectinate near apex; hair 1-C long and slender; 4-C small, multiple, cephalad of 6-C; 5,6-C widely separated; 8-C short, multiple; 12,13-C approximated, removed from cephalic border. *Antenna:* moderately long and slender; uniformly lightly pigmented; spicules short, distinct; hair 1-A usually 3-5b, in basal half. *Thorax:* hair 1-P branched; 8-P strongly developed; 9-P branched; 13-P absent. *Abdomen:* spiracular sensilla strongly developed; hair 1-I single; 2-III-V strongly mesad of hair 1; 6-I double or triple, 6-II usually double; 6-III-VI long and single; 7-I long, single; 12-I absent. *Segment VIII:* 8–14 comb scales in a single curved row, individual scale small, elongate, fringed, and with apex produced into slender spine; hairs 1,2-VIII with poorly pigmented common basal plate; 2,4-VIII both branched. *Siphon:* index about 2.5–3.0; moderately to strongly pigmented, darkened on basal ring, integumentary sculpturing distinct; acus strongly developed, attached; pecten of about 16–18 long teeth, progressively longer distally, the proximal close-set, the distal 2 or more slightly more widely spaced, usually all with 1 or more subbasal denticles; hair 1-S usually double. *Anal Segment:* saddle narrowly incomplete; acus not developed; moderately pigmented, darkened at base and dorsally; integumentary sculpturing weak to moderate; marginal spicules not developed; hair 1-X missing in all specimens; 2-X multiple; 3-X single; ventral brush usually with 7 pairs of multiple hairs on grid and 2 unpaired hairs proximad; gills missing in all specimens.

SYSTEMATICS.—This larva, known from a single collection of 4 specimens (ABG, 372, USNM), cannot be placed in any recognized subgenus of *Aedes.* It has some features of species of *Verrallina* in the head chaetotaxy and of species of *Aedimorphus* in segment VIII. Since the larval stages of both subgenera are poorly known, it seems advisable not to name this species until all the stages are known. Five adults reared from the same collection and identified as *lineatus* by A. Stone may possibly belong to the same species; unfortunately it appears that they are now lost, as I could not locate them in the USNM.

BIONOMICS AND DISEASE RELATIONS.—The single larval collection was made in ground pools in a woodland area, apparently in association with *Aedes painei, mcdonaldi,* and *imprimens.*

DISTRIBUTION (fig. 293).—*Solomon Islands:* Bougainville. Not known elsewhere.

Subgenus AEDIMORPHUS Theobald

1903. *Aedimorphus* Theobald, Monog. Culicidae 3:290. *TYPE SPECIES: *Uranotaenia domestica* Theobald, 1901, West Africa; monobasic.

1904. *Ecculex* Felt, N.Y. State Mus., B. 79:391*c*. *TYPE SPECIES: *Culex sylvestris* Theobald, 1901, Canada; original designation.

1905. *Reedomyia* Ludlow, Canad. Ent. 37:94. *TYPE SPECIES: *R. pampangensis* Ludlow, 1905, Philippines; monobasic.

1905. *Lepidotomyia* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:80. TYPE SPECIES: *L. alboscutellata* Theobald, 1905, New Guinea; monobasic.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—*Head:* eyes usually narrowly separated above antennae; decumbent scales of vertex usually largely narrow, rarely largely broad and flat; erect scales numerous; proboscis usually distinctly longer than forefemur; palpus short, usually about 0.15–0.20 of proboscis, usually (?) 4-segmented, segment 5 not developed except as a minute sclerotization; antenna long, usually (?) as long as or longer than proboscis. *Thorax:* mesonotum largely with narrow scales; acrostichal and dorsocentral rows usually complete; scutellum with narrow or broad scales; paratergite with or without scales; *apn* and *ppn* usually largely with narrow scales, some broad ones frequently developed on *ppn;* other pleural scaling varied, *psp, ssp,* and *pra* with or without scales; lower *mep* without bristles or hairs. *Legs:* both claws of foreleg and midleg always toothed, those of hindleg simple or toothed. *Abdomen:* tergite I usually extensively scaled; laterotergite with large scale patch. *Genitalia:* segment VIII partially or completely retracted; cercus variable, usually long; spermathecae variable, from 1 to 3.

MALES.—Essentially as in the females; sometimes rather strongly differentiated. *Palpus:* usually as long as or longer than proboscis; 5-segmented, segment 5 rarely short; segments 4 and 5 usually thickened, hairy and turned down, rarely slender, bare and turned up. *Antenna:* shorter than proboscis; flagellar hairs long and numerous, mainly directed dorsad and ventrad. *Thorax: apn* scales sometimes broad. *Legs:* claws of foreleg and midleg enlarged, at least larger of each pair with tooth. *Abdomen:* hairs rather numerous and long.

MALE GENITALIA.—Moderately large and prominent. *Segment VIII:* tergite sometimes widened distally. *Segment IX:* tergite usually narrowed in middle, lobe more or less distinct, with or without hairs; sternite usually with postmedian row of hairs. *Sidepiece:* simple in structure, no distinct apical or basal tergomesal lobes; mesal membrane from base to apex. *Claspette:* present or absent. *Clasper:* usually irregular in shape; frequently with distal lobe or process; spiniform always present, usually subapical or on a lobe or process, accessory spiniforms frequently developed. *Phallosome:* aedeagus complex, with lateral teeth distally. *Proctiger:* sometimes complex; a basal sternal arm developed in some species; paraproct usually without strong apical spine; cercal hairs not developed.

PUPAE.—*Cephalothorax:* hair 8-C cephalad or at level of trumpet bases. *Trumpet:* short, only slightly widened distally, tracheoid sometimes slightly indicated. *Metanotum:* hair 10-C mesad of 11-C. *Abdomen:* hairs 2,3-I approximated. *Terminal Segments:* female cercal lobe usually prominent. *Paddle:* marginal spicules usually small or indistinct.

LARVAE.—Extremely varied; subgeneric characters not evident. *Head:* hair 4-C always (?) short, varied in position; 5,6-C usually strongly developed. *Antenna:* usually long; almost always spiculate; hair 1-A strongly developed, usually multiple. *Thorax* and *Abdomen:* not studied for most species; hair 12-I absent in South Pacific species. *Segment VIII:* comb varied, from a few teeth in single row to a large patch; scales varied, small and fringed to large spines. *Siphon:* frequently long; acus usually developed; pecten varied, frequently with distal teeth enlarged and widely spaced; hair 1-S varied in position, usually small; valves small; trachea usually strongly developed. *Anal Segment:* saddle always (?) incomplete; marginal spicules usually poorly developed or indistinct; acus sometimes developed; hair 1-X frequently single, if branched usually short; 2-X usually multiple; 3-X single; ventral brush well developed, usually with unpaired hairs proximad of grid; gills varied, usually long.

SYSTEMATICS.—*Aedimorphus* as currently understood appears to be a heterogeneous complex of several more or less distantly related phylads which have a similar development of the aedeagus and proctiger in the male. In this respect, as well as in other features of the male genitalia and sometimes other male characters, *Aedimorphus* resembles *Stegomyia*. On the other hand, the female genitalic characters, the head scaling, and the male palpus are often but not always very similar to *Ochlerotatus*. The immature stages are very diverse in development but unfortunately have not been sufficiently studied to be utilized for a clarification of phyletic relationships; in general they appear to resemble some groups of *Ochlerotatus*. In larval habitats and morphology, as well as adult characters, the A (*apicoannulatus*) and B (*nummatus*) groups are markedly different from the rest of the subgenus and should probably be segregated into 2 separate subgenera, as suggested by Edwards (1932:166).

Only 2 of the 7 or more groups recognized in *Aedimorphus* (Edwards, 1932:166–167; 1941:157; Knight and Hull, 1953:454) occur in the South Pacific. The 2 groups are very strikingly different in all stages. *A. alboscutellatus* is a member of group C of Knight and Hull, a heterogeneous widespread group which was divided into 4 groups by Edwards (1941:157). *A. nocturnus* is a member of group G (*vexans*), which is not sharply differentiated from group F (*dentatus*).

BIONOMICS AND DISEASE RELATIONS.—All the known species of *Aedimorphus* are breeders in temporary ground pools except for groups A and B, which utilize treeholes. In this respect *Aedimorphus* replaces *Ochlerotatus* in the Ethiopian region and, to a lesser extent, in the Oriental. Females of many species attack man readily and may be very serious pests. Some species attack in the daytime, others are chiefly nocturnal biters. Several species have been found to be naturally infected with viruses, and *ochraceus* (Theobald, 1901) may be a vector of *Wuchereria bancrofti* in East Africa.

Neither of the South Pacific species has been incriminated in disease transmission and only *nocturnus* may be a serious pest at times.

DISTRIBUTION (figs. **295**, **296**).—*Aedimorphus* is predominantly Ethiopian in distribution. It is well represented in the Oriental region but appears to be poorly developed in the Indomalayan and Australasian regions. Only the *vexans* and *alboscutellatus* complexes are widespread and are represented in north temperate regions, the former being the only representative of the subgenus in the New World. These 2 complexes are also the only representatives of *Aedimorphus* in the South Pacific, *alboscutellatus* in the Solomons and *nocturnus* of the *vexans* complex from the New Hebrides and New Caledonia to Samoa and Rarotonga.

KEYS TO SPECIES

(Keys to tribe Aedini, pp. 318–321)

ADULTS

1. Scutellum with broad silvery scales; midfemur, hindfemur, and all tibiae with apical silvery patches; paratergite bare . . . . 1. *alboscutellatus*
Scutellum with narrow pale brownish scales; femora and tibiae without silvery patches; paratergite with scales . . . . . 2. *nocturnus*

MALE GENITALIA

1. Claspette not developed; clasper strongly swollen apically, with several accessory spiniforms . . . . 1. *alboscutellatus*
Claspette distinct; clasper not strongly swollen apically, with short inner arm bearing 1 spiniform . . . . 2. *nocturnus*

PUPAE

1. Hair 2-IV,V cephalad of hair 3, far removed from caudal border of tergite . . . . 1. *alboscutellatus*
Hair 2-IV,V caudad of hair 3, near caudal border of tergite . . . . 2. *nocturnus*

LARVAE

1. Comb scales small, fringed apically; siphon long, pecten not reaching middle; hair 6-III-VI short . . . . 1. *alboscutellatus*
Comb scales large, usually with long apical spine; siphon short, pecten usually reaching to about middle; hair 6-III-VI long . . . . 2. *nocturnus*

1. Aedes (Aedimorphus) alboscutellatus (Theobald)

Figs. **295-298**

1905. *Lepidotomyia alboscutellata* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:80–81. TYPE: lectotype ♀, labeled as type, Simbang, Huon Gulf, New Guinea, 1898, Biro; by present selection (BUDA).

1909. *Culex argentinotus* Banks, Philippine J. Sci. 4(A):547. TYPES: syntypes, ♂, ♀, Taytay, Rizal Province, Luzon, Philippines, May 13–16, 1909, Banks (MANILA, destroyed).—Synonymy with *alboscutellatus* by Edwards (1922*b*:467).

1921. *Aedes omurensis* Yamada, Annot. Zool. Jap. 10(3):73. TYPES: syntypes, ♂, ♀, Omura, Kiushu, Japan, Yamada (TOKYO).—Synonymy with *alboscutellatus* by Edwards (1922*a*:101).

Aedes (*Aedimorphus*) *alboscutellatus* of Edwards (1924:372; 1932:167); Taylor (1934:20); Barraud (1934:250–251); Knight, Bohart, and Bohart (1944:24, 50); Penn (1949*b*); Knight and Hull (1953:457–459); Iyengar (1955:30); Laird (1956); Stone, Knight, and Starcke (1959).

Aedes (*Ecculex*) *alboscutellatus* of Edwards (1922*a*:101; 1922*b*:467).

Reedomyia alboscutellata of Theobald (1907:261–262).

FEMALE.—*Wing:* 3.55 mm. *Proboscis:* 2.13 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.67 mm. *Head:* eyes narrowly separated; decumbent scales of vertex largely linear except for broad ones laterally, dark in front, light golden caudally; a narrow orbital line of curved narrow pale golden scales continued on frons to level of lower edge of eyes; lateral broad scales largely dark; erect scales long and dark, moderately numerous, and extending to orbital bristles; sides with broad beige scales; clypeus bare; labium entirely dark-scaled; palpus about 0.16 of proboscis, dark-scaled, apparently 4-segmented, segment 5 represented by a minute apical sclerotization; antenna distinctly longer than proboscis; torus with 1,2 small broad scales in addition to hairs; flagellar segment 1 with several small broad scales. *Thorax:* integument brown to light brown; mesonotum with rather thin vestiture of small narrow curved scales, largely bronzy; variable patches of light golden scales on middle of anterior promontory, humeral angle, caudomesal corner of fossa in front of wing root, and sometimes scattered elsewhere; acrostichal and dorsocentral rows complete, bristles moderately long; scutellum almost completely covered by broad long flat silvery scales; paratergite bare; *apn* with small patch of narrow curved light golden scales in lower part; *ppn* with widely spaced narrow curved dark scales in upper half, sometimes a few of the scales pale or broad or both; *ppl* with patch of light metallic scales with slight golden tinge; *ssp* with patch of short light golden hairs and sometimes a few scales against *stp;* a small patch or tuft of broad silvery scales on upper *stp,* caudal *stp,* and upper anterior *mep;* scales absent from other pleural sclerites; lower *mep* bristles not developed. *Legs:* forecoxa dark-scaled except for pale scales at base and apex, midcoxa and hindcoxa with pale scales; trochanters largely with pale scales; forefemur dark-scaled on anterior, ventral, and lower posterior surfaces, pale-scaled on dorsal and upper posterior, apex with small patch of whitish scales on middle of anterior surface; midfemur dark-scaled on anterior and dorsal surfaces except for large apical silvery patch, ventral and posterior surfaces largely light-scaled, dark distally toward dorsal surface; hindfemur dark-scaled dorsally and on upper portions of anterior and posterior surfaces, a large apical silvery patch; tibiae largely dark dorsally, paler ventrally except for hindleg and with conspicuous apical dorsal patch of silvery scales, sometimes some pale scales dorsally; tarsi largely dark-scaled, paler ventrally; both claws of all legs with large subbasal or premedian tooth. *Wing:* dorsal scales largely dark, a small patch of silvery or metallic beige scales at base of C; squame scales small; plume scales usually relatively short and broad; remigial bristles usually long and conspicuous; alula with a long marginal fringe of short hairs or hairlike scales. *Haltere:* knob largely dark-scaled. *Abdomen:* tergite I extensively dark-scaled; laterotergite with large patch of silvery or very pale beige metallic scales; tergites II-VII largely dark-scaled, with long basolateral whitish or pale beige patches, dorsal surfaces with variable basal transverse dingy pale bands sometimes indicated on III-VI, a rather large median basal dorsal pale dingy spot sometimes developed on VII; sternites largely pale-scaled, usually with dark apical bands. *Genitalia:* segment VIII incompletely retracted; cercus long, slender, exerted; only 1 large spermatheca.

MALE.—Essentially as in the female, differing chiefly in the following characters. *Head:* decumbent scales of vertex usually all pale. *Palpus:* 5-segmented; long, exceeding proboscis from more than full length to less than 0.5 of segment 5; segments 4 and 5 subequal; segment 5 without scales. *Antenna:* slightly shorter than proboscis. *Thorax: apn* scales usually broad; *ppn* scaling reduced. *Legs:* claws of foreleg and midleg enlarged, unequal, both members of pair with subbasal tooth. *Abdomen:* tergites with lateral pale markings reduced or absent; basal transverse tergal pale bands whitish or yellowish, usually well developed on III-VII; sternite VIII entirely silvery scaled.

MALE GENITALIA (fig. **297**).—As figured; diagnostic characters as in the key. *Segment VIII:* tergite distinctly widened distally, with several thickened bristles. *Segment IX:* tergite deeply and widely emarginate on caudal border; lateral tergal lobe wide and with 4–6 thin hairs; sternite with lateral longitudinal apodeme, a transverse line of about 4 hairs beyond middle. *Sidepiece:* relatively short; bristles and scales restricted to lateral and ventral surfaces; mesal portion of dorsal surface with short hairs from near base to near apex; mesal surface with narrow membrane from base to apex; no lobes of any kind. *Claspette:* not differentiated. *Clasper:* complex, irregular in shape, as figured; spiniform flattened; 3 smaller accessory spiniforms on lobe. *Phallosome:* aedeagus complex; broad at base; with several postmedian lateral curved spines. *Proctiger:* complex; basal lateral sclerotization expanded laterally, separated from paraproct; paraproct apparently arising from sternal sclerotization which extends laterad of aedeagus, apex produced into narrow slender process rounded apically; cercal setae not developed.

PUPA (fig. **297**).—*Abdomen:* 2.55 mm. *Trumpet:* 0.45 mm. *Paddle:* 0.85 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately and uniformly pigmented a bright yellowish brown; all hairs short; hair 8-C cephalad of trumpet level. *Trumpet:* uniformly pigmented a dark brown; integumentary sculpturing strong; tracheoid not developed. *Abdomen:* moderately and uniformly pigmented a bright yellowish brown; hair 3-I strongly caudad of 2-I; 1-II small; 2-II-VII more or less spiniform, far removed from caudal border on III-VII, where it is usually cephalad of hair 3; 5-IV-VI double or triple, usually as long as following tergite on IV,V. *Terminal Segments:* female cercus prominent. *Paddle:* uniformly lightly to moderately pigmented except for darker base, midrib, and external buttress; marginal spicules small, indistinct; hair 1-P short, branched beyond base.

LARVA (fig. **298**).—*Head:* 0.81 mm. *Siphon:* 1.39 mm. *Anal Saddle:* 0.33 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately to lightly pigmented except for lighter ocular areas and darkened postocular areas and collar; hairs moderately to strongly pigmented; mental plate as figured; inner mouthbrushes with attenuate tips; hairs 4-6-C far caudad of level of antennae; 4-C at or caudad of level of 5-C; 8-C small, multiple; 13-C far cephalad of 12-C. *Antenna:* long and slender; lightly pigmented, distal part usually darkened; spicules short and heavy; hair 1-A in basal half. *Thorax:* integumentary spiculation indistinct; hairs and tubercles strongly pigmented; hair 9-P short, branched. *Abdomen:* integumentary spiculation indistinct; hairs and tubercles strongly pigmented; hairs 6-I,II,7-I heavy, moderately long; 6-III small; 6-IV-VI very small, branched; 13-III-V very small, branched. *Segment VIII:* comb in a patch of about 16–22 or more short fringed scales; hairs 1,2-VIII on common basal plate; 3-VIII short, with numerous branches. *Siphon:* index about 4.0–4.5; distinctly narrowed apically; moderately to strongly pigmented, darkened on basal ring and apically, where integumentary sculpturing is distinct; acus strongly developed; pecten restricted to basal half, usually with about 14–18 teeth, the distal 1–3 enlarged and widely spaced, the proximal smaller and close-set, all with 2 or more basal denticles; hair 1-S far distad of pecten, small. *Anal Segment:* saddle incomplete; with strong acus; moderately pigmented, darkened at base and dorsally; integumentary sculpturing slight; marginal spicules small, distinct only dorsad of hair 1; hair 1-X small, branched, removed from caudal margin; 2-X short, multiple; 3-X long and single; ventral brush with 6 pairs of hairs, 1 member of the proximal pair sometimes removed from grid; gills long, slender, tapered.

MATERIAL EXAMINED.—342 specimens; 79♀; 82♂; 68 pupae; 113 larvae; 15 individual larval rearings.

SYSTEMATICS.—*A. alboscutellatus* as currently interpreted is a very widespread and variable species. Although the adults from all the areas appear to conform to a clearly recognizable type, there is a great deal of variation in ornamentation, and the male genitalia of the various known populations show slight differences in the clasper. It is possible that 2 or more species are confused under *alboscutellatus,* but it seems more likely that only 1 variable species is involved and that it may have a tendency to form local races. Since the samples of the various populations are very small and immature stages are very poorly known, this problem cannot be resolved at present.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *alboscutellatus* are rarely collected. In the Solomons they have been found in flooded swamp areas, woodland pools, and rockholes and potholes in a stream bed. Females have been collected biting in the daytime in forested areas, but were never abundant in the Solomons.

Nothing is known of the disease relations of *alboscutellatus*.

DISTRIBUTION (figs. **295, 296**).—*Solomon Islands:* Bougainville; New Georgia; Roviana; Guadalcanal. Also reported from *New Britain, Emirau, Admiralty Islands, New Guinea, Australia, Japan, Philippines, Borneo, Ceram, Java, Sumatra, Malaya, Thailand, Assam, Burma, India,* and *Ceylon.*

2. Aedes (Aedimorphus) nocturnus (Theobald)

Figs. **295, 296, 299, 300**

1903. *Culex nocturnus* Theobald, Monog. Culicidae 3:159–160. *TYPES: syntypes, 2 ♀, marked as types by Theobald, Ba, Fiji, Apr.-June, Hall (BMNH).

1913. *Culex nocturnus niger* Theobald *in* Sarasin and Roux, Nova Caledonia A. Zool. 1(3):163–164. TYPE: holotype ♀ (?), Canala, New Caledonia, Sarasin and Roux (BASEL).—Synonymy with *vexans* by Edwards (1924:372, questionable; 1932:171), with *nocturnus* by Edwards (1922*a*:99).

Aedes (*Aedimorphus*) *vexans nocturnus* of Bohart and Ingram (1946:15–17); Knight and Hull (1953:460–463); Iyengar (1955:30); Laird (1956); Rageau (1958*b*:3–4); Stone, Knight, and Starcke (1959).

Aedes (*Aedimorphus*) *vexans* var. *nocturnus* of Rageau (1958*a*:877); Rageau and Vervent (1958:16).

Aedes (*Aedimorphus*) *vexans* of Edwards (1924:372; 1932:170–171, in part); Buxton and Hopkins (1927:91–95); Taylor (1934:20); Paine (1935, 1943:22–23); Lee (1944*a*:72); Knight, Bohart, and Bohart (1944:35, 36); Perry (1946:16–17).

Aedes (*Ochlerotatus*) *vigilax* in part of Edwards (1922*a*:99).

Ochlerotatus vexans of Edwards (1917:218, in part); O'Connor (1923).

Culex nocturnus of Bahr (1912); Jepson (1915).

FEMALE.—*Wing:* 3.67 mm. *Proboscis:* 2.17 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 3.08 mm. Extremely variable in ornamentation of vertex, proboscis, thorax, legs, and wings; superficially very similar to *vigilax*, from which it can readily be distinguished by the presence of a patch of *ssp* scales against *stp*. *Head:* eyes narrowly separated above antennae; decumbent scales of vertex narrow except for patch of broad scales laterally, largely pale except for small median patch of bronzy scales in front; orbital line with narrow pale scales continued on frons to lower end of eyes; lateral broad scales dark; erect scales rather short, numerous, extending to orbital bristles, usually light in front, dark caudally and laterally; sides with broad scales, largely pale; clypeus bare; labium extremely variable in scale coloration but always with some pale scales ventrally near middle, usually with a very wide incomplete median pale band extending to dorsal surface but margins of pale area not sharply defined dorsally; palpus about 0.2 of proboscis, dark-scaled, with variable number of pale scales at base of segments and on apex, 4-segmented, no indication of segment 5; antenna distinctly longer than proboscis; torus with rather numerous small broad pale scales in addition to hairs; flagellar segment 1 with a few small broad pale scales. *Thorax:* integument reddish brown to light brown; mesonotum with rather dense vestiture of narrow curved scales, extremely variable in color, from dark bronzy to whitish, without distinct pattern, pale scales predominantly lateral and caudal; acrostichal and dorsocentral rows complete, bristles moderate; scutellum with rather long narrow curved pale scales; paratergite with variable number of broad pale scales, chiefly on lower surface; *apn* with narrow pale scales; *ppn* with extensive upper area of narrow curved scales, the upper dark, the lower pale and somewhat broadened; *ppl* with whitish or dingy pale elongate broad scales extending to *acx; psp* with variable patch of broad whitish scales; *ssp* with broad pale scales usually in 2 separate patches, an elongate one along *stp* and a small one above; *stp* with a large upper and a smaller caudal patch of broad whitish scales; *pra* usually with a few erect broad whitish scales among bristles but without lower patch of flat scales; *mep* with large patch of broad whitish scales in upper anterior portion; scales absent from other pleural sclerites; lower *mep* bristles not developed. *Legs:* forecoxa with pale scales at base and apex, a variable number of dark scales in between; midcoxa with pale scales at base, dark apically; hindcoxa with pale scales; trochanters largely with pale scales; femora extremely variable, always pale at base and apex, ventral and posterior surfaces pale, anterior surface from largely dark to very strongly speckled with light scales; tibiae variable in coloration, pale at base and apex, dark on dorsal and pale on ventral surfaces except on hindleg, frequently with extensive pale speckling or even pale lines; tarsi with variable basal white rings or dorsal white patches, usually on all segments of hindleg, usually confined to segments 1–3 on foreleg and midleg or even further reduced; both claws of foreleg and midleg with large subbasal tooth, hind claws simple. *Wing:* dorsal scaling extremely variable in coloration; from all dark to extensively speckled with light scales; squame scales small; plume scales long, linear; usually 1 conspicuous remigial bristle; alula with long marginal fringe of short slender scales. *Haltere:* knob pale-scaled above, dark below. *Abdomen:* tergite I moderately scaled, scales all dark except sometimes a few pale in middle proximally, hairs long and numerous; laterotergite with large patch of pure white scales; tergites II-VII predominantly dark-scaled, with long lateral patches of white or whitish scales, basal on II, progressively removed from base on distal segments; dorsum of tergites II-VI with variable transverse basal whitish bands, widened in middle on II, and laterally on more distal segments, not joined to lateral pale markings; apex of distal tergites sometimes with pale scales; sternites II-VII largely with pale scales. *Genitalia:* segment VIII largely retracted, except for apex of sternite, without scales; cercus long but rather broad, without scales; 1 large and 2 small spermathecae.

MALE.—Essentially as in the female, differing chiefly in the following characters. *Head:* eyes more widely separated; usually no dark narrow scales on vertex. *Palpus:* from barely reaching apex of proboscis to exceeding it by full length of segment 5, dark-scaled except for variable basal white bands on segments 2–4; segments 4 and 5 subequal; segment 5 with only a few scales at base dorsally. *Antenna:* slightly shorter than proboscis. *Thorax: apn* scales broadened; other pleural scaling reduced; *ppl* scales not extending on *acx*. *Legs:* claws of foreleg and midleg enlarged, unequal, both members of pair with subbasal tooth. *Abdomen:* tergites without separate lateral pale patches; transverse basal pale bands strongly widened laterally on distal segments; sternite VIII with large lateral pale patches.

MALE GENITALIA (fig. 299).—As figured; diagnostic characters as in the key. *Segment VIII:* tergite distinctly widened distally, with several thickened bristles. *Segment IX:* tergite strongly constricted in middle; tergal lobe poorly defined, with 4–7 thin hairs; sternite with lateral longitudinal sclerotization, a row of about 4 hairs beyond middle. *Sidepiece:* elongate; bristles and scales restricted to lateral surfaces and lateral portions of dorsal and ventral surfaces; mesal portion of dorsal surface with short hairs from near base to near apex; mesal surface with wide membrane from base to apex; no distinct lobes. *Claspette:* distinctly developed as a separate sternomesal sclerotization with numerous hairs apically; tergal and mesal hairs longer and more slender than the thickened sternal. *Clasper:* as figured; spiniform elongate, arising from subapical inner process. *Phallosome:* aedeagus small, complex, broadened subbasally, about 4 postmedian to apical curved spines on each side; ventral paramere long. *Proctiger:* basal lateral sclerotization strong, separated from paraproct sclerotization which has a sternal process; apex of paraproct with poorly sclerotized short dorsal tooth; cercal setae not developed.

PUPA (fig. 299).—*Abdomen:* 2.85 mm. *Trumpet:* 0.51 mm. *Paddle:* 0.89 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly to moderately unevenly pigmented, darkened dorsally and on appendage cases; hair 8-C cephalad of trumpet level. *Trumpet:* uniformly strongly pigmented; integumentary sculpturing distinct; tracheoid slightly indicated at base. *Abdomen:* lightly pigmented, darkened on intersegmental areas; sternite II distinctly spiculate in middle of caudal border; hair 3-I laterad of 2, not strongly caudad; 1-II rather large; 2-II-VII poorly developed, not spiniform, near caudal border on III-VII, usually markedly caudad of hair 3; 5-IV-VI single or double, usually shorter than following tergite. *Terminal Segments:* female cercus prominent. *Paddle:* uniformly lightly pigmented except for slightly darker base, midrib, and external buttress; marginal spicules variable, usually indistinct; hair 1-P moderately developed, usually single.

LARVA (fig. 300).—*Head:* 0.87 mm. *Siphon:* 1.1 mm. *Anal Saddle:* 0.38 mm. Chaetotaxy as figured; diagnostic characters as in the key; variable, particularly in siphon index and comb scales. *Head:* moderately pigmented, lighter on ocular areas, darkened on postocular and on collar; hairs moderately to strongly pigmented; mental plate as figured; inner mouthbrushes strongly pectinate apically; hairs 4,6-C at about level of antennal base, 4-C sometimes a little cephalad or caudad of 6-C; 5,6-C usually both single and long, 5-C considerably caudad and mesad of 6-C; 8-C single, moderately long; 13-C single, near 12. *Antenna:* rather short; variable in pigmentation, distal part darkened; spicules short and heavy; hair 1-A in basal half. *Thorax:* integumentary spiculation indistinct; hairs and tubercles strongly pigmented; hair 9-P single. *Abdomen:* spiculation, hairs and tubercles as on thorax; hairs 6-I-VI, 7-I all heavy, moderately long; 13-III-V single. *Segment VIII:* comb extremely variable, usually in a partial double row, sometimes a single irregular row of 6–12 scales fringed at base and with long apical spine; hairs 1,2-VIII on common basal plate; 3-VIII well developed. *Siphon:* index variable, usually about 3.0–3.5; not markedly narrowed apically; moderately to strongly pigmented, darkened on basal ring; spiculation uniform, distinct; acus strongly developed; pecten usually restricted to basal half, usually with 12–18 teeth, the distal 2 or more enlarged and widely spaced, the more proximal smaller, close-set, all usually with 1 or more basal denticles, most distal often simple; hair 1-S moderate in size, variable in position distad of pecten. *Anal Segment:* saddle narrowly incomplete; with strong acus; moderately pigmented, darkened at base and dorsoapically, integumentary sculpturing distinct; marginal spicules small, not developed dorsally; hair 1-X single, near caudal margin; 2-X moderate, multiple; 3-X long, single; ventral brush with 6,7 pairs of hairs on grid and 2–4 unpaired hairs proximad, total hairs usually 16; gills long, slender, tapered.

MATERIAL EXAMINED.—1,191 specimens; 275 ♀; 109 ♂; 65 pupae; 742 larvae; 6 individual larval rearings.

SYSTEMATICS.—The taxonomic status of *nocturnus* is very uncertain, and its clarification must await a thorough study of the *vexans* complex, which is widely distributed throughout the major zoögeographic regions except in the Malagasy, Ethiopian, and Neotropical. In the past the South Pacific populations have been regarded as *vexans* or as the subspecies *nocturnus* of *vexans*. For the present I am regarding them as members of a distinct species, although the differences from typical *vexans* appear to be confined to the branching of head hairs 5 and 6 of the larva.

Every South Pacific population of *nocturnus* I have examined is strikingly different from all the others in overall adult ornamentation, but there is usually a great deal of variation within each population in these characters. In general it appears that they fall into 2 groups: (1) the eastern populations from Fiji, Samoa, Tonga, Ellice, and Gilbert Islands and (2) the western populations from the New Hebrides, New Caledonia, and the Loyalties. The typical *nocturnus* from Fiji is usually very extensively marked with pale scales on the legs and wings and on the labium of the female, but the other eastern populations are variable in this respect. The western populations are uniformly dark, darker than some populations of *vexans* from North America. It is possible that the 2 groups of populations are of different age in origin, and it may be significant that none are found in the Solomons. However, it is possible that *nocturnus* is merely 1 or more introduced strains of *vexans*. For the present I am considering *nocturnus* to be indigenous to the South Pacific.

Populations of the *vexans* complex with larval head hairs in general similar to those of South Pacific *nocturnus* have been reported from elsewhere in the Pacific basin (see below under Distribution). Their relationships cannot be determined satisfactorily with the material available at present.

A. nocturnus is superficially very similar to *A.* (*O.*) *vigilax*, with which it is often confused; it can easily be differentiated from the latter by the absence of a large patch of scales below the *pra* bristles and by the presence of *ssp* scales.

BIONOMICS AND DISEASE RELATIONS.—Very little specific information is available on the bionomics of South Pacific *nocturnus* (Paine, 1943:22; Perry, 1946:16–17; Laird, 1956). The immature stages are found chiefly in temporary grassy ground pools, puddles, and hoofmarks or in ponds and ditches following rains. Females attack man readily in the neighborhood of breeding sites and may at times become serious nocturnal pests in settlements following heavy rains. The bite is said to be very irritating. Nothing is known of the disease relations of *nocturnus*.

DISTRIBUTION (figs. **295**, **296**).—*New Hebrides:* Espiritu Santo; Emae; Efate; Futuna; Aneityum. *Loyalty Islands:* Ouvea; Mare. *New Caledonia:* Art (Belep); widely distributed on main island; Ile des Pins. *Gilbert Islands:* Tarawa. *Ellice Islands:* Nui; Funafuti. *Rotuma Island. Fiji:* Taveuni; Viti Levu; Vanua Levu; Makongai; Kandavu. *Wallis Islands:* Uea. *Tonga:* Niuafoou; Niuatabutabu; Tongatabu. *Samoa:* Savaii; Upolu; Tutuila. *Tokalau Islands* (Laird, 1959). *Northern Cook Islands:* Danger group. *Southern Cook Islands:* ? Rarotonga. Reported also from *New Guinea, Indonesia, Philippines, Palau, Marianas, Carolines,* and *Marshall Islands.*

Subgenus LORRAINEA Belkin, n. subg.

TYPE SPECIES.—**Aedes* (*Skusea*) *dasyorrhus* King & Hoogstraal, 1946, New Guinea. INCLUDED SPECIES.—**A.* (*L.*) *amesii* (Ludlow, 1903), Philippines; **A.* (*L.*) *dasyorrhus;* **A.* (*L.*) *fumidus* Edwards, 1938, Singapore; *Aedes* (*L.*) *furvus* Edwards, 1928, Malaya (= **fuscus* Leicester, 1908); *Aedes* (*L.*) *celebicus* Mattingly, 1959, Kabaena; **Aedes* (*L.*) *lamelliferus* Bohart & Ingram, 1946, Caroline Islands.—This subgenus is dedicated to my wife, Lorraine.

Aedes (*Skusea*) in part of Edwards (1932:158); Mattingly (1959:19–33); Stone, Knight, and Starcke (1959); and authors.

FEMALES.—*Head:* eyes apparently contiguous above antennae; no frontal scales; all decumbent scales very broad; erect scales restricted to occiput; palpus about 0.2 of proboscis, 5-segmented, segment 5 very small, hidden in scales; antenna longer than proboscis. *Thorax:* mesonotum with narrow dark scales; acrostichals and dorsocentrals present; scutellum with broad scales; paratergite broad, without scales or hairs. *Legs:* tarsi dark-scaled; claws all simple. *Wing:* remigium without distinct bristles; alula with broad scales. *Abdomen:* tergite I and laterotergite almost completely covered with scales. *Genitalia:* segment VIII apparently largely retractile; cercus short, broad; 3 spermathecae.

MALES.—Essentially as in the females. *Palpus:* from 0.75 of to slightly longer than proboscis; 5-segmented, segments 4 and 5 subequal, slender, and with at most a few hairs. *Antenna:* shorter than proboscis; flagellar whorls long and dense; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg and midleg enlarged, larger member of each pair simple, smaller apparently with small basal tooth (Knight and Hull, 1952:158–159).

MALE GENITALIA.—Short, deeply retracted. *Segment VIII:* short; normal in width. *Segment IX:* tergite poorly developed, without lobes or hairs; sternite with patch of hairs. *Sidepiece:* complex; a conspicuous basal sternal lobe with apical spiniforms; additional sternal and tergal lobes may be present; mesal surface more or less membranous. *Claspette:* strongly developed; complex. *Clasper:* rather short, simple, with scales and long hairs; spiniform apical, long. *Phallosome:* aedeagus simple, without teeth, apex produced in middle. *Proctiger:* strongly developed; paraproct spine with sharp caudal angle; cercal setae not developed.

PUPAE.—*Cephalothorax:* hair 1-C long; 2,3-C widely separated, 2-C short, 3-C long; 8-C behind level of trumpet. *Abdomen:* hairs 2,3-I approximated; 1-II near midline; 1-III-VII strongly displaced laterad; 2-III-VII distinctly mesad of hair 1, near caudal border; 9-VI small, lateral, similar to 9-II-V. *Terminal Segments:* female cercus projecting slightly. *Paddle:* external and internal margins with fringe of very long hairlike spicules.

LARVAE.—*Head:* collar very poorly developed; maxillary sutures widely separated, divergent caudally; labial plate very short; inner mouthbrushes thickened, strongly pectinate apically; hairs 4,6,7-C cephalad of antennal base; 4-C cephalad of 6-C, strongly developed, multiple. *Antenna:* short, simple, without spicules; hair 1-A single, postmedian. *Thorax:* essentially as in *Stegomyia. Abdomen:* essentially as in *Stegomyia;* hair 12-I absent; 6-I-VI strongly developed, long and usually all branched; 2-III-VII strongly mesad of hair 1. *Segment VIII:* comb in a large patch of small fringed spatulate scales; hair 4-VIII close to hair 3. *Siphon:* relatively short, incomplete at base ventrally; acus absent; pecten teeth fringed; hair 1-S long, single; valves short; trachea well developed. *Anal Segment:* saddle incomplete, very small; acus not developed; marginal spicules not developed; hair 1-X long; 2-X multiple; 3-X single; ventral brush with 5 pairs of hairs all on poorly developed grid; gills varied.

SYSTEMATICS.—The species included in *Lorrainea* were formerly placed in *Skusea,* whose type species is *pembaensis* Theobald, 1901 from East Africa and Madagascar. I find very little in common between the 2 groups other than superficial characters of the scaling of the head and scutellum of the adults. *Lorrainea* shows affinities with *Stegomyia* but differs rather markedly in all stages, as indicated in the diagnosis. Particularly striking is the different type of aedeagus in the male.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *Lorrainea* are apparently confined to water collections in plants; they have also been found in artificial containers. These habitats are in sharp contrast to the crabholes used by *pembaensis.* Nothing is known of the adult bionomics or their disease relations.

DISTRIBUTION (fig. **301**).—Species of *Lorrainea* have been reported from New Guinea, Philippines, Indonesia, Malaya, Micronesia, and the Solomons.

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Aedes (Lorrainea) dasyorrhus King & Hoogstraal

Figs. **301-303**

1946. *Aedes* (*Skusea*) *dasyorrhus* King and Hoogstraal, Ent. Soc. Wash., Proc. 48:100–106. *TYPE: holotype ♂ with genitalia mount (660A), Cape Tjeweri, Jatufa Bay, Hollandia, New Guinea, from can at edge of mangrove swamp, Feb. 4, 1945, W. V. King (USNM, 58006).

Aedes (*Skusea*) *dasyorrhus* of Iyengar (1955:28); Mattingly (1959:25); Stone, Knight, and Starcke (1959).
Aedes (*Skusea*) *amesi* of Edwards (1926:110).

FEMALE.—*Wing:* 2.58 mm. *Proboscis:* 1.58 mm. *Forefemur:* 1.58 mm. *Abdomen:* about 2.1 mm. *Head:* all decumbent scales very broad, very densely imbricate, dark except for lateral patch of whitish scales; erect scales very short, broad, restricted to occiput; labium dark-scaled, with conspicuous short hairs; palpus about 0.20 of proboscis, dark-scaled; antenna distinctly longer than proboscis; torus apparently with a few small broad dark scales and hairs; flagellar segment 1 with a few inconspicuous broad dark scales; flagellar whorl bristles long. *Thorax:* integument dark brown; mesonotum densely covered with narrow dark brown or bronzy scales, linear on disc, lanceolate on sides; caudal portion of prescutellar area with patch of large broad scales similar to those on scutellum but slender; a few broad whitish or pale outstanding scales above paratergite; mesonotal bristles long and heavy, very conspicuous, acrostichals developed only about halfway to prescutellar area; scutellum with long broad dark bronzy iridescent scales, densely imbricate on all lobes; paratergite bare; *apn* with a few dingy white broad outstanding scales; *ppn* with long narrow upper patch of small broad scales, majority dark, sometimes a few whitish, bristles usually 4; *ppl* with patch of broad silvery white scales; *psp* and *pra* without scales, rarely 1,2 light scales among *pra* bristles; *stp* with more or less continuous large patch of broad silvery white scales in upper portion and along posterior margin, sometimes patch divided; *mep* with small upper patch of silvery white broad scales, lower *mep* bristles absent. *Legs:* coxae largely with silvery white scales; trochanters pale to silvery; remainder of legs dark-scaled, with strong iridescent purplish to bluish reflections; femora with usual pale area below and behind; claws all simple. *Wing:* dorsal wing scales all dark; plume scales rather short, not markedly outstanding; remigium without bristles; alula with a patch of short, rather broad scales on margin and dorsally. *Haltere:* knob dark-scaled above, lighter below. *Abdomen:* tergites largely dark-scaled, with strong purplish to bluish green iridescence; tergite I almost completely and densely imbricate with dark scales; laterotergite completely covered with silvery white scales; tergite II with small silvery white basolateral scale patch; tergites III-VI entirely dark-scaled or with very small patch of pale scales basolaterally; proximal sternites with some pale or whitish scales at base, distal largely dark-scaled. *Genitalia:* segment VIII apparently completely retractile; cercus large and very broad.

MALE.—Essentially as in the female. *Palpus:* about 0.8–0.9 of proboscis; without conspicuous bristles except 3 on apex of segment 5. *Antenna:* distinctly shorter than proboscis. *Legs:* claws of foreleg and midleg enlarged, all simple. *Abdomen:* tergites with conspicuous basolateral silvery white spots on II-VII; basal sternites largely light-scaled.

MALE GENITALIA (fig. **302**).—As figured; diagnostic characters as in the key; short, deeply retracted. *Segment VIII:* short; normal. *Segment IX:* poorly developed; tergite without lobes or bristles, very narrow; sternite with conspicuous broad lateral sclerotization supporting sidepiece, a patch of 9,10 bristles in the middle. *Sidepiece:* rather short, with conspicuous complex claspette and with apical, mesal, and basal sternal lobes; scales and long hairs largely restricted to lateral and ventral surfaces; middle of dorsal surface with long membranous area, tergomesal border sclerotized as a narrow bar bearing about 2 rows of long hairs or bristles;

mesal surface membranous to beyond middle where a conspicuous hairy lobe projects dorsomesad; mesal apical angle produced, with a small knoblike tergomesal lobe with hairs and a larger sternomesal process bearing about 5 flattened curved bristles; inner basal sternal angle produced into a caudomesal process bearing 2 very long flattened modified setae. *Claspette:* a complex large structure, quite independent of other lobes described above; with a tergal, outwardly directed lobe with short hairs at base on caudal surface and more or less distinct distal fingerlike process bearing 2 or more long bristles; main body of claspette with small poorly sclerotized mesal long-spiculate process, a strongly sclerotized sternomesal process, and a central part where all join; sternomesal portion bears a long flattened specialized seta, the central portion 3 shorter flattened specialized setae and 3 short heavy bristles more mesally. *Clasper:* very short and broad, with dense covering of broad, striated scales on outer and ventral surfaces and several long hairs; spiniform about as long as body of clasper, slender at base and with conspicuous subapical dorsal flattened process. *Phallosome:* aedeagus simple, constricted near base, conspicuously widened in distal half, apex rounded and with conspicuous sharp median projection. *Proctiger:* very strongly developed; basolateral sclerotization very prominent; dorsal spine of paraproct with a sharp caudal angle; cercal setae not developed.

PUPA (fig. 302).—*Abdomen:* 2.67 mm. *Trumpet:* 0.36 mm. *Paddle:* 0.55 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* dorsal surface and wing cases strongly pigmented, remainder lightly; hairs 1,3-C strongly developed. *Trumpet:* uniformly moderately pigmented. *Abdomen:* lightly pigmented, anterior tergites darkened; hair 1-III-VI strongly displaced laterad, weak; 2-III-VII strongly displace mesad, near caudal border of tergite. *Paddle:* lightly pigmented except for darkened midrib; very long fine hairlike spicules on outer and inner margins; hair 1-P strongly developed.

LARVA (fig. 303).—*Head:* 0.95 mm. *Siphon:* 0.65 mm. *Anal Saddle:* 0.21 mm. Chaetotaxy as figured, hairs and tubercles moderately to strongly pigmented; diagnostic characters as in the key; in general quite similar to species of *Stegomyia* but comb scales in large patch. *Head:* foramen magnum very wide, collar indistinct; moderately pigmented, lighter on ocular areas, darker around foramen magnum; spiculation not apparent; mental plate as figured; inner mouthbrushes pectinate; hair 4-C anterior, multiple. *Antenna:* short; uniformly pigmented; without spicules; hair 1-A single, inserted in distal half. *Thorax* and *Abdomen:* no distinct spiculation; hair 13-III-V usually long and single. *Segment VIII:* comb of very numerous poorly pigmented scales in a large patch; individual scale with long slender basal part and spatulate, distally fringed apex. *Siphon:* short, index about 2.25–2.5; no acus; strongly pigmented except for lighter broad apical ring; integumentary sculpturing indistinct; about 8–12 pecten teeth in basal half, teeth rather evenly spaced, long and narrow, very finely fringed on proximal edge; hair 1-S long, distad of pecten. *Anal Segment:* saddle very small, darkly pigmented, with imbricate sculpturing but no marginal spicules; hair 1-X on edge of saddle, single to triple, long; ventral brush with 5 pairs of hairs on a grid without longitudinal bars; "gills bulbous, dorsal pair about as long as saddle, ventral pair not so wide and about three-fourths as long" (King and Hoogstraal).

MATERIAL EXAMINED.—27 specimens; 15♀; 11♂; 2 pupae (New Guinea); 5 larvae; no individual rearings.

SYSTEMATICS.—The specimens from the Solomons are referred only provisionally to *dasyorrhus*, which was described from New Guinea. The male genitalia are very similar but there are some minor differences; the larvae also appear to differ in details of chaetotaxy. However, there is a great deal of variation in both populations, and the samples are too small to evaluate the differences. The females from the Solomons appear to lack the lateral tergal abdominal light spots on III-VII which are clearly evident in New Guinea specimens. It is very probable that only 1 species is involved and that the differences noted are individual variations associated with different larval habitats.

As pointed out by King and Hoogstraal (1946*b*:106), the nearest known relative of *dasyorrhus* is *amesii* (Ludlow, 1903) from the Philippines and possibly Malaya (Hoogstraal and Chamberlain, 1946).

BIONOMICS AND DISEASE RELATIONS.—The natural breeding sites of *dasyorrhus* appear to be holes in horizontal tree trunks projecting out into or over ocean waters (Bick, 1951:410; Franclemont, field notes, 36). The water in the holes is salty and obviously receives salt water spray. Other collections have been made in tin cans in mangrove areas (King and Hoogstraal, 1946*b*:104) and in tires by a dock (C. O. Berg, field notes, 108). This species appears to tolerate a high degree of salinity and to utilize artificial containers; this may account for its wide distribution. Nothing is known of the bionomics of the adults or their disease relations.

DISTRIBUTION (fig. 301).—*Solomon Islands:* New Georgia; Florida. Also reported from *New Guinea* (Hollandia, Milne Bay) and *Schouten Islands* (Boak).

Subgenus CHRISTOPHERSIOMYIA Barraud

1923. *Christophersiomyia* Barraud, Indian J. Med. Res. 10:786–787. *TYPE SPECIES: *Stegomyia thomsoni* Theobald, 1905, N. W. Provinces, India; original designation.

FEMALES.—Ornate; in general appearance combining features of *Finlaya* and *Stegomyia. Head:* eyes contiguous (*chionodes*) or narrowly separated above antennae; decumbent scales all broad and flat; erect scales restricted to occiput; clypeus bare; proboscis straight, moderately slender, about length of forefemur, with a postmedian complete or incomplete white-scaled ring; palpus about 0.25–0.3 of proboscis length, apparently 4-segmented, segment 4 short, antenna distinctly longer than proboscis. *Thorax:* scutellum with broad flat scales; *apn* predominantly with long narrow curved scales, some broadened; paratergite with scales; *pra* with scales; acrostichals and dorsocentrals all absent; lower *mep* bristles present, usually 1–4. *Legs:* both claws of all legs with small subbasal tooth. *Abdomen:* laterotergite completely scaled. *Genitalia:* not studied in detail; segment VIII completely retracted; cercus rather short and broad but projecting.

MALES.—Essentially similar to the females. *Palpus:* same length and apparently segmentation as in the females. *Antenna:* flagellar whorls with numerous long bristles extending chiefly dorsally and ventrally; flagellar segments 12 and 13 elongate. *Legs:* claws very similar to those of females, only slightly longer but subequal on foreleg and midleg.

MALE GENITALIA.—*Segment IX:* tergite long, shallowly emarginate in the middle of caudal border to form a pair of short lateral tergal lobes bearing a group of short setae. *Sidepiece:* simple; without lobes other than poorly developed claspette; mesal surface with membrane; scales restricted to dorsolateral, lateral, and ventral surfaces. *Claspette:* poorly developed as a relatively small sternomesal lobe bearing rather numerous simple bristles. *Clasper:* simple; with a few simple subapical setae; spiniform simple, rather long. *Phallosome:* aedeagus simple, usually without conspicuous denticles or spicules, more or less swollen distally in tergal aspect. *Proctiger:* poorly sclerotized except for paraproct which ends in a single heavy spine; cercal setae not developed.

PUPAE (Peters *in* Peters and Dewar, 1956:40–42).—Known only for *annulirostris, gombakensis,* and *thomsoni;* not seen; said to be similar to *Stegomyia* but with hair 1-C long and single or double, hair 7-C very long and single, and paddle rounded apically and without long fringe.

LARVAE.—Known only for *annulirostris, gombakensis,* and *thomsoni;* only *annulirostris* (?) seen; in general very similar to *Stegomyia. Head:* labrum extremely short, indistinct; mouthbrushes normal; aulaeum normal; mental plate well developed; hair 1-C very long and slender; 4-6-C caudad of level of antennal base; 5,6-C long and branched; 5-C multiple; 6-C usually double; 4-C short, multiple, and cephalad of 6-C. *Antenna:* long, usually at least 0.67 of head length; shaft distinctly but sparsely spiculate; hair 1-A near middle of shaft, usually triple and with main shaft stronger. *Thorax:* hair 6-M branched. *Abdomen:* hair 12-I absent. *Segment VIII:* comb scales in a single, free, more or less regular row, individual scale with large apical spine and fine basal fringes; hair 2-VIII distant from 1-VIII. *Siphon:* short to moderate; index 2.0–4.0; acus absent or small and detached; pecten varied, distal teeth usually somewhat more widely spaced; no accessory siphonal hairs. *Anal Segment:* saddle incomplete; caudal margin of saddle without spicules; hair 1-X well developed; 2-X usually double; 3-X single; ventral brush with 4 pairs of hairs (4-X), usually unevenly paired and without basal grid or boss; gills long.

SYSTEMATICS.—*Christophersiomyia* is known at present by 6 species: *annulirostris* (Theobald, 1905), *ibis* Barraud, 1931, and *thomsoni* (Theobald, 1905) from the eastern Oriental region including Ceylon, *brayi* Knight, 1947 from Luzon, Philippines, *gombakensis* Mattingly, 1959 from Malaya, and the new species *chionodes,* from Bougainville. The subgenus shows the strongest affinities with *Stegomyia* but is easily separated from it by the features mentioned in the diagnosis, particularly by the short palpus and the relatively simple aedeagus of the male, which however may have a few inconspicuous denticles.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *Christophersiomyia* have been collected in treeholes (*thomsoni*), treeholes and water butts (*annulirostris*), and a stream rock pool (*brayi*). Adults of *gombakensis* have been taken biting, but nothing is known of the bionomics and disease relations of the adults of the other species.

DISTRIBUTION (fig. 304).—*Christophersiomyia* is known only from Ceylon, India, Malaya, Luzon in the Philippines, and Bougainville in the Solomons.

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Aedes (Christophersiomyia) chionodes Belkin, n. sp.

Figs. 304, 305

TYPES.—*Holotype:* ♂ with genitalia slide (590601-2), Torokina, Bougainville, Solomon Islands, April 1945, F. N. Ratcliffe (SYDN). *Allotype:* ♀, same data as holotype (SYDN). *Paratypes:* 1♀, same data as holotype; 1♀, same data as holotype except collected May, 1945.—The specific name refers to the snow-white scaling of the thorax.

FEMALE.—*Wing:* 3.1 mm. *Proboscis:* 2.0 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 2.7 mm. *Head:* decumbent scales all snow-white except for a large patch of dark scales laterally on each side at about level of upper part of *apn* and a smaller indistinct patch of dingy scales below it at about level of lower part of *apn;* erect scales pale beige in the middle, dark laterally; labium with an incomplete postmedian ring of snowy white scales, sharply defined ventrally and laterally but divided longitudinally by a narrow streak of dark scales dorsally, length of ring about 0.15–0.18 of labium length, a very small apical midventral triangular patch of white scales; palpus dark-scaled; antennal torus with large patch of broad dark beige scales; flagellar segment 1 with rather large patch of broad scales, predominantly pale but some dark. *Thorax:* integument brown; a dense vestiture of snow-white scales throughout except for small areas in front of prescutellar space and on lateral scutellar lobes; mesonotal scales predominantly very long and narrow, some broader and curved and a patch of broad semierect scales in antealar space against supraalar bristles, all scales snow-white except for some dingy or dark narrow scales at about level of wing root from supraalar bristles to anterior prescutellars, extent of this dark patch cannot be determined as all specimens are partially denuded in this area but it appears to be small and irregular and may be divided in the middle; midlobe of scutellum with snow-white scales, lateral lobe predominantly with snow-white scales but with a variable number of dingy or dark scales laterally; paratergite with dense vestiture of small broad snow-white semierect scales; pleural scaling entirely snow-white, scales all broad except some on *apn* and on upper *ppn; apn* with broad flat scales on anterior face, narrow curved scales in the middle, broader curved scales posteriorly, and longer broader curved scales ventrally; *ppn* almost completely covered with scales, narrow above, broad below, and intermediate in the middle; *ppl* with large patch of scales extending to sides of *pst; acx* and *pcx* with a few scales; *psp* with a few scales caudad of bristles; *ssp* with a large scale patch connected to patches on lower *ppn* and upper *stp;* a large scale patch below *pra* bristles, continuous with patch on *mep* and sometimes upper *stp; stp* with a large upper patch of scales continuous with that of *ssp* and *mep* and sometimes *pra* and a large separate lower patch; *mep* with a very large scale patch from upper to lower bristles, extending to anterior margin throughout and usually prolonged ventrad behind lower *mep* bristles; prescutellar and supraalar bristles well developed; usually 2–4 lower *mep* bristles, at least 1 quite strong; usually only 1 weak upper *stp* bristle, posterior row also weak except for 2 heavy lower bristles, several small hairs between the 2 scale patches in front of posterior row of bristles. *Legs:* coxae with snow-white scales, interrupted by a patch of dark scales in the middle on forecoxa; trochanters with snow-white scales; forefemur predominantly dark-scaled but with a conspicuous whitish marking on posterior surface starting in basal 0.1, broad and extending to dorsal and ventral margins to about 0.5 and then continued as a narrow posteroventral streak to about 0.9; midfemur in general similar to forefemur but posterior white marking less extensive and a very conspicuous subapical dorsal white spot present; hindfemur predominantly with white scales from base, anterior surface with a narrow apical dark ring and a dorsal dark streak from about 0.65–0.7, this dark streak is continued as a dark band on posterior surface to ventral margin; all tibiae almost entirely dark-scaled, foretibia with a few scattered pale scales on posterior and ventral surfaces, hindtibia with a few pale scales apically on anterior surface; tarsi dark-scaled except for generally paler ventral surface and the following white or whitish markings, (1) a small basal dorsal spot on segment 1 of foretarsus, (2) a narrow basal ring on segment 1 and a narrower incomplete basal ring or basal dorsal patch on segment 2 of midtarsus, (3) distinct somewhat broader basal rings on segments 1–3 and a few dingy scales at base of segment 4 of hindtarsus. *Wing:* scales all dark except for small basal white patch on vein C; usually 1,2 inconspicuous remigial bristles; plical area without scales at base ventrally. *Haltere:* knob predominantly with dark scales at base, a few whitish scales below in front, distal part apparently with pale scales. *Abdomen:* tergite I with extensive area of dark scales; laterotergite densely covered with snow-white scales; tergites II-VI largely dark-scaled, with subapical lateral triangular patches of white scales, patches narrowed basad, reaching base of segment on II-IV, progressively smaller and more distant from base on V,VI; tergite VII with a narrow lateral border of white scales; tergites II-VII with basal median white markings not joined to lateral patches, usually only a few scales on II, progressively longer on III-VI, and occupying more than half the length of tergite on VII; sternites II-VI largely white-scaled and with progressively broader apical bands of dark scales; sternite VII largely dark-scaled and with few pale scales on distal margin in the middle.

MALE.—Essentially as in the female but much smaller; head and thorax without any dark or dingy scales; foretibia with dingy white indefinite streak on ventral surface; proboscis and part of head broken off in only known specimen.

MALE GENITALIA (fig. **305**).—As figured and as described for the subgenus; diagnostic characters as in the key; apparently distinguishable only by the claspette as figured; sternite IX with 2 setae; aedeagus without denticles.

PUPA and LARVA.—Unknown.

MATERIAL EXAMINED.—3 ♀, 1 ♂; no immature stages.

SYSTEMATICS.—*A. chionodes* is undoubtedly a member of the subgenus *Christophersiomyia.* The male genitalia are practically indistinguishable from *brayi* Knight, 1947 from the Philippines and, for that matter, from all the other known species of the subgenus except *gombakensis* Mattingly, 1959. However, the ornamentation of the proboscis and the legs is different from all the other species. The affinities of *chionodes* appear to be with *brayi* and *ibis* Barraud, 1931 from India (known from a single female). The presence of this form in the Solomons would appear to be most unusual, since the subgenus is not known from the Papuan and Australian regions. It is possible that species of *Christophersiomyia* have been overlooked in these areas, but I believe that this is another example of insular preservation of a form of a relict group, paralleling that of *robinsoni* and *tulagiensis* of the *edwardsi* group of *Stegomyia.*

BIONOMICS AND DISEASE RELATIONS.—No information other than that given for the type series is available for *chionodes.* In all probability, this species breeds in treeholes or possibly rockholes, as do other species of the subgenus.

DISTRIBUTION (fig. 304).—*Solomon Islands:* Bougainville. Not known elsewhere.

Subgenus STEGOMYIA Theobald

1901. *Stegomyia* Theobald, *in* Howard, Mosquitoes, pp. 234, 235, 236, June 1; J. Trop. Med. 4:235, July 15; Liverpool Sch. Trop. Med., Mem. 4, App., p. ii, Sept. TYPE SPECIES: *Culex aegypti* Linnaeus, 1762; an application to the International Commission on Zoological Nomenclature for suspension of the rules and validation of current taxonomic usage is being made by P. F. Mattingly; the problem is too complex to be reviewed here.

1904. *Scutomyia* Theobald, Entomologist 37:77. *TYPE SPECIES: *S. albolineata* Theobald, 1904, Malaya; monobasic.

1906. *Quasistegomyia* Theobald, Wellcome Res. Lab., Rpt. 2:69–70. *TYPE SPECIES: *Q. unilineata* Theobald, 1906, Sudan; monobasic.

1908. *Pseudostegomyia* Ludlow, Mosq. Philippine Islands, p. 10. *TYPE SPECIES: *Stegomyia gardnerii* Ludlow, 1905, Philippines; monobasic.—Apparently an error for *Quasistegomyia* Theobald, 1906 (see Theobald, 1910:135).

1925. *Catatassomyia* Dyar and Shannon, Insecutor Inscitiae Menstruus 13:71. *TYPE SPECIES: *C. meronephada* Dyar & Shannon, 1925, Philippines; monobasic.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Ornate, usually blackish with white markings on thorax and legs. *Head:* eyes almost touching or well separated above antennae, space sometimes with scales; decumbent scales usually all broad and flat; erect scales usually few and restricted to occiput; clypeus bare or with scales; proboscis usually about as long as forefemur; palpus short, 4-segmented, segment 4 usually with slight apical process, segments 1 and 2 ankylosed or segment 1 indistinct. *Thorax:* acrostichals usually absent; dorsocentrals usually few; scutellum usually with broad flat scales, usually largely white; *apn* usually with broad flat scales; paratergite usually scaled; lower *mep* bristles usually absent. *Legs:* claws of foreleg and midleg toothed or simple; those of hindleg usually simple. *Abdomen:* laterotergite always scaled. *Genitalia:* segment VIII largely retractile, somewhat compressed, sternite with conspicuous rounded lateral lobe; segment IX shield-shaped, shorter than cercus, with wide and deep caudal emargination; cercus broad and not very long, scaled; postgenital plate with rather shallow notch (Edwards, 1941:125).

MALES.—*Palpus:* variable, usually at least 0.6 of proboscis; segments 4 and 5 subequal, slender, upturned, and with only a few hairs. *Legs:* claws of foreleg and midleg usually unequal, one enlarged, simple or toothed.

MALE GENITALIA.—*Segment IX:* tergite variously developed, with or without bristles. *Sidepiece:* mesal membranous area sometimes developed, basal mesal lobe developed into more or less distinct claspette; usually no other lobes developed. *Claspette:* variously developed but never with a single apical seta or appendage. *Clasper:* usually simple; spiniform variable in position, often apical or subapical. *Phallosome:* aedeagus with distinct lateral sclerotized plates with numerous lateral teeth. *Proctiger:* paraproct without teeth; cercal setae not developed.

PUPAE.—Subgeneric characters not evident, see under groups; hair 8-C well behind level of trumpets, at least halfway from trumpet to posterior margin of mesonotum.

LARVAE.—*Head:* labrum and mouthbrushes normal; aulaeum normal; mental plate well developed; hairs 4-6-C far forward; 4,5-C always cephalad of antennal base; 5,6-C seldom strongly branched. *Antenna:* shaft usually without spicules. *Thorax:* hair 6-M branched. *Segment VIII:* comb scales usually in a single more or less regular row, rarely joined or with comb plate or with an additional row of scales; hair 2-VIII distant from 1-VIII. *Siphon:* usually short; acus absent or small; pecten teeth usually closely and evenly spaced, the distal frequently lighter in color; no accessory siphonal hairs. *Anal Segment:* saddle complete or incomplete; ventral brush of 4,5 pairs of hairs, all usually on a more or less developed grid or boss.

EGGS.—Usually thick-shelled, resistant to desiccation, and with diapause; laid singly usually above water surface on sides of container.

SYSTEMATICS.—*Stegomyia* is a rather compact, clearly marked subgenus but includes at present a number of annectent and aberrant forms which should be removed or segregated as distinct subgenera. Particularly disturbing is the inclusion of *vittatus* (Bigot, 1861), which has been considered a *Stegomyia* only on the basis of a few unimportant adult characters; on larval characters, however, it does not belong to the subgenus at all.

As in the other subgenera of *Aedes,* little progress has been made in the classification of *Stegomyia* since Edwards (1932:166–167) divided it into 4 groups. Knight and Rozeboom (1946:83) defined a fifth group for *albolineatus* and its relatives. Knight and Hurlbut (1949:26–27) subdivided the *scutellaris* group into 3 subgroups, and Knight and Hull (1952:166–167) summarized the characteristics of all the groups and subgroups. Mattingly (1952; 1953) has begun a revision of *Stegomyia* of the Ethiopian region.

In the following treatment I am recognizing 4 groups from the South Pacific, only 3 of which are indigenous: (1) the *aegypti* group, represented by the ubiquitous introduced *aegypti,* (2) the *albolineatus* group, represented by the indigenous nominate species in the Solomons, (3) the *edwardsi* group, represented by the endemic *tulagiensis* and *robinsoni* in the Santa Cruz Islands, and (4) the *scutellaris* group, the dominant one of the area, represented by 15 endemic described forms and 2 endemic undescribed forms. Included also in this group are *marshallensis,* which may be present in the southern Gilbert Islands, *albopictus* and *scutellaris,* which are not found in the area but are treated here for comparison. The group occurs throughout the South Pacific except New Caledonia, the Loyalty Islands, New Zealand, and a few islands at the extreme eastern end of the area.

BIONOMICS AND DISEASE RELATIONS.—The typical breeding sites of *Stegomyia* are treeholes. Many species utilize water collections in dead plant material on the ground as well as artificial containers, and a smaller number breed in plant axils. Small collections of water on the ground may be used by a few forms; coral rockholes and crabholes are sometimes used by *polynesiensis.* The eggs are usually resistant to desiccation and enable the species to survive unfavorable periods. They may be found in the debris in the containers.

Females are typically diurnal feeders. Several species attack man readily but will also feed on a variety of domestic and wild mammals, birds, reptiles, and even amphibians. Large swarms are not essential for mating; several species have been readily colonized in the laboratory.

Stegomyia is the most important subgenus of *Aedes* from the standpoint of disease transmission. *A. aegypti* is the classical vector of urban yellow fever and dengue and is a proven vector of other viruses. *A. albopictus* is also an important vector of dengue. Some of the members of the *scutellaris* group are efficient vectors of the nonperiodic form of *Wuchereria bancrofti* in the South Pacific.

DISTRIBUTION (fig. **306**).—The natural distribution of *Stegomyia* is confined to the Old World, but *aegypti* has been introduced through commerce to the New World. *Stegomyia* occurs chiefly in the tropical areas throughout the Old World but is also represented in the southern part of the Palaearctic, notably in the Mediterranean and in Japan. In the South Pacific indigenous species are absent only from New Zealand, New Caledonia and the Loyalty Islands, and probably Eastern Polynesia.

KEYS TO SPECIES

(Keys to tribe Aedini, pp. 318–321)

ADULTS (largely females)

(sp. 21 and 22 not included)

AEGYPTI GROUP

1. Mesonotum with lyre-shaped silvery markings; clypeus with a pair of silvery patches . . . . 1. *aegypti*
Mesonotum without lyre-shaped silvery markings and clypeus without scales 2

ALBOLINEATUS GROUP

2(1). Upper part of pleuron without silvery scales; paratergite bare . . . . 2. *albolineatus*
Upper part of pleuron with silvery scales on *apn* and *ppn;* paratergite with silvery scales 3

3(2). Mesonotum with a small oval median silvery spot anteriorly 4
Mesonotum with a long median longitudinal silvery line extending from anterior margin to at least near level of wing root 5

EDWARDSI GROUP

4(3). Hindtarsal segment 4 silvery on more than basal half; mesonotum with conspicuous patch of yellowish white scales in supraalar area . . . . 3. *tulagiensis*
Hindtarsal segment 4 silvery on less than basal

half; mesonotum with only a few light bronzy scales in supraalar area . . . . 4. *robinsoni*

SCUTELLARIS GROUP

5(3). Abdominal tergites with complete or incomplete *basal* silvery transverse bands dorsally and with separate basolateral triangular silvery patches . . . . 4a. *albopictus*

Abdominal tergites without transverse bands or with complete or incomplete *subbasal* to *submedian* silvery transverse bands dorsally, connected to lateral markings 6

6(5). Supraalar silvery line not developed *or* with only narrow scales posteriorly 7

Supraalar silvery line complete, extending over wing root toward scutellum *and* with broad scales posteriorly 9

7(6). Abdominal tergites III-VI usually all with distinct transverse silvery bands; pleural scaling in broad patches, not distinctly in line . . . . 8. *gurneyi*

Abdominal tergites III-VI without distinct transverse silvery bands, at most with a few median scales; pleural scaling in rather narrow distinct diagnoal lines 8

8(7). Supraalar silvery line not developed posteriorly, represented by a patch of broad scales in front of wing root only; median lobe of scutellum with dark scales apically . . . . 5. *aobae*

Supraalar silvery line more or less complete, extending above wing root but with narrow scales only; median lobe of scutellum entirely silvery . . . . 7. *futunae*

9(6). Lower mesepimeral silvery scale patch completely absent or represented at most by 3 scales 10

Lower mesepimeral silvery scale patch always developed, usually with numerous scales 11

10(9). Hindtarsal segment 4 silvery for more than 0.75 . . . . 17. *rotumae*

Hindtarsal segment 4 silvery for less than 0.75 . . . . 19. *upolensis*

11(9). Hindtarsal segment 5 with apical half or more dark on anterior and dorsal surfaces . . . . 12. *marshallensis*

Hindtarsal segment 5 silvery to apex on anterior and dorsal surface 12

12(11). Males . . . . see Key to Male Genitalia

Females 13

13(12). Abdominal tergite VII usually with a complete or dotted transverse dorsal silvery band; one or more additional tergites usually with complete or dotted transverse silvery bands 14

Abdominal tergite VII with lateral silvery markings not connected by complete or dotted transverse dorsal band; other tergites usually at most with a few light scales dorsally in middle but without distinct bands 17

14(13). Ventral surface of hindfemur with a distinct streak of silvery or white scales distally . . . . 20. *varuae*

Ventral surface of hindfemur without light streak distally 15

15(14). Hindtarsal segment 4 usually silvery in basal 0.5 only . . . . 18. *tongae*

Hindtarsal segment 4 usually silvery to more than 0.7 16

16(15). Wing without silvery spot at base of vein C . . . . 16. *quasiscutellaris*

Wing with a small silvery spot at base of vein C . . . . 9. *hebrideus;* 17a. *scutellaris*

17(13). Lateral prescutal light line developed, with at least 5 white scales at or near scutal angle . . . . 15. *pseudoscutellaris*

Lateral prescutal light line not developed, at most 1–3 light scales at scutal angle . . 18

18(17). Foretarsal segment 3 usually with conspicuous large basal silvery patch . . 13. *pernotatus*

Foretarsal segment 3 at most with a few pale scales at base on anterior surface 19

19(18). Wing without silvery spot at base of vein C . . . . 10. *hoguei*

Wing with distinct silvery spot at base of vein C 20

20(19). Abdominal tergites usually without pale scales dorsally suggesting transverse bands; hindtarsal segment 4 usually silvery for more than 0.67 . . . . 14. *polynesiensis*

Abdominal tergites usually with some pale scales dorsally suggesting transverse bands; hindtarsal segment 4 usually silvery for less than 0.67 21

21(20). Ventral surface of hindfemur without pale streak distally . . . . 6. *cooki*

Ventral surface of hindfemur with distinct pale streak distally . . . . 11. *horrescens*

MALE GENITALIA

(sp. 21 and 22 not included)

ALBOLINEATUS GROUP

1. Spiniform of clasper submedian in origin . . . . 2. *albolineatus*

Spiniform of clasper subapical in origin . . . 2

AEGYPTI GROUP

2(1). Ninth tergite deeply emarginate in the middle and with very large broadly triangular lateral sclerites . . . . 1. *aegypti*

Ninth tergite rounded, truncate, or produced into a lobe in the middle and with very small ventrolateral lobes 3

3(2). Spiniform of clasper extremely slender, narrowed subapically and then widened to form spatulate apex 4
Spiniform of clasper moderate to slender, not markedly narrowed subapically and without distinct spatulate apex 5

EDWARDSI GROUP

4(3). Claspette with a long sternal fingerlike process bearing more than 12 long bristles; clasper with slender preapical bristles . . . . 3. *tulagiensis*
Claspette with a short sternal process bearing 3 progressively longer bristles; clasper with conspicuous preapical bristles . . . . 4. *robinsoni*

SCUTELLARIS GROUP

5(3). Ninth tergite produced into a conspicuous medial caudal lobe . . . . . . 4a. *albopictus*
Ninth tergite broadly rounded or truncate in the middle 6

6(5). Claspette complex, expanded apically . . . 7
Claspette simple, truncate or rounded apically 12

7(6). Claspette with a distinct narrow fingerlike mesal process bearing a group of specialized bristles apically 8
Claspette without narrow fingerlike mesal process bearing specialized bristles apically 10

8(7). Mesal fingerlike process of claspette sternal . . . . 12. *marshallensis*
Mesal fingerlike process of claspette tergal 9

9(8). Mesal fingerlike process of claspette with numerous slender curved bristles on tergal and mesal faces proximally . . . . 5. *aobae*
Mesal fingerlike process of claspette without bristles on tergal and mesal faces proximally . . . . 13. *pernotatus*

10(7). Claspette with a conspicuous apicosternal projection bearing several very long bristles distally; expanded portion of claspette facing mesad . . . . 8. *gurneyi*
Claspette without distinct apicosternal projection; expanded portion of claspette facing laterad 11

11(10). Claspette with expanded apical portion densely packed with bristles throughout . . . . 7. *futunae*
Claspette with expanded apical portion with bristles largely confined to double or partially double marginal row around periphery except sternally . . . . . 16. *quasiscutellaris*

12(6). Claspette short, sternal face diagonally truncate to form oval bristly area . . . . 17. *rotumae*
Claspette more or less elongate, sternal face not diagonally truncate 13

13(12). Claspette with apex more or less distinctly truncate in lateral aspect, at least with distinct apicosternal angle 14
Claspette more or less rounded apically and usually without distinct apicosternal or apicotergal angles 16

14(13). Claspette strongly compressed; its apex distinctly truncate in lateral aspect and with a complete apical row of specialized setae from apicotergal to apicosternal angles . . . . 11. *horrescens*
Claspette only slightly compressed or cylindrical; its apex slightly truncate and with specialized setae restricted to small area near the distinct apicosternal angle . . 15

15(14). Specialized setae of claspette at least as long as the longest tergal hairs . . . 9. *hebrideus*
Specialized setae of claspette at most two-thirds as long as the longest apical tergal hairs . . . . 17a. *scutellaris*

16(13). Claspette with lateral or sternolateral hairs extending almost to point of attachment of lobe to sidepiece 17
Claspette with lateral or sternolateral hairs extending only about halfway to point of attachment of lobe to sidepiece 18

17(16). Claspette with several specialized setae along upper part of laterosternal margin . . . . 15. *pseudoscutellaris*
Claspette without specialized setae along upper part of laterosternal margin or anywhere else . . . . 14. *polynesiensis*

18(16). Claspette with very conspicuous short, broad, sharply pointed specialized setae in upper 0.25 of sternal margin 19
Claspette with poorly developed slender, apically attenuate or curved specialized setae on sternal margin 20

19(18). Claspette with a patch of subapical hairs on mesotergal surface . . . . 10. *hoguei*
Claspette without subapical hairs on mesotergal surface . . . . 20. *varuae*

20(18). Claspette long, apical hairs about as long as lobe . . . . 19. *upolensis*
Claspette short, apical hairs only slightly more than half length of lobe . . . . 6. *cooki*; 18. *tongae*

PUPAE

(17a. *scutellaris* and sp. 21 and 22 not included)

1. Paddle margins without fringe of very long hairlike spicules 2

Paddle margins with fringe of very long hairlike spicules 3

AEGYPTI and ALBOLINEATUS GROUPS

2(1). Paddle margins with distinct denticles; paddle hair usually single, rarely double . . . . 1. *aegypti*

Paddle margins without distinct denticles, at most with slight spicules or crenulations; paddle hair with at least 3 branches . . . . 2. *albolineatus*

3(1). Apex of paddle truncate or shallowly emarginate 4

Apex of paddle rounded or produced 5

EDWARDSI GROUP

4(3). Hair 1-IV,V usually with 3 or more branches; hair 5-IV-VII usually with 3 or more branches . . . . 3. *tulagiensis*

Hair 1-IV,V usually single or double; hair 5-IV-VII usually double . . . . 4. *robinsoni*

SCUTELLARIS GROUP

5(3). Hair 9-VI at or very near caudolateral angle of tergite, its distance from caudal margin distinctly less than 0.5 that of hair 6-VI . . . . 4a. *albopictus*

Hair 9-VI removed a considerable distance cephalad from caudolateral angle of tergite, its distance from caudal margin distinctly more than 0.5 that of hair 6-VI 6

6(5). Hair 9-VI not of the same order of magnitude as hair 9-V, usually 3.0 as long 7

Hair 9-VI of the same order of magnitude as hair 9-V, usually less than 2.0 as long 12

7(6). Hair 1-II primarily branched only *and* with at least 5 branches 8

Hair 1-II secondarily branched *or* with only 3,4 simple branches 10

8(7). Hair 1-III usually with at least 5 branches; hair 9-VI,VII usually single; hair 5-IV,V usually single . . . . 17. *rotumae*

Hair 1-III usually with at most 4 branches; hair 9-VI,VII and 5-IV,V usually double 9

9(8). Hair 1-IV,V strongly developed, long, usually double . . . . 11. *horrescens*

Hair 1-IV,V weakly developed, short or long, single to triple . . . . ? 6. *cooki;* . . . . . . 15. *pseudoscutellaris;* ? 18. *tongae*

10(7). Hair 9-VI,VII heavy, with barbs or branches . . . . 14. *polynesiensis*

Hair 9-VI,VII slender, smooth, and single 11

11(10). Hair 7-IV,V with at least 5 branches . . . . 10. *hoguei*

Hair 7-IV,V usually double, at most 4b . . . . 19. *upolensis*

12(6). Hair 1-II primarily branched only 13

Hair 1-II usually secondarily branched . . 15

13(12). Hair 1-IV,V about as long as following tergite; hair 5-IV,V about twice as long as following tergite *or* double . . . . 7. *futunae*

Hair 1-IV,V less than 0.5 of following tergite; hairs 5-IV,V single, less than 1.5 of following tergite 14

14(13). Hair 9-VI usually more than 0.5 length of 9-VII; hair 1-III usually at least 4b . . . . 5. *aobae*

Hair 9-VI less than 0.5 length of 9-VII; hair 1-III usually single or double . . . . 13. *pernotatus*

15(12). Hair 9-VI short, not extending beyond caudolateral angle of tergite . . . . 20. *varuae*

Hair 9-VI longer, extending distinctly beyond caudolateral angle of tergite 16

16(15). Hair 9-IV,V strongly developed, thickened; hair 1-VI weak, usually at least triple . . . . 9. *hebrideus*

Hair 9-IV,V weaker, thin; hair 1-VI stronger, usually single or double 17

17(16). Hair 9-IV,V short, not reaching caudolateral margin of tergite . . . . 16. *quasiscutellaris*

Hair 9-IV,V longer, usually reaching caudolateral margin of tergite 18

18(17). Hair 5-IV,V long, about 1.5 length of following tergite; hair 9-VIII strongly branched at base . . . . 8. *gurneyi*

Hair 5-IV,V shorter, only slightly longer than following tergite; hair 9-VIII weakly branched near middle . . 12. *marshallensis*

LARVAE

(17a. *scutellaris* and sp. 21 not included)

1. Ventral brush with 5 pairs of hairs 2

Ventral brush with 4 pairs of hairs 3

AEGYPTI and ALBOLINEATUS GROUPS

2(1). Anal saddle with very inconspicuous short marginal spicules; comb scales with very strong basal denticles . . . . 1. *aegypti*

Anal saddle with very long spinelike marginal spicules; comb scales without basal denticles . . . . 2. *albolineatus*

3(1). Anal saddle with very long spinelike marginal spicules 4

Anal saddle with very inconspicuous short marginal spicules 5

EDWARDSI GROUP

4(3). Hair 1-S short, not reaching apex of siphon, usually double; pecten usually with 6,7 teeth . . . . 3. *tulagiensis*

Hair 1-S long, extending beyond apex of siphon, usually single; pecten usually with 10–13 teeth . . . . 4. *robinsoni*

SCUTELLARIS GROUP

5(3). Anal segment with complete saddle 6
Anal segment with saddle incomplete, broadly or narrowly interrupted ventrally 12
6(5). Hair 4a-X single 7
Hair 4a-X double or triple 9
7(6). Hair 5-M usually double . . . . 18. *tongae*
Hair 5-M usually single 8
8(7). Majority of comb scales with fine fringes at base of free portion; thorax and abdomen with large stellate and heavily branched dorsal hairs . . . . 15. *pseudoscutellaris*
Majority of comb scales with strong denticles and no fine fringes at base of free portion; thorax and abdomen without distinct stellate or heavily branched dorsal hairs . . . . 13. *pernotatus*
9(6). Hair 5-M usually double . . . . 6. *cooki*
Hair 5-M usually single 10
10(9). Middle comb scales with the unfringed spine-like distal part longer than the basal part; latter usually with fine spicules only . . . . 14. *polynesiensis*
Middle comb scales with the unfringed spine-like distal part shorter than the basal part; latter usually with coarser spicules or denticles 11
11(10). Pecten teeth 12 or more; hair 1-X at least 4b; hairs 2-IV,V with about twice as many branches as hairs 1-IV,V; hair 6-C usually 2,3b . . . . 11. *horrescens*
Pecten teeth 10 or less; hair 1-X usually 2b; hairs 2-IV,V with about the same number or fewer branches than hairs 1-IV,V; hair 6-C usually single . . . . 17. *rotumae*
12(5). Hair 13-P present 13
Hair 13-P not developed 14
13(12). Hair 5-M double or triple . . . . 19. *upolensis*
Hair 5-M single . . . . 10. *hoguei*
14(12). Hair 4a-X double to multiple 15
Hair 4a-X single 17
15(14). Hair 5-M single . . . . 22. Wallis form
Hair 5-M double to multiple 16
16(15). Majority of comb scales broad and fringed on apex; hair 5-M at least 4b . . . . 5. *aobae*
Majority of comb scales tapered to a point apically; hair 5-M double . . . . 7. *futunae*
17(14). Hair 5-M double or triple . . . . . . 20. *varuae*
Hair 5-M single 18
18(17). Majority of comb scales connected by basal sclerotizations which form a more or less distinct plate . . . . 8. *gurneyi*
Majority of comb scales free, rarely a few connected at base 19
19(18). Majority of comb scales fringed for more than half length of the free portion or frayed apically . . . . 12. *marshallensis*
Majority of comb scales fringed for less than half length of the free portion, usually not frayed apically 20
20(19). Middle comb scales with the free portion very slender, nearly parallel-sided from base and at least as long as attached portion in dorsal aspect . . . . 4a. *albopictus*
Middle comb scales shorter, usually with the free portion widened at base and distinctly shorter than attached portion in dorsal aspect 21
21(20). Hair 4-P usually single, 6-M usually triple, 7-I usually double . . . . . . 16. *quasiscutellaris*
Hair 4-P usually 2,3b, 6-M usually 4,5b, 7-I usually single . . . . 9. *hebrideus*

AEGYPTI GROUP

1. Aedes (Stegomyia) aegypti (Linnaeus)

Figs. **307**, **313**, **314**

1762. *Culex aegypti* Linnaeus *in* Hasselquist, Reise nach Palaestina, p. 470. TYPE: ♀, Egypt (lost).—An application to the International Commission on Zoological Nomenclature for suspension of the rules and validation of current taxonomic usage is being made by P. F. Mattingly (1957*c*:395); the problem is too complex to be reviewed here.

1901. *Stegomyia fasciata* var. *queenslandensis* Theobald, Monog. Culicidae 1:297. *TYPE: lectotype ♀, marked as type by Theobald, Burpengary, South Queensland, Nov., Bancroft; by present selection (BMNH).

For complete synonymy, see Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *aegypti* of Edwards (1932:162); Taylor (1934:20); Paine (1935, 1943:18–19); Lee (1944*a*:67); Knight, Bohart, and Bohart (1944:36, 49); Bohart and Ingram (1946:11–12); Perry (1946:17); Iyengar (1955:28); Laird (1956); Rageau (1958*a*:877; 1958*b*:3); Stone, Knight, and Starcke (1959); Christophers (1960); and other recent authors.

Aedes (*Stegomyia*) *argenteus* of Edwards (1921*b*:325–326; 1924:370; 1925:267; 1928*b*:43–44); Buxton and Hopkins (1927:113–116); Paine and Edwards (1929:305); and authors.

Stegomyia fasciata of Bahr (1912); O'Connor (1923); and authors.

Aedes calopus of authors.

Stegomyia calopus of authors.

FEMALE.—*Wing:* 3.08 mm. *Proboscis:* 2.0 mm. *Forefemur:* 1.8 mm. *Abdomen:* about 2.83 mm. This ubiquitous and universally known species has been treated in detail in a recent book by Christophers (1960). No attempt will be made to describe it here for it can be easily recognized from all South Pacific mosquitoes by the characters used in the key: lyre-shaped silvery markings on the mesonotum and the clypeus with a pair of silvery patches. Even when completely denuded, *aegypti* can be identified in the South Pacific area by the lighter mesonotal integument in the broad curved lateral prescutal and posterior fossal lines where the broad silvery markings would be present.

MALE.—Essentially as in the female except for usual sexual characters.

MALE GENITALIA (fig. 313).—As figured; diagnostic characters as in the key; can be recognized readily from all South Pacific *Stegomyia* by the shape of tergite IX. Paraproct with a sternal arm near base.

PUPA (fig. 313).—*Abdomen:* 3.16 mm. *Trumpet:* 0.47 mm. *Paddle:* 0.76 mm. Chaetotaxy as figured; diagnostic characters as in the key. Can be recognized from all South Pacific *Stegomyia* by the presence of distinct denticles on the external and internal margin of the paddle and the usually unbranched condition of the paddle hair.

LARVA (fig. 314).—*Head:* 0.71 mm. *Siphon:* 0.68 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key. Can be recognized from all South Pacific *Stegomyia* by 5 pairs of hairs in the ventral brush, comb scales with very strong denticles at base of the apical spine, the mesopleural and metapleural tubercles with an apically hooked spine about twice as long as the basal portion of the tubercle, and the anal saddle without strong marginal spicules.

MATERIAL EXAMINED.—803 specimens; 159 ♀; 152 ♂; 153 pupae; 339 larvae; 2 individual larval rearings.

SYSTEMATICS.—*A. aegypti* is undoubtedly a native of the Ethiopian region, where the majority of the other members of the *aegypti* group (group A of Edwards) are found. Mattingly (1957*c*:399) seems to favor a southern Palaearctic origin for *aegypti;* the supporting evidence is not very convincing, however, since it deals chiefly with very recent events, geologically speaking, and *aegypti* is one of the most primitive members of *Stegomyia*, probably originating prior to the end of the Tertiary.

Mattingly (1957*c*:395) recognizes 3 forms of *aegypti:* the native dark Ethiopian subspecies *formosus* (Walker, 1848) and the 2 more or less distinct "domestic" forms, (1) the intermediate "type form" and (2) the pale variety *queenslandensis* (Theobald, 1901), which have been spread throughout most of the tropical and subtropical regions of the world, largely through commerce. The dispersal of *aegypti* may very well have been started by the Portuguese in their circuitous route to the Indies, which included stops in West Africa and eastern Brazil before rounding the Cape of Good Hope. Merrill (1954) has emphasized the importance of this route in the dispersal of economic plants.

The domestic forms of *aegypti* are probably more numerous than indicated by Mattingly, since undoubtedly there have been repeated dispersals of different stocks not only from the original home in Africa but also of the various introduced populations and the intermingling of all of these to a greater or lesser extent. The observed differences between the "type form" and *queenslandensis* may be owing, in part at least, to environmental modifications.

The South Pacific populations of *aegypti* conform largely to the "type form" of Mattingly, but the form *queenslandensis* has been found in New Caledonia and on some other islands. No attempt is made to differentiate these populations here, for the available material is in poor condition.

BIONOMICS AND DISEASE RELATIONS.—The bionomics of *aegypti* have attracted a great deal of interest, and the literature on the subject is voluminous. A detailed discussion is given by Christophers (1960) and a partial summary by Horsfall (1955:477–504). In the South Pacific, as well as in other areas where it has been introduced, *aegypti* is a domestic species and is predominantly a breeder in artificial containers of all types. Only rarely has the introduced form been found in treeholes, the natural native habitat, and even less frequently in the leaf axils of plants.

Domestic *aegypti* females are predominantly diurnal feeders but will attack man readily in artificial light; some will bite even in total darkness. The flight range of domestic *aegypti* is rather limited, and the adults are very sensitive to temperature and humidity.

In the South Pacific *aegypti* has been of importance only in the transmission of dengue (Perry, 1948). It appears to be of no importance as a vector of *Wuchereria bancrofti* in this area. Potentially, however, it is a very important mosquito and should always be controlled. In the South Pacific this is a relatively simple matter, since *aegypti* is largely confined to seaports and is not known to utilize anything but artificial containers for breeding.

DISTRIBUTION (fig. 307).—Widespread in the South Pacific but usually confined to the coast and particularly the larger seaports in association with Europeans and other adventives. *Solomon Islands:* Roviana; Russell; Florida; Tulagi; Guadalcanal. *Nauru. New Hebrides:* Espiritu Santo; Tangoa; Efate; Tana. *New Caledonia:* Houailou; Bourail; Tantouta; Noumea; APO 25. *Loyalty Islands:* Ouvea; Lifu. *Ellice Islands:* Lakena; Funafuti. *Fiji:* Taveuni; Viti Levu; Ovalau; Makongai. *Tonga:* Haapai; Tongatabu. *Wallis:* Uea. *Samoa:* Savaii; Upolu; Tutuila. *Southern Cook Islands:* Rarotonga. *Society Islands:* Borabora; Huahine; Raiatea; Tahiti. *Austral* (*Tubuai*) *Islands* (Iyengar, 1955:47). *Tuamotu Archipelago:* Makatea. *Pitcairn.* Widely distributed in tropical, subtropical, and warm temperate regions elsewhere.

ALBOLINEATUS GROUP

FEMALES.—*Head:* eyes narrowly separated; vertex with median anterior more or less diamond-shaped area of narrow white scales extending between eyes, followed caudad by broad scales to occiput. *Thorax:* mesonotum with a conspicuous white-scaled median longitudinal line but without large white-scaled patches; pleuron with a single broad longitudinal band of broad silvery-white scales from *ppl* to upper *mep;* paratergite bare; *psp* without scales. *Legs:* hindtarsus with only segments 1–3 marked or banded, occasionally a few white scales on segment 4; claws all simple.

MALE GENITALIA.—Spiniform of clasper submedian or subbasal, never near apex; claspette varied; paraproct without sternal arm near base.

PUPAE.—Apparently all similar to *albolineatus* as described and figured below; hair 5-C strongly developed, single, barbed; 9-II-VI all short, subequal, and lateral; paddle rounded apically, without fringe or conspicuous spicules; hair 1-P branched.

LARVAE.—Antenna often with small but distinct spicules; siphon with small detached or attached acus; anal saddle with long marginal spicules; ventral brush with 5 pairs of strongly branched hairs.

SYSTEMATICS.—The *albolineatus* group was erected by Knight and Rozeboom (1946:83) for the widespread nominate species and *boharti* Knight & Rozeboom, 1946 from the Philippines and Indonesia, *arboricolus* Knight & Rozeboom, 1946, *bambusicolus* Knight & Rozeboom, 1946, *laffooni* Knight & Rozeboom, 1946, *hoogstraali* Knight & Rozeboom, 1946 all from the Philippines, and *pseudalbolineatus* Brug, 1939 from Indonesia. *A. impatibilis* (Walker, 1860) from Celebes is possibly also a member of the group (Knight and Hull, 1952:187–188).

The group is remarkable for the occurrence of 2 or more larval forms in several of the species without apparent correlated differences in the pupa or adult.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of the group are normally found in treeholes and bamboo stumps and more rarely in fallen leaves. Leaf axils of sago palms and aroids, as well as a rockhole, lagoon, and jungle pool have been reported as breeding sites for *albolineatus* (see below). Coconut shells and husks are frequently utilized by the more adaptable species and artificial containers may be used also.

Females seldom bite man. The group as a whole does not appear to be involved in disease transmission or to be of any economic importance.

DISTRIBUTION (fig. 308).—The group is distributed from Assam through Malaya, Indochina, and Indonesia to the Philippines, New Guinea and adjacent islands, and the Solomons.

2. Aedes (Stegomyia) albolineatus (Theobald)

Figs. **308**, **315**, **316**

1904. *Scutomyia albolineata* Theobald, Entomologist 37:77. *TYPE: holotype ♀, Kuala Lumpur, Malaya, June 27, 1903, G. F. Leicester (BMNH).

Aedes (*Stegomyia*) *albolineatus* of Edwards (1925:258; 1932:164); Paine and Edwards (1929:306, 314); Taylor (1934:20); Lee (1944*a*:70); Knight, Bohart, and Bohart (1944:29, 50); Iyengar (1955:29); Laird (1956); Stone, Knight, and Starcke (1959, not including several erroneous records).

FEMALE.—*Wing:* 2.6 mm. *Proboscis:* 2.2 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.5 mm. *Head:* integument black; broad longitudinal median band of broad silvery white scales caudad of anterior patch of narrow silvery white scales to erect scales; a longitudinal streak of a few broad white scales at about level of middle of *apn;* remaining decumbent scales black dorsally, white laterally and ventrally from level of lower margin of *apn;* erect scales numerous, black except for lighter ones in the middle anteriorly; no orbital white-scaled line; clypeus bare; proboscis and palpus dark-scaled; torus with large mesal patch of broad silvery white scales. *Thorax:* integument blackish throughout; mesonotum with narrow blackish scales and a broad median longitudinal line of narrow silvery white scales from anterior promontory to just before level of wing root; acrostichals absent, dorsocentrals strongly developed; a patch of short golden bristles just in front of wing root; midlobe of scutellum with broad silvery white scales and sometimes a few broad dark scales apically, lateral lobe with broad dark scales only; *apn* and *ppn* with narrow dark scales only; *stp* with a ventrocaudal patch of broad silvery white scales below the broad silvery band; pleural bristles usually all light except on *apn. Legs:* coxae with silvery white scales; trochanters with silvery white and dark scales; forefemur dark-scaled except for more or less distinct anterior silvery white knee-spot and a silvery white streak on posterior surface broad at base and narrowed to apex; midfemur with distinct anterior silvery white knee-spot and a silvery white ventral streak from base to apex; hindfemur largely silvery white, with a preapical dark band extended dorsally as a streak and expanding basad on posterior surface; tibiae dark, lighter ventrally; foretarsus completely dark-scaled; midtarsus usually with a few white scales dorsally on base of segments 1 and 2; hindtarsal segments 1–3 with long basal silvery white areas, that on segment 2 forming complete ring, others interrupted on posterior surface, segment 4 sometimes with a few white scales dorsally at base. *Wing:* entirely dark-scaled; no remigial bristles on base of R. *Haltere:* knob dark-scaled. *Abdomen:* tergites and sternites black-scaled and with silvery white scale markings; tergite I dark, laterotergite white; tergites II-VII with large basal lateral white patches which expand into subbasal transverse bands on III-VII, usually more or less complete on IV-VII, incomplete on III; sternites II-VII with broad transverse white bands, basal on II-V, submedian on VI,VII.

MALE.—Essentially as in the female. *Palpus:* about 0.5–0.7 of proboscis. *Thorax:* mesonotal white line slightly narrower. *Legs:* midtarsus entirely dark; hindtarsus with basal white bands restricted to segments 1 and 2 and incomplete on posterior surface; anterior claw of foreleg with subbasal tooth, other claws simple. *Abdomen:* tergites with white bands usually complete only on VI,VII, sometimes also on V.

MALE GENITALIA (fig. **315**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite without distinct lobes, with 3–6 bristles on each side. *Sidepiece:* short. *Claspette:* poorly developed, with about 3,4 heavy short bristles and 5–8 more slender bristles. *Clasper:* slender; spiniform large, inserted slightly beyond middle and almost reaching to apex. *Phallosome:* aedeagus with 5–7 lateral distal teeth.

PUPA (fig. **315**).—*Abdomen:* 3.58 mm. *Trumpet:* 0.48 mm. *Paddle:* 0.71 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* lightly to moderately pigmented, mesonotum darker; hairs moderately pigmented; hair 1-C distinctly removed from caudal border; 5-C long, usually single and barbed. *Trumpet:* uniformly pigmented a bright light yellowish brown. *Metanotum:* darkened. *Abdomen:* lightly to moderately pigmented, segments I-III darker, sometimes conspicuously so; hairs moderately to darkly pigmented; hair 2 distinctly laterad or at level of hair 1 on III-VII; 9-II-VI lateral, subequal, well removed from caudolateral angle; 9-VII heavy, dorsolateral, cephalolaterad of 6-VII. *Paddle:* uniformly lightly to moderately pigmented, midrib darker and brighter; marginal spicules short, indistinct; hair 1-P strong, always with several branches.

LARVA (fig. **316**).—*Head:* 0.77 mm. *Siphon:* 0.67 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, lighter on ocular areas; aulaeum with long filamentous fringes; mental plate with 10–12 teeth on each side of median tooth, outer 3,4 teeth very widely spaced and sharply pointed; chaetotaxy extremely varied, hair 6-C single or branched; 1-C long, slender, attenuate. *Antenna:* uniformly pigmented; length varied; spicules varied, sometimes absent; hair 1-A branched. *Thorax:* integument sometimes spiculate; hairs and tubercles strongly pigmented; hair 13-P not developed; hairs 3,8,9,14-P, 1,13,14-M, 1,3,5,8,13-T stellate. *Abdomen:* integument sometimes spiculate; hairs and tubercles strongly pigmented; hairs 1,2,5,13-I-VII, 11-I, 9-II-VII, 7-II-VI, 6,8-VII stellate. *Segment VIII:* comb scales 9–12, thornlike, basally fringed. *Siphon:* index about 2.5–3.0; strongly pigmented, with black basal ring; spiculation varied; acus always present, rarely narrowly attached; pecten teeth usually 4–8; hair 1-S usually 4-7b. *Anal Segment:* saddle incomplete, strongly pigmented, caudal marginal spicules strong, varied; hair 1-X usually branched, rarely single; ventral brush of 5 pairs of strongly branched hairs.

MATERIAL EXAMINED.—2,289 specimens; 401 ♀; 376 ♂; 208 pupae; 1,304 larvae; 57 individual rearings (55 larval, 2 pupal).

SYSTEMATICS.—Throughout its wide range *albolineatus* exhibits a tremendous amount of variation, particularly in the larva, as pointed out by Brug (1939) and Knight and Rozeboom (1946:86–88). The populations from the Solomons differ in many respects from those described from elsewhere and may prove to be at least subspecifically distinct when the entire complex is studied critically.

Two distinct larval types of *albolineatus* are found in the Solomons. These are somewhat similar to types A and C of Knight and Rozeboom. In type A, the antenna is shorter, hair 6-C is usually single, and the siphon and body are rather strongly spiculate. In type C the antenna is longer, hair 6-C is strongly branched, and the siphon and body are not noticeably spiculate. I can find no correlation between these larval types and the rather numerous adult variations.

BIONOMICS AND DISEASE RELATIONS.—*A. albolineatus* breeds commonly in treeholes, coconut shells and husks, and bamboo stumps and less frequently in fallen leaves and artificial containers. Bonne-Wepster and Brug (1932:63) report it breeding in leaf axils of sago palms and taro and in a rockhole, a jungle pool, and a lagoon; all these records need verification.

Females of *albolineatus* are very seldom attracted to man; on Guadalcanal they were never collected actually biting. In the Solomons this species, in spite of its abundance, is of no economic importance.

DISTRIBUTION (fig. 308).—*Solomon Islands:* Bougainville; Treasury; Kolombangara; Wanawana; New Georgia; Rendova; Russell; Florida; Guadalcanal; Malaita; Ugi; Santa Ana; Bellona; Rennell. Also reported from *New Britain, New Ireland, Admiralties, New Guinea, Moluccas, Borneo, Philippines, Indonesia, Malaya, Indochina,* and *Assam.* Several records in Stone, Knight, and Starcke (1959) appear to be erroneous (Hainan, Formosa, Ogasawara Gunto, Marianas, Hawaii) and probably refer to *albopictus.*

EDWARDSI GROUP

FEMALES.—*Head:* eyes very widely separated; vertex with an anterior triangular patch of broad silvery white scales extending cephalad between eyes but not caudad to erect scales. *Thorax:* mesonotum with a small median oval patch of narrow silvery white scales anteriorly and a patch of whitish scales in supraalar area; paratergite largely with silvery white scales; pleuron with restricted patches of broad silvery white scales on *apn*, caudal middle part of *ppn, ppl,* upper and lower *stp* and *mep;* lower *mep* hairs present or absent. *Legs:* hindtarsus with broad white rings on segments 1–4, all of segment 5 white; claws all simple.

MALE GENITALIA.—Claspette strongly developed; spiniform of clasper subapical; paraproct without sternal arm near base.

PUPAE.—Known only for South Pacific species. *Cephalothorax:* hair 1-C near caudal border of sclerite; 1,3-C branched; 5-C strong, usually double. *Abdomen:* hair 2 at about level of hair 1 on III-VII; 5-IV-VI branched; 9-VI,VII dorsolateral. *Paddle:* with long fringe; apex truncate or more or less emarginate; paddle hair usually at least 0.7 of paddle length.

LARVAE.—Known only for South Pacific species. Head and chaetotaxy essentially as in the *albolineatus* group and hairy members of the *scutellaris* group; antenna without spicules; siphon short, pecten extending beyond 0.70, acus not developed; anal segment with incomplete saddle with strong spinelike marginal spicules, ventral brush of 4 pairs of strongly branched hairs set in a strongly sclerotized basal boss.

SYSTEMATICS.—The *edwardsi* group is erected for the nominate species from the Andaman Islands, the 2 South Pacific species treated below, and the unnamed form from Saigon provisionally identified as *edwardsi* by Borel (1930:234–236). The remarkable, apparently discontinuous, distribution of the group may be altered by the discovery of forms in intermediate areas or by the inclusion of some of the other species now placed in the heterogeneous group B of Edwards (1932:163–164). However, it is possible that this is a relict group with no other representatives surviving.

The *edwardsi* group combines some of the features of the *albolineatus* and *scutellaris* groups; the larva is very strongly suggestive of *albolineatus,* the male genitalia are not unlike some members of the *scutellaris* group, and the pupa shares some characteristics of both. The ornamentation of the adults is essentially as in the *scutellaris* group, except that the silvery markings are reduced in extent and approach the condition characteristic of the *albolineatus* group.

As indicated in the discussion of the mosquito fauna of the Santa Cruz Islands, the *edwardsi* group may have been formed through hybridization of members of the *albolineatus* and *scutellaris* groups. This group may have been widespread at one time; it is also possible that hybridization occurred independently in the east and in the west from different stocks of the same 2 parental groups. Therefore the 2 South Pacific species are only provisionally associated with *edwardsi,* pending a study of the immature stages of the latter which may resolve the problem.

BIONOMICS AND DISEASE RELATIONS.—Very little definite information on the bionomics of the group is available at present. Treeholes and possibly leaf axils are apparently the normal breeding sites. Females, to judge by the small number of specimens collected, are not readily attracted to man. The group is of no economic importance.

DISTRIBUTION (fig. 309).—At present the group is known only from the Andaman Islands in the Bay of Bengal, southern Indochina, and the Santa Cruz Islands in the South Pacific.

3. Aedes (Stegomyia) tulagiensis Edwards

Figs. 309, 317, 318

1926. *Aedes* (*Stegomyia*) *edwardsi* var. *tulagiensis* Edwards, B. Ent. Res. 17:109. *TYPE: holotype ♀, marked by Edwards as type, near Tulagi Hospital, Santa Cruz Island, Jan., 1926, A. G. Carment (BMNH).

Aedes (*Stegomyia*) *edwardsi tulagiensis* of Edwards (1932:164); Taylor (1934:20); Knight, Bohart, and Bohart (1944:33, 51); Iyengar (1955:29); Stone, Knight, and Starcke (1959); incorrectly listed under Solomon Islands and not listed for Santa Cruz Islands.

Aedes (*Stegomyia*) *edwardsi* of Lee (1944*a*:117; incorrectly listed for Solomon Islands).

FEMALE.—*Wing:* 2.67 mm. *Proboscis:* broken. *Forefemur:* 1.83 mm. *Abdomen:* about 2.33 mm. *Head:* decumbent scales dark dorsally except for anterior silvery white patch and a pair of broad longitudinal silvery white stripes at level of *apn,* the latter separated by a longitudinal dark stripe from silvery white sides and lower surface; erect scales yellowish; clypeus bare; proboscis dark-scaled; palpus with apical segment (4) largely silvery white dorsally, remainder dark; torus with large silvery white scale patch. *Thorax:* integument uniformly brown, lighter on membranes; mesonotum with dense vestiture of small curved dark bronzy scales; the anterior silvery patch of narrow scales small, narrow, not reaching level of scutal angle, removed a little more than its own length from anterior promontory; supraalar light scales yellowish white; dorsocentrals strongly developed; all scutellar lobes with broad silvery scales, distal third of midlobe with smaller dark scales; paratergite with silvery scales; *apn* with large patch of flat silvery scales; *ppn* with short narrow curved dark bronzy scales in upper third and a discrete patch of silvery scales at about middle posteriorly; *ppl* with patch of silvery scales; *psp* and *pra* without scales; *stp* with patch of silvery scales in upper part below upper bristle and another in lower posterior part along caudal bristles; *mep* with patch of silvery scales in front of upper *mep* bristles and a few smaller translucent whitish scales in lower middle; silvery patches of *apn, ppn,* and paratergite more or less in line but not connected in front; acrostichals absent, dorsocentrals strong; lower *mep* bristles and hairs not developed. *Legs:* coxae with silvery scales; femora with small apical dorsoanterior silvery patches, whitish or silvery ventrally and at base dorsally; tibiae dark; foretarsus with small basal dorsal silvery patches on segments 1 and 2; midtarsus similar to foretarsus, except that silvery markings are reduced to only a few scales on segment 2; hindtarsus with broad complete silvery basal rings on segments 1–4, that on 4 extending more than 0.5 of segment, segment 5 completely silvery-scaled. *Wing:* a conspicuous small silvery spot on base of vein C. *Haltere:* light on base and stem; dark-scaled on knob. *Abdomen:* tergites dark-scaled and with silvery-scaled patches laterally; tergite I dark; laterotergite all silvery; tergites II-V with triangular basal lateral silvery patches; tergites VI,VII with smaller submedian lateral silvery patches; sternites largely dark-scaled and with basal silvery bands widened laterad.

MALE.—Essentially as in the female. *Palpus:* slightly shorter than proboscis; segments 2,3 with dorsal basal silvery bands; segments 4,5 with ventral basal silvery bands. *Legs:* anterior claws of foreleg and midleg strongly enlarged, both simple.

MALE GENITALIA (fig. **317**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rather evenly rounded, lateral tergal lobe hidden, not produced, with 2 groups of 2 bristles each. *Sidepiece:* long and slender. *Claspette:* strongly developed; with long sternal fingerlike process bearing more than 12 bristles. *Clasper:* very slender, with several slender preapical hairs; spiniform preapical, very slender, narrowed subapically then slightly but distinctly expanded. *Phallosome:* aedeagus widened apically, with about 7 apical teeth on each side.

PUPA (fig. **317**).—*Abdomen:* 2.59 mm. *Trumpet:* 0.3 mm. *Paddle:* 0.48 mm. Chaetotaxy as figured, hairs moderately pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly pigmented, mesonotum darker. *Trumpet:* uniformly moderately pigmented. *Metanotum:* darkened. *Abdomen:* lightly pigmented, darkened on segments I-III; hair 1-IV,V usually with 3 or more branches; 5-IV-VII usually with 3 or more branches. *Paddle:* uniformly lightly pigmented, midrib darker; apex truncate or slightly emarginate; marginal fringe very long; hair 1 about 0.7 of paddle length.

LARVA (fig. **318**).—*Head:* 0.71 mm. *Siphon:* 0.49 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly a moderate, bright yellowish brown; mental plate with about 11,12 teeth on each side of prominent median tooth, most lateral teeth more widely spaced. *Antenna:* uniformly pigmented, concolorous with head capsule. *Thorax* and *Abdomen:* integument densely short-spiculate; hairs and tubercles strongly pigmented. *Segment VIII:* comb of about 12 long slender scales, with sharp apex and subapical spicules. *Siphon:* index about 2.0–2.5; moderately pigmented a yellowish brown, with a dark basal ring; spicules very short, not conspicuous; pecten of about 6,7 spines with a few spicules; hair 1-S not reaching apex of siphon, usually double. *Anal Segment:* saddle lightly to moderately pigmented, darker at base; marginal spicules very strong.

MATERIAL EXAMINED.—129 specimens; 3 ♀; 1 ♂; 12 pupae; 113 larvae; no individual rearings.

SYSTEMATICS.—The female of *tulagiensis* is superficially so similar to *edwardsi* (Barraud, 1923) that it was described as a variety of the latter. I find that adults of *tulagiensis* differ in having the anterior mesonotal silvery patch much farther removed from the anterior promontory, starting at about the level where the patch ends in *edwardsi*. *A. edwardsi* has several lower *mep* hairs and more extensive upper *stp* and upper *mep* scale patches. The previously unknown male of *tulagiensis* differs markedly in the development of the claspette. *A. tulagiensis* is superficially very similar to *robinsoni* but can be readily distinguished in all stages, as noted under the latter species.

I can find no significant differences in the 2 populations from the different breeding sites on 2 different islands.

The name applied to this species is confusing and may be caused by a mislabeling, for I can find no record of a Tulagi hospital on Santa Cruz Island. There is a remote possibility that this species occurs in the Florida group in the Solomons on the well-known island of Tulagi, which does have a hospital. However, this seems unlikely, as it was not found there during World War II, when the area was rather extensively collected, and the rediscovery of the species on Santa Cruz Island definitely establishes its presence in the Santa Cruz group.

BIONOMICS.—The immature stages of *tulagiensis* have been collected in a pandanus leaf axil (Bonnet, 77) and a treehole (Bonnet, 92). Nothing is known of the adult habits, but presumably this species does not bite man.

DISTRIBUTION (fig. **309**).—*Santa Cruz Islands:* Nupani (Reef Islands); Santa Cruz. Not known elsewhere.

4. Aedes (Stegomyia) robinsoni Belkin, n. sp.

Figs. 309, 319, 320

TYPES.—*Holotype:* ♂ (Bonnet, 40-0) with genitalia slide (570523-7), near Govt. House, Peuo, Vanikoro, Santa Cruz Islands, from large treehole in flame tree, Aug. 11, 1956, D. Bonnet (USNM, 64793). *Paratypes:* 3 ♂, 8 pupae, 29 larvae, all same locality, date, and collector as holotype, as follows; 1 ♂, 1 pupa, 19 larvae (Bonnet, 38), from tree fern stump; 2 ♂, 7 pupae, 10 larvae (Bonnet, 40), same data as holotype.—This species is dedicated to W. A. Robinson, the leader of the Robinson-Peabody Museum Expedition to the Southwest Pacific, 1956, in recognition of his contributions to the knowledge of the mosquitoes and mosquito-borne diseases of the South Pacific.

FEMALE.—Unknown.

MALE.—*Wing:* 2.2 mm. *Proboscis:* 1.66 mm. *Forefemur:* 1.6 mm. *Abdomen:* about 1.83 mm. Essentially as in the male and female of *tulagiensis*, differing chiefly in the following; mesonotum without a conspicuous patch of yellowish white scales in supraalar area, only a few light bronzy scales evident; 1 specimen with several very long golden hairlike scales at anterior end of prescutellar area; scutellum apparently with fewer dark scales on apex of median lobe; scale patch on upper *stp* larger; 1 specimen with an outstanding long white hairlike scale on lower *mep;* tarsal light markings more restricted, hindtarsal segment 4 light on less than basal half; anterior claw of foreleg with premedian tooth, that of midleg simple; wing with larger basal silvery patch on costa.

MALE GENITALIA (fig. 319).—As figured; diagnostic characters as in the key; essentially as in *tulagiensis,* differing chiefly in the following; claspette with very short sternal process bearing only about 3 progressively longer bristles; clasper apparently without long preapical hairs.

PUPA (fig. 319).—*Abdomen:* 2.7 mm. *Trumpet:* 0.41 mm. *Paddle:* 0.47 mm. Chaetotaxy as figured; diagnostic characters as in the key; essentially as in *tulagiensis;* hair 1-IV,V usually single or double; 5-IV-VII usually double.

LARVA (fig. 320).—*Head:* 0.73 mm. *Siphon:* 0.47 mm. *Anal Saddle:* 0.24 mm. Chaetotaxy as figured; diagnostic characters as in the key; essentially as in *tulagiensis;* thoracic and abdominal integument not as distinctly spiculate, usually very minutely spiculate; comb usually with about 16 scales, apex of scales fringed and without distinct enlarged median spine; siphon index about 1.8–2.2; pecten usually with about 10–13 spines; siphonal hair 1-S extending beyond apex of siphon, usually single.

MATERIAL EXAMINED.—41 specimens; 4 ♂, 8 pupae; 29 larvae; 1 pupal individual rearing.

SYSTEMATICS.—*A. robinsoni* is very similar to *tulagiensis* but can be easily differentiated in all stages by the diagnostic characters mentioned above. In most respects *robinsoni* is closer to *edwardsi* than is *tulagiensis,* particularly in the male genitalia and the extent of the pleural scaling.

BIONOMICS.—The immature stages of *robinsoni* have been collected in a tree fern stump (Bonnet, 38) and in a large treehole in a poinciana tree (Bonnet, 40). All the known adults are males reared from these collections; no females were found biting in the vicinity of the breeding sites.

DISTRIBUTION (fig. 309).—*Santa Cruz Islands:* Vanikoro. Not known elsewhere.

SCUTELLARIS GROUP

FEMALES.—*Head:* eyes rather widely separated; a conspicuous median longitudinal silvery white line of broad scales from the frons just above antennal base, between the eyes, caudad usually to erect occipital scales, this line widens above the eyes and may be extended laterad to form orbital lines; remainder of dorsal decumbent scales dark; a conspicuous lateral longitudinal line of broad silvery white scales at level of silvery scales of *apn,* followed ventrad by a broader longitudinal band of dark scales; below the latter all the scales are silvery white; erect scales sometimes yellowish in line with median silvery line, dark laterad; clypeus bare; proboscis largely dark-scaled, sometimes labium with ventral streak of white or whitish scales; apical segment (4) of palpus with silvery white scales dorsoapically; antennal torus with an almost complete ring of silvery scales; flagellar segment 1 without distinct scale patch. *Thorax:* (fig. 305) a dense mesonotal vestiture of narrow curved dark bronzy scales, rarely all light; a conspicuous narrow median longitudinal line of narrow silvery white scales from anterior promontory usually to prescutellar space, tapered posteriorly; a curved supraalar line of broad silvery scales from paratergite in front and above wing root, usually but not always extended toward scutellum, sometimes restricted to prealar patch; sometimes a light prescutal lateral line, a light posterior dorsocentral line, and a light prescutellar line; acrostichals absent, anterior and posterior dorsocentral bristles well developed; scutellum with silvery scales on all lobes, midlobe usually with some dark scales apically, lateral rarely; paratergite completely covered with silvery scales; pleuron with narrow dark scales on upper part of *ppn* and with extensive pattern of broad silvery scales on *apn,* middle of *ppn, ppl,* upper part of *stp* and upper *mep,* and on lower *stp* and usually lower *mep;* most frequently the silvery scaling forms 2 more or less continuous diagonal pleural lines, (1) one from *apn* to *ppn,* paratergite and continued in front and above wing root as supraalar line, (2) another from *ppl* to upper *stp* and upper *mep;* this pattern sometimes more or less broken; no scales on other pleural sclerites except frequently on *ssp* adjoining *stp* and rarely at base of *pra* bristles; *pst* always with silvery scales; lower *mep* bristles and hairs not developed. *Legs:* coxae with patches of silvery scales, forecoxa and midcoxa usually with dark scales also; trochanters usually with both light and dark scales; femora with apical dorsoanterior silvery patch, small on foreleg, larger on midleg and hindleg; anterior surface of forefemur dark, that of midfemur also dark but sometimes with a silvery line or a few light scales; lower surface of forefemur and midfemur light-scaled, encroaching on posterior face, remainder dark-scaled; anterior surface of hindfemur silvery from base to a variable distance toward apical light spot, at base the silvery scaling covers almost the entire anterior width, distally it is variously narrowed or tapered; posterior surface of hindfemur with dingy white scales in a pattern similar to anterior surface but usually only to about middle; dorsal surface of hindfemur dark except for variable distance at base; ventral surface of hindfemur light at base, dark distally, the latter part with or without a median light streak; tibiae dark, lighter ventrally; tarsi with conspicuous silvery markings, restricted to segments 1–3 on foreleg and midleg, usually present on all segments on hindleg, hindtarsal segment 5 usually all white, sometimes extensively darkened distally, laterally, or ventrally; claws all simple. *Wing:* costa with or without basal light-scaled spot. *Haltere:* upper part of stem and knob largely dark-scaled, a variable number of light scales on anterior and lower part of knob. *Abdomen:* tergites dark-scaled, with silvery lateral markings, often extended as incomplete or complete transverse bands; tergite I usually completely dark-scaled; laterotergite completely silvery-scaled; sternites dark-scaled, with conspicuous basal or subbasal silvery transverse bands.

MALES.—Essentially as in the females. *Palpus:* usually about as long as proboscis; dark-scaled, with basal silvery bands on upper surface of segments 2,3 and lower surface of segments 4,5. *Legs:* enlarged anterior claw of foreleg and midleg with submedian tooth.

MALE GENITALIA.—*Sidepiece:* elongate; mesal surface extensively membranous. *Claspette:* strongly developed. *Clasper:* elongate; spiniform subapical. *Proctiger:* paraproct without sternal arm near base.

PUPAE.—*Cephalothorax:* hair 1-C removed from caudal border of sclerite; 1,3-C frequently single. *Trumpet:* usually short. *Abdomen:* hairs 2-IV,V usually distinctly mesad of hair 1. *Paddle:* apex more or less produced, never truncate or emarginate; margins with fringe of long filamentous hairlike spicules; hair 1-P long but usually less than 0.7 of paddle length.

LARVAE.—*Antenna:* without spicules. *Thorax* and *Abdomen:* integument without distinct spicules; hair 13-P sometimes present. *Segment VIII:* comb scales varied in development, in a single more or less regular arcuate row, sometimes with small sclerotized comb plate. *Siphon:* relatively short, index usually about 2.0–3.5; pecten generally restricted to basal 0.6; pecten teeth with distinct denticles on anterior edge. *Anal Segment:* saddle complete to narrowly or widely incomplete; saddle margin without long spicules; ventral brush with 4 pairs of hairs on a more or less distinct grid or basal boss; gills varied.

SYSTEMATICS.—The *scutellaris* group has attracted a great deal of attention from the time of World War II to the present because of the importance of some of the species of the group as vectors of filarial worms and dengue viruses. Marks (1954) gives the most recent general review of the group in the restricted sense and cites much of the literature.

There has been considerable discussion regarding the taxonomic status of the nominal forms in the group. The majority of the workers have regarded these forms as distinct species chiefly because of the clear-cut, nonoverlapping differences in the male genitalia. Some doubt has been cast on this interpretation by several workers, notably Rozeboom and his students and Woodhill and coworkers, on the basis of laboratory hybridization experiments which have shown partial interfertility, at least in some crosses. According to these investigators, a complete reproductive barrier is the absolute criterion of a species and, since under laboratory conditions there is partial fertility between some of the forms, these cannot be species. However, it has not been demonstrated that any of the forms crossed experimentally interbreed in nature. Even *polynesiensis* and *pseudoscutellaris,* which according to Rozeboom and Gilford (1954) produce an intermediate hybrid progeny in the laboratory without a reduction in fertility, apparently do not interbreed on Fiji, where they occur sympatrically.

I consider that all the forms treated here are distinct species. The fact that the reproductive barrier is not complete and breaks down under certain conditions is, I believe, of primary importance in the evolution of the group. Apparently many of the species have been developed from small populations isolated on individual islands or island groups. Under these circumstances, genetic reproductive barriers with related stocks are not necessarily developed. When 2 such stocks come together after considerable lapse of time and considerable morphological and physiological divergence, there is a possibility of the establishment of a stabilized hybrid species. This may happen as a result of the transport by man of some species from one island to another. Once formed, such species of hybrid origin appear to be more adaptable and become dominant and may be further dispersed through human agency. Such species may completely replace the endemic forms, coexist with them, or form additional species of hybrid origin. I suspect that this has been true at least with *polynesiensis* and *cooki,* possibly also with *hebrideus* and *varuae,* and perhaps with additional forms as well.

In the past very little attention has been given to the immature stages in this group, and most forms have been described on the basis of differences in ornamentation of females and striking differences in the male genitalia. I find that larval characters are at least as good as those of the male genitalia for diagnostic purposes and give promise of being of paramount value in establishing a natural classification of the group.

The majority of the species in the eastern area of the South Pacific (the *pseudoscutellaris* complex) have 2 strikingly different types of larvae: (1) the "normal," "nonhairy" larva, with relatively poor development of the hairs of the thorax and abdomen, and (2) the "hairy" larva, with numerous and usually stronger branches in these hairs (3,8,9,14-P, 1,13,14-M, 1,4,5,8,13-T and 1,2,5,13-I-VII, 11-I, 9-II-VII, 7-II-V, 6,8-VII). In most instances, "hairy" larvae also show a tendency toward stronger development and branching of the head hairs, an elongation of the antenna, stronger development of the comb scales, and stronger pigmentation and spiculation of the siphon and anal saddle. The "hairy" condition is apparently the primitive one, for it is found usually only in specimens from treeholes; furthermore, it is the normal condition in the related and more generalized *edwardsi* and *albolineatus* groups. The "nonhairy" condition is largely restricted to specimens from secondary breeding sites, such as coconut shells and artificial containers. The only species in the western part of the South Pacific showing a more or less "hairy" condition is *hoguei.*

The pupae of the group are rather uniform but appear to show diagnostic as well as group characters. I have not studied this stage in any detail; since the material of several species is very scanty, it is very probable that the provisional key given here will not prove to be reliable.

Our knowledge of the group is too fragmentary at present to enable us to reconstruct its phylogeny. However, even now certain trends in the evolution of the group in the South Pacific are evident. The eastern species (the *pseudoscutellaris* complex) appear to be the earliest and most primitive derivatives of the ancestral stock, which have been preserved in isolation, while the western forms are the more recent derivatives, which have replaced the ancient stocks on the larger land masses. Replacement probably occurred several times and at different periods in the past, resulting in the accumulation of the numerous forms in the intermediate area between the Santa Cruz Islands and Samoa. As indicated above, the possible hybrid origin of some of the species complicates the situation considerably. It is also probable that several additional species will be found on isolated volcanic or elevated coral islands which are remnants of ancient island chains. At present our knowledge of the group is particularly scanty in the critical areas of the Santa Cruz group, Torres and Banks Islands, and the New Hebrides. Even in Fiji and Tonga unrecognized species may exist. I have included in the treatment below 2 questionable forms, one from Vanua Lava Island in the Banks group and the other from the isolated group of Wallis.

Three of the species of the group in the South Pacific are quite adaptable and have been dispersed rather widely by man: *polynesiensis* in the eastern portion and *hebrideus* and *varuae* in the western. *A. marshallensis* is another such species and may enter into the area in the Southern Gilbert Islands. All the remaining species are restricted in distribution, but it is possible that the present distribution of *quasiscutellaris* and *upolensis* may be owing in part to human agency.

In the following treatment I have listed the species of the group in alphabetical order for ease of reference and also because a phylogenetic arrangement is impossible at present. However, I have indicated the probable affinities under the systematic discussion of some of the species.

BIONOMICS AND DISEASE RELATIONS.—The basic breeding sites of the *scutellaris* group are treeholes. Most species will readily utilize water in coconut shells and husks and in other plant material on the ground, and several are commonly found in artificial containers. A few species are known to breed occasionally in crabholes and some perhaps may utilize water collections in coral holes. Very rarely species of the group may be found in leaf axils, usually those of pandanus.

Not all species attack man readily. The natural hosts are not known but are probably often birds or bats, the only warm-blooded vertebrates present in numbers in the habitats of the majority of species of the group.

A. "scutellaris" from New Guinea has been incriminated as a vector of dengue (Mackerras, 1946), and it has been suspected that other members of the group may also be involved (Horsfall, 1955:514).

Nonperiodic filariasis of the South Pacific east of Buxton's line (between Santa Cruz–New Caledonia and Ellice-Fiji) is transmitted predominantly by members of the *pseudoscutellaris* complex, although in the western portion of this area, members of the *kochi* group may also be involved. The chief or suspected vectors of nonperiodic filariasis are *polynesiensis, pseudoscutellaris,* and *tongae.* The 5 other species of the complex described from the area are also probably good vectors; at least *rotumae* and *cooki* are presumed to be vectors on epidemiological grounds, and even *futunae, upolensis,* and *horrescens,* which occur within the range of *polynesiensis,* may be involved as well, at least locally.

DISTRIBUTION (figs. **310-312**).—The group occurs from India and the Maldive Islands to the Marquesas and the Tuamoto Archipelago and from Japan to Australia. At the western and eastern ends there has been considerable dispersal by man, particularly of *albopictus* and *polynesiensis,* and also of several other species in the Pacific Ocean area. The majority of species have been recognized from the South Pacific, where the group occurs on every major inhabited island group except New Caledonia, Loyalties, and New Zealand.

4a. Aedes (Stegomyia) albopictus (Skuse)

Figs. **310, 321, 322**

1895. *Culex albopictus* Skuse, Indian Mus. Notes 3(5):20 (1894). TYPE: ♀, Calcutta (SYDN).—Type data from Barraud (1934:233).
For complete synonymy, see Stone, Knight, and Starcke (1959).

Aedes (Stegomyia) albopictus of Edwards (1920:134; 1921*b*:325; 1922*b*:464; 1924:370; 1932:164; 1941:153); Barraud (1923*a*:779; 1923*b*:497; 1934:233–235); Taylor (1934:20); Lee (1944*a*:69); Stone, Knight, and Starcke (1959); and authors.
Stegomyia scutellaris of Theobald (1901*a*:298–300); Leicester (1908:86–87); and authors.

FEMALE.—*Wing:* 2.7 mm. *Proboscis:* 1.88 mm. *Forefemur:* 1.75 mm. *Abdomen:* about 2.63 mm. *Head:* median silvery line reaching erect scales; orbital line of silvery scales developed; lateral silvery line expanded dorsomesad caudally; labium without ventral light streak; apical palpal segment silvery on about distal half. *Thorax:* median silvery line broad; lateral prescutal light line not developed; supraalar silvery line poorly developed, posterior part with narrow scales; posterior dorsocentral line with conspicuous silvery scales; prescutellar light line conspicuous, with some silvery scales; median scutellar lobe with few dark scales; pleural silvery scaling in large patches, not forming distinct diagonal lines, *apn* patch broad, upper *stp* patch broad and extending on *ssp* area, lower *mep* patch large and broadly connected to upper, *pra* usually with a few scales below bristles. *Legs:* forecoxa with broad band of dark scales through middle; midfemur without silvery line on anterior surface; hindfemur with anterior silvery line short, lower surface without light line in distal half; foretarsus and midtarsus with silvery markings small, restricted to segments 1,2; hindtarsal segment 4 silvery on basal 0.6 dorsally, segment 5 all silvery. *Wing:* costa with basal silvery spot. *Abdomen:* tergites II-VI with basolateral triangular silvery patches, broad distally and not connected to the dorsal basal transverse silvery bands which are widened into conspicuous sublateral patches; tergite VII with subbasal transverse silvery band expanded laterad into large submedian patch.

MALE.—Essentially as in the female. *Palpus:* distinctly longer than proboscis. *Legs:* hindtarsus more extensively silvery, segment 4 for about basal 0.75.

MALE GENITALIA (fig. **321**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with conspicuous median caudal lobe with narrow process; lateral tergal lobe conspicuous, exposed dorsally and sclerotized. *Sidepiece:* relatively short and broad. *Claspette:* large; with expanded distal part; sternal margin of expansion with about 5 long widened specialized curved setae; disc with numerous shorter more normal bristles. *Clasper:* relatively heavy; apex somewhat swollen and with numerous long hairs; spiniform relatively short, inserted very near apex.

PUPA (fig. **321**).—*Abdomen:* 2.4 mm. *Trumpet:* 0.38 mm. *Paddle:* 0.66 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly pigmented, mesonotum darkened. *Trumpet:* uniformly dark; pinna extending to about middle. *Abdomen:* lightly pigmented, darkened on anterior segments toward tergal midline; hair 9-VI at or very near caudolateral angle of tergite, its distance from caudal margin distinctly less than 0.5 that of hair 6-VI. *Paddle:* uniformly lightly pigmented, midrib bright and darker.

LARVA (fig. **322**).—*Head:* 0.8 mm. *Siphon:* 0.73 mm. *Anal Saddle:* 0.27 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderately pigmented except for dark collar. *Antenna:* relatively long; uniformly pigmented, darker than head capsule. *Thorax* and *Abdomen:* tubercles and hairs moderately to strongly pigmented. *Segment VIII:* comb of about 8–12 long slender scales, free portion of scale longer than attached, fringe restricted to basal portion, very fine. *Siphon:* index about 2.0–2.5; moderately pigmented, darker on basal ring; 7–14 pecten teeth, usually with several basal anterior denticles. *Anal Segment:* saddle widely incomplete; moderately pigmented, darkened proximally and dorsally, marginal spicules very small.

MATERIAL EXAMINED.—40 specimens; 10 ♀; 10 ♂; 10 pupae; 10 larvae; no individual rearings.

SYSTEMATICS.—While adults of *albopictus,* as well as related sibling species, are easily differentiated from the other members of the *scutellaris* group by the characteristic abdominal ornamentation, the larvae of *albopictus* proper are extremely similar to and difficult to separate from those of "*scutellaris,*" *hensilli* Farner, 1945, *hebrideus,* and *quasiscutellaris.* Great care must be taken in identifying *albopictus;* positive identification can be made at present only on male genitalia, since several forms are known which have similar ornamentation.

BIONOMICS AND DISEASE RELATIONS.—*A. albopictus* has been reported breeding in treeholes, bamboo, leaf axils of several plants, rock pools, and even *Nepenthes* pitchers. In some areas it is very commonly found in artificial containers, much as *aegypti.* It is probable that some of the records from unusual breeding sites apply to sibling species rather than to *albopictus* proper.

A. albopictus in some areas is a more or less domestic species and has been spread by commerce to several islands, notably Hawaii. Females behave and feed much like *aegypti.*

A. albopictus is considered to be an efficient vector of dengue. In addition, it is frequently a serious pest because of its domestic breeding and habits.

DISTRIBUTION (fig. **310**).—*A. albopictus* is widespread in the Oriental and Indomalayan regions and occurs as well in Mauritius, Japan, the Bonins, Marianas, and Hawaii. Some of the present distribution has been accomplished through commerce, as in the instance of Hawaii. *A. albopictus* does not occur in the South Pacific; it is unlikely that it will become established, for it does not seem to be able to compete successfully with other members of the *scutellaris* group. It is included here for comparison only, to discourage erroneous reports of this species similar to those made for New Guinea.

5. Aedes (Stegomyia) aobae Belkin, n. sp.

Figs. **311**, **312**, **323**, **324**

TYPES.—*Holotype:* ♂ with associated pupal skin (Bonnet, 61-2A), near Crater Lake, Aoba Island, New Hebrides, from large treehole in deep shade, Aug. 24, 1956, D. Bonnet (USNM, 64794). *Allotype:* ♀ with associated larval and pupal skins (Bonnet, 61-1A), same data as holotype (USNM). *Paratypes:* 8 ♀, 6 ♂, 3 pupae, 6 larvae (Bonnet, 61), same data as holotype; 1 ♀ (Bonnet, 62), same data as holotype except that taken biting in shade; 2 ♀ (Bonnet, 60), same locality, date, and collector as holotype, taken biting in daytime in deep-shaded forest near gardens of Episcopal Girls' School.

FEMALE.—*Wing:* 3.3 mm. *Proboscis:* 2.08 mm. *Forefemur:* 2.13 mm. *Abdomen:* about 2.56 mm. *Head:* eyes less widely separated than in other species of group, frontal scaling more restricted; median silvery line restricted, not reaching erect scales; orbital line partially developed; lateral silvery line not expanded caudad; labium without ventral light streak; apical palpal segment silvery on all but basal 0.25 or less. *Thorax:* median silvery line very narrow; lateral prescutal light line not developed; supraalar silvery line not developed, only a small patch of broad silvery scales in front of wing root; posterior dorsocentral line moderately developed, with some silvery scales anteriorly; prescutellar light line not developed; median scutellar lobe with numerous dark scales distally; pleural silvery scaling in narrow streaks, forming more or less distinct diagonal lines, upper line strongly interrupted and zigzag, *apn* streak very narrow, upper *stp* narrow and occasionally with a few scales on *ssp* face, lower *mep* with only a few scales in middle of sclerite and not connected to upper *mep*. *Legs:* forecoxa with posterior median patch of dark scales; midcoxa with apical patch of dark scales; midfemur without anterior silvery line; hindfemur with anterior silvery line short, lower surface with an indistinct light streak in distal half; foretarsus and midtarsus with silvery markings large and conspicuous on segments 1,2 on both legs and sometimes on 3 of foreleg, small or absent on 3 of midleg; hindtarsal segment 4 silvery on about basal 0.6–0.67, segment 5 all silvery. *Wing:* costa with conspicuous basal silvery spot. *Abdomen:* tergites II-V with arcuate lateral silvery markings, the more dorsal portion submedian, no indication of dorsal transverse connection on any segment; tergites VI,VII each with submedian lateral irregular light patch.

MALE.—Essentially as in the female. *Palpus:* distinctly shorter than proboscis. *Legs:* tarsal silvery markings less extensive than in female, on foreleg and midleg restricted to segments 1,2.

MALE GENITALIA (fig. **323**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in the middle, lateral tergal lobe prominent but hidden from above. *Sidepiece:* moderately long; dorsal bristles rather short; mesal dorsal area with rather long hairs extending into mesal surface to slightly beyond middle distad of claspette. *Claspette:* rather short; with a mesal tergal fingerlike lobe bearing usually 2 heavy spiniforms and 1 slender bristle; tergal surface with very long slender curved hairs, external surface with similar but shorter hairs. *Clasper:* relatively heavy; with numerous long hairs on the distinct subapical expansion; apical spicules short; spiniform subapical, moderate.

PUPA (fig. **323**).—*Abdomen:* 3.02 mm. *Trumpet:* 0.34 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, ventral surface lighter. *Trumpet:* uniformly moderately pigmented; pinna from 0.6. *Abdomen:* lightly to moderately pigmented, darkened on anterior segments. *Paddle:* uniformly lightly to moderately pigmented, midrib bright and darker.

LARVA (fig. **324**).—*Head:* 0.72 mm. *Siphon:* 0.76 mm. *Anal Saddle:* 0.27 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, darker on collar, lighter on ocular areas. *Antenna:* relatively short; uniformly darker than head capsule. *Thorax* and *Abdomen:* tubercles and hairs moderately to strongly pigmented. *Segment VIII:* comb of 10–14 scales, free portion of scale broad, fringed apically and with strong denticles near base, without apical spine. *Siphon:* index about 2.5–3.0; strongly pigmented, lighter on apex; 16–22 pecten teeth set close together. *Anal Segment:* saddle moderately widely incomplete; moderately pigmented, darkened proximally; marginal spicules distinct, short, sharply pointed.

MATERIAL EXAMINED.—30 specimens; 13 ♀; 6 ♂; 5 pupae; 6 larvae; 2 individual rearings (1 larval, 1 pupal).

SYSTEMATICS.—*A. aobae* is a very clearly marked species in all stages and appears to be related to *pernotatus* and *futunae.* A single female from Vanua Lava Island in the Banks group north of the New Hebrides (Oct., 1929, L. E. Cheesman, BMNH) is entirely similar to the type material. There is no possibility that this specimen is mislabeled and that it was actually collected on Aoba, since Miss Cheesman (*in lit.*) did not visit the latter island. The occurrence of this form on Vanua Lava is of great interest; it apparently indicates that the island of Aoba in the New Hebrides is part of the same island arc as the main islands of the Banks group and is probably of a different age than the main chain of the New Hebrides to the west and the secondary chain to the east. It is remarkable that *aobae* retains this relict distribution and has not been supplanted by *pernotatus,* which surrounds it except to the north, or by the dominant *hebrideus.*

BIONOMICS AND DISEASE RELATIONS.—The single collection of immature stages (Bonnet, 61) was made in a large treehole in deep shade in association with *Culex pacificus* and *Tripteroides melanesiensis.* Three females were taken biting. Nothing is known of the disease relations of *aobae.*

DISTRIBUTION (figs. **311, 312**).—*Banks Islands:* Vanua Lava. *New Hebrides:* Aoba. Not known elsewhere.

6. Aedes (Stegomyia) cooki Belkin, n. sp.

Figs. 311, 312, 325, 326

TYPES.—*Holotype:* ♂ with genitalia slide (580704-23), Niue Island, Sept., 1957, M. O. T. Iyengar (BMNH). *Allotype:* ♀, same data as holotype, except from cistern, collected in Oct., 1957 (BMNH). *Paratypes:* 13 ♀, 5 larvae, same data as allotype; 1 ♂ with genitalia slide (580714-7), same data as holotype, collected Sept. 20, 1957; 1 ♂ with genitalia slide (580714-1), same data as holotype, collected Sept. 21, 1957; 3 pupae, same data as holotype except from coconut shells, Apr. 10, 1958.—This species is named after Captain James Cook, the European discoverer of Niue Island in 1774.

FEMALE.—*Wing:* 3.3 mm. *Proboscis:* 2.3 mm. *Forefemur:* 2.08 mm. *Abdomen:* about 2.83 mm. *Head:* eyes moderately separated, frontal scaling normal; median silvery line narrow, reaching erect scales; orbital line partially developed; lateral silvery line broad, not expanded caudad; labium without ventral light streak; apical palpal segment silvery on more than distal half. *Thorax:* median silvery line narrow; lateral prescutal light line not developed; supraalar silvery line complete, with broad scales; posterior dorsocentral and prescutellar light lines well developed, with golden scales; median scutellar lobe with numerous dark scales distally; pleural silvery scaling in narrow streaks, forming distinct diagonal lines, upper line continuous except over spiracle and nearly straight, *apn* streak long and narrow, upper *stp* narrow and not extending on *ssp* face, lower *mep* small and usually not connected to upper. *Legs:* forecoxa with large posterior patch of dark scales; midcoxa with apical patch of dark scales; midfemur without anterior silvery line; hindfemur with anterior silvery line moderately long and rather broad distally, ventral surface without light streak in distal part; foretarsus and midtarsus with silvery markings small, restricted to segments 1,2; hindtarsal segment 4 silvery on about basal 0.4–0.67, segment 5 all silvery. *Wing:* costa with very small basal silvery spot. *Abdomen:* tergites II-VII with arcuate lateral silvery markings, the dorsal part submedian, those on VI,VII with only a short dorsal projection; dorsum of tergites without transverse light bands but usually with more or less distinct middorsal subbasal patches of dingy light scales on III-V and less conspicuous on II and VI, rarely with dorsal light dots on III-V.

MALE.—Essentially as in the female. *Palpus:* slightly shorter than proboscis. *Legs:* tarsal silvery scaling less extensive than in female, restricted to segment 1 on foreleg and midleg. *Abdomen:* tergites III-V with more or less complete transverse subbasal light bands, an incomplete dotted band on VI.

MALE GENITALIA (fig. 325).—As figured; diagnostic characters as in the key; apparently indistinguishable from *tongae.*

PUPA (fig. 325).—*Abdomen:* 2.95 mm. *Trumpet:* 0.46 mm. *Paddle:* 0.64 mm. Very similar to *pseudoscutellaris* and probably *tongae;* material insufficient to determine diagnostic characters to separate the 3 forms.

LARVA (fig. 326).—*Head:* 0.78 mm. *Siphon:* 0.68 mm. *Anal Saddle:* 0.28 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* strongly pigmented, blackish on collar. *Antenna:* relatively short, darker than head capsule. *Thorax* and *Abdomen:* tubercles and hairs strongly pigmented; hair 2 thickened. *Segment VIII:* 11–15 comb scales, free portion of middle comb scales long, spinelike, light apically, base with fine fringes. *Siphon:* index about 2.0–2.5; strongly pigmented; lighter apically, darkened at base; 11–19 pecten teeth set close together. *Anal Segment:* saddle complete; strongly pigmented, darkened at base and dorsally; marginal spicules moderately developed.

MATERIAL EXAMINED.—52 specimens; 14 ♀; 3 ♂; 5 pupae; 30 larvae; no individual rearings.

SYSTEMATICS.—*A. cooki* combines characteristics of *polynesiensis* and *tongae.* The male genitalia cannot be differentiated with certainty at present from those of *tongae,* although there appear to be some slight differences. The abdominal ornamentation of the females is intermediate between *tongae* and *polynesiensis.* The larva is quite similar to *polynesiensis* but apparently is distinguishable by the branched condition of hair 5 of the mesothorax. The pupa seems to be very similar to *tongae;* the latter in turn is very similar to *pseudoscutellaris.* The combination of characters in *cooki* is suggestive of the origin of this species through hybridization between *tongae* and *polynesiensis.* This may have taken place as a result of the introduction of *polynesiensis* and *tongae* by the Polynesians into the isolated island of Niue. The natives of Niue came originally from Samoa and are known to have visited Tonga. It is also possible, but less probable, that *tongae* was indigenous to Niue and that only *polynesiensis* was introduced. At the present time *cooki* is the only known species of the *scutellaris* group on Niue.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *cooki* are known from collections in a cistern, coconut shells, pandanus axils, rain barrels, canoes, and tin cans. *A. cooki* is apparently the only member of the group on Niue and is presumably the local vector of filariasis, which is quite prevalent (Iyengar, 1954*b*:27).

DISTRIBUTION (figs. 311, 312).—*Niue Island* (between Tonga and Southern Cook Islands). Not known elsewhere.

7. Aedes (Stegomyia) futunae Belkin, n. sp.

Figs. 311, 312, 327, 328

TYPES.—*Holotype:* ♂ (Bonnet, 10-0) with genitalia slide (570517-6), Mu'a, Alofi Island, Futuna (Horne, Hoorn) group, from treehole at base of large tree in deep forest, July 29, 1956, D. Bonnet (USNM, 64795). *Allotype:* ♀ (Bonnet, 10-17) with associated larval and pupal skins, same data as holotype (USNM). *Paratypes:* 2 ♀ (Bonnet, 10-1), 3 ♂ with associated pupal skins (Bonnet, 10-1, 2, 10), 2 ♂ (Bonnet, 10-0), 1 pupal skin, ♀ lost (Bonnet, 10-9), 4 pupae, 40 larvae (Bonnet, 10-0), same data as holotype; 3 ♀ (Bonnet, 08), 4 ♀ (Bonnet, 09), same data as holotype except taken biting in bush in daytime.

FEMALE.—*Wing:* 3.1 mm. *Proboscis:* 2.06 mm. *Forefemur:* 2.06 mm. *Abdomen:* about 2.67 mm. *Head:* eyes moderately separated, frontal scaling normal; median silvery line narrow, reaching erect scales; orbital silvery line not developed; lateral silvery line broad, not expanded caudad; labium without distinct ventral light streak; apical palpal segment usually silvery on more than distal half. *Thorax:* median silvery line narrow; lateral prescutal line not developed; supraalar silvery line more or less complete but with narrow scales only; posterior dorsocentral line poorly indicated, with a few light coppery scales anteriorly; prescutellar line not developed, occasionally a few light coppery scales; median scutellar lobe without dark scales; pleural scaling in streaks, forming distinct diagonal lines, the upper continuous and nearly straight to wing root, *apn* streak long but rather broad, upper *stp* rather broad but not extending on *ssp* face, lower *mep* large and connected to upper. *Legs:* forecoxa with wide median band of dark scales; midcoxa with large apical patch of dark scales; midfemur without anterior silvery line; hindfemur with anterior surface dingy white in basal 0.5 and with an indefinite narrow lightish line extending distad about halfway to apical silvery patch, lower surface with an indefinite dingy light line extending to near apex; foretarsus and midtarsus with very small silvery markings on segments 1,2 only; hindtarsal segment 4 silvery in about basal half, segment 5 entirely silvery. *Wing:* costa with only 2,3 silvery scales at base. *Abdomen:* tergites II-VI with large basolateral silvery patches, more or less triangular and with more or less distinct straight dorsal submedian prolongation on V,VI; tergite VII with a more or less complete broad transverse submedian silvery band connecting larger lateral silvery patches; other tergites without transverse dorsal silvery bands, but a few light subbasal median scales may be present, particularly on III.

MALE.—Essentially as in the female. *Palpus:* about as long as proboscis. *Legs:* tarsal silvery scaling more extensive than in female on all legs.

MALE GENITALIA (fig. 327).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in middle, lateral tergal lobe prominent but hidden from above. *Sidepiece:* moderately long; dorsal bristles moderate; mesal dorsal area with sparse, moderately long hairs extending about 0.67 to apex, but not invading mesal surface. *Claspette:* rather short; expanded on apex, and with a simple mesal tergal projection; expanded portion facing laterad and densely packed with bristles and with a patch of longer bristles at tergomesal angle. *Clasper:* slender in basal 0.67 then strongly expanded and with numerous long hairs conspicuous particularly on apex; apical spicules rather long; spiniform subapical but not distant, moderate.

PUPA (fig. 327).—*Abdomen:* 3.52 mm. *Trumpet:* 0.54 mm. *Paddle:* 0.77 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately to strongly brightly pigmented, ventral surface lighter. *Trumpet:* uniformly moderately brightly pigmented; pinna from about 0.6. *Abdomen:* moderately brightly pigmented, darkened on anterior segments and transverse anterior bars on tergites and sublateral longitudinal lines on sternites; larger hairs barbed or branched. *Paddle:* uniformly moderately brightly pigmented, midrib slightly darker.

LARVA (fig. 328).—*Head:* 0.82 mm. *Siphon:* 0.87 mm. *Anal Saddle:* 0.32 mm. Only hairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented a yellowish brown, lighter on ocular areas, darkened on collar. *Antenna:* unusually long and slender; uniformly moderately pigmented, a little lighter apically. *Thorax* and *Abdomen:* hairs and tubercles very strongly pigmented; hairs conspicuously barbed. *Segment VIII:* 16–20 comb scales; free portion of median comb scale with conspicuous denticles and fringes at base, distal portion narrowed then expanded into broad blade. *Siphon:* index about 2.3–3.2, a distinct subapical constriction; strongly pigmented a deep yellowish brown, darkened at base, strongly short-spiculate; about 20 close-set pecten teeth, distal ones frayed on apex; hair 2-S very slender. *Anal Segment:* saddle very narrowly incomplete; moderately pigmented, darkened basally and dorsally; marginal spicules slender, moderately long.

MATERIAL EXAMINED.—61 specimens; 9 ♀; 6 ♂; 9 pupae; 37 larvae; 4 individual rearings (1 larval, 3 pupal).

SYSTEMATICS.—*A. futunae* is a very clearly marked species in all stages. Its affinities appear to be with *aobae* and *pernotatus,* but the male genitalia resemble most closely those of *quasiscutellaris,* and the supraalar silvery line of the adults is reduced much as in *gurneyi.*

BIONOMICS AND DISEASE RELATIONS.—The single collection of the immature stages of *futunae* was made in a treehole in a deep forest in association with a few *polynesiensis.* In day-biting collections in the bush, *futunae* was also the dominant species. The only other collection of immature stages made on Alofi Island was in a coconut half in a bush area and contained *polynesiensis* only. Thus *futunae* appears to be the endemic species more or less restricted to the bush, while *polynesiensis* appears to be introduced on Alofi and may be gradually replacing it. There is no evidence of hybridization between the 2 species in the small series at hand.

The relation of *futunae* to filariasis is unknown, but, since it is apparently more abundant than *polynesiensis,* it may be the main vector in the Futuna group.

DISTRIBUTION (figs. 311, 312).—*Horne Islands* (Hoorn, Futuna): Alofi; probably occurs also on Futuna Island, which is only a couple of miles from Alofi. Not known elsewhere.

8. Aedes (Stegomyia) gurneyi Stone & Bohart

Figs. **311, 312, 329, 330**

1944. *Aedes (Stegomyia) gurneyi* Stone and Bohart, Ent. Soc. Wash., Proc. 46:217–218. *TYPE: holotype ♂, Bougainville, Solomon Islands, from treehole in jungle, A. B. Gurney, 153 (USNM, 56982).

Aedes (Stegomyia) gurneyi of Stone and Farner (1945:159); Marks (1954); Iyengar (1955:29); Stone, Knight, and Starcke (1959).

Aedes (Stegomyia) near *albopictus* of Knight, Bohart, and Bohart (1944:39, fn.).

FEMALE.—*Wing:* 2.75 mm. *Proboscis:* 1.86 mm. *Forefemur:* 1.86 mm. *Abdomen:* about 2.5 mm. *Head:* eyes moderately separated, frontal scaling extensive; median silvery line relatively broad, reaching erect scales; orbital silvery line partially developed; lateral silvery line broad, expanded dorsomesad caudally; labium without ventral light streak; apical palpal segment usually silvery on more than distal half. *Thorax:* median silvery line relatively broad, slightly yellowish caudally; lateral prescutal line more or less distinct, with golden scales anteriorly, silvery near scutal angle; supraalar silvery line incomplete, with broad silvery scales near paratergite and with narrow golden or light coppery scales above wing root; posterior dorsocentral and prescutellar lines well developed, with golden or light coppery scales; median scutellar lobe with numerous dark scales; pleural scaling in rather broad patches, the upper forming a more or less straight line, the lower not distinctly in line, *apn* patch rather broad, upper *stp* very broad and always extending conspicuously on *ssp* face, lower *mep* large and connected to upper. *Legs:* forecoxa with only a few dark scales posteriorly in middle; midcoxa with large apical patch of dark scales; midfemur without anterior silvery line; hindfemur with the anterior silvery line long, lower surface without light streak in distal part; foretarsus and midtarsus with silvery markings large on segments 1,2 and occasionally a few scales on 3 of foreleg; hindtarsal segment 4 silvery for more than 0.8 from base, segment 5 all silvery. *Wing:* costa with conspicuous basal silvery patch. *Abdomen:* tergites

II-VI with arcuate lateral silvery markings, the dorsal part subbasal and connected above to form subbasal transverse silvery bands on II-VI; tergite VII with broad subbasal transverse silvery band.

MALE.—Essentially as in the female; palpus about as long as proboscis.

MALE GENITALIA (fig. 329).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded or truncate in middle; lateral tergal lobe small and hidden from above. *Sidepiece:* moderately long; dorsal bristles rather long; mesal dorsal area with sparse long hairs extending to about middle, not invading mesal surface. *Claspette:* very large and conspicuous; with expanded apex facing mesad, tergal portion directed cephalad, sternal caudad, latter apically with several very long bristles. *Clasper:* relatively slender; only slightly expanded at apex and with few hairs; apical spicules short; spiniform moderate, inserted near apex.

PUPA (fig. 329).—*Abdomen:* 2.4 mm. *Trumpet:* 0.38 mm. *Paddle:* 0.57 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly pigmented, darkened on mesonotum. *Trumpet:* uniformly moderately pigmented; pinna from about 0.7. *Metanotum:* darkened. *Abdomen:* moderately pigmented anteriorly, lightly caudad. *Paddle:* uniformly lightly pigmented, midrib darker.

LARVA (fig. 330).—*Head:* 0.71 mm. *Siphon:* 0.76 mm. *Anal Saddle:* 0.24 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, lighter on ocular areas, darkened on collar. *Antenna:* moderate in length; uniformly darker than head capsule. *Thorax* and *Abdomen:* hairs and tubercles moderately to strongly pigmented. *Segment VIII:* 6–9 comb scales arising from a more or less distinct blackish comb plate, 1,2 scales sometimes only partially attached to plate; free portion of scale very slender and spinelike, usually some slender denticles at base. *Siphon:* index about 2.2–2.6; very strongly pigmented, darkened on basal ring, apex distinctly lighter; 7–12 pecten teeth. *Anal Segment:* saddle moderately widely incomplete; rather uniformly strongly pigmented; marginal spicules practically undeveloped.

MATERIAL EXAMINED.—209 specimens; 51 ♀; 35 ♂; 23 pupae; 100 larvae; 1 individual larval rearing.

SYSTEMATICS.—*A. gurneyi* shows some superficial similarities to *albopictus* in the pleural ornamentation of the adults as well as in shape of the claspette of the sidepiece of the male genitalia. In the poor development of the supraalar silvery line, it is suggestive of *futunae.* The immature stages show some resemblance to *marshallensis, hebrideus, quasiscutellaris,* and *albopictus.*

I have seen some females from Emirau Island which resemble *gurneyi* very closely. A single damaged male from Boram, Wewak, New Guinea, has the genitalia somewhat similar but with a distinct sternal process on the claspette and a differently developed tergite IX; it apparently differs also in the silvery ornamentation of the abdomen.

BIONOMICS AND DISEASE RELATIONS.—Immature stages of *gurneyi* are known predominantly from treeholes and tree stumps. A few collections are known from leaf axils, including pandanus, and from artificial containers. It is not known whether reports from ground pools are owing to errors in labeling or to flushing of immature stages from normal habitats. Females have not been reported to attack man; therefore, this species is apparently of no economic importance.

DISTRIBUTION (figs. 311, 312).—*Solomon Islands:* Bougainville; Pavuvu; Guadalcanal; Bellona. This species or related forms may occur to the west.

9. Aedes (Stegomyia) hebrideus Edwards

Figs. 311, 312, 331, 332

1926. *Aedes* (*Stegomyia*) *variegatus* var. *hebrideus* Edwards, B. Ent. Res. 17:102–103. *TYPE: holotype ♂, marked as type by Edwards, with attached genitalia mount, Hog Harbour, Espiritu Santo, New Hebrides, Aug., 1925, P. A. Buxton, NH-79 (BMNH).

Aedes (*Stegomyia*) *hebrideus* of Farner and Bohart (1944; 1945:46–47, in part); Stone and Farner (1945, in part).

Aedes (*Stegomyia*) *scutellaris hebrideus* of Knight, Bohart, and Bohart (1944:39, 55).

Aedes (*Stegomyia*) *scutellaris* var. *hebrideus* of Edwards (1932:165).

Aedes (*Stegomyia*) *variegatus* var. *hebrideus* of Buxton and Hopkins (1927).

Aedes (*Stegomyia*) *scutellaris* in part of Stone (1947); Marks (1954); Iyengar (1955:29); Rageau (1958*a*:877); Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *scutellaris scutellaris* of Laird (1956); Rageau and Vervent (1958:17–18).

Aedes (*Stegomyia*) *zonatipes* in part of Bohart and Ingram (1946:26–27).

FEMALE.—*Wing:* 3.33 mm. *Proboscis:* 2.16 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 2.93 mm. *Head:* eyes moderately separated, frontal scaling extensive; median silvery line relatively broad, reaching erect scales; orbital silvery line partially developed; lateral silvery line moderate, not distinctly expanded; labium with or without ventral light streak; apical palpal segment usually silvery for more than distal half. *Thorax:* median silvery line narrow; lateral prescutal line not developed; supraalar silvery line complete, with broad silvery scales posteriorly; posterior dorsocentral and prescutellar lines distinct, usually with silvery scales; median scutellar lobe with numerous dark scales; pleural scaling in moderately broad streaks, forming distinct diagonal lines, *apn* streak rather broad, upper *stp* narrow, rarely extending to *ssp* face, lower *mep* large and usually separate or very narrowly connected to upper. *Legs:* forecoxa with a very small median posterior patch of dark scales; midcoxa with large apical patch of dark scales; midfemur without anterior silvery line; hindfemur with anterior silvery line long, lower surface without light streak in distal part; foretarsus and midtarsus with conspicuous silvery markings on segments 1,2 only; hindtarsal segment 4 silvery to beyond 0.75, segment 5 all silvery. *Wing:* costa with very small basal silvery patch. *Abdomen:* tergites II-VI with arcuate lateral silvery markings, the dorsal part submedian and connected above to form premedian transverse silvery bands on III-VI, frequently incomplete on III; tergite VII with broad submedian transverse silvery band.

MALE.—Essentially as in the female; palpus about as long as proboscis.

MALE GENITALIA (fig. 331).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in the middle; lateral tergal lobe indistinct and hidden from above, with about 3 hairs. *Sidepiece:* moderately long and slender; dorsal bristles very long; mesal dorsal surface with a patch of very long hairs basally, not extending on mesal surface or reaching middle of sidepiece. *Claspette:* simple; prominent, slender but with a distinct apicosternal angle distad of which are 3–5 specialized thickened bristles in a group; latter are more prominent than all the other hairs which are subequal in length, no greatly elongated hairs at apicotergal angle. *Clasper:* heavy, uniform in width, and without distinct subapical expansion; hairs rather numerous, apical spicules moderate; spiniform rather short and heavy, subapical.

PUPA (fig. 331).—*Abdomen:* 3.14 mm. *Trumpet:* 0.48 mm. *Paddle:* 0.67 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, ventral surface lighter. *Trumpet:* uniformly moderately pigmented; pinna from about 0.65–0.73. *Abdomen:* moderately pigmented, lighter caudad, slightly darkened areas in anterior part of tergites and sublateral diagonal lines of sternites. *Paddle:* uniformly lightly pigmented, midrib darker and brighter.

LARVA (fig. 332).—*Head:* 0.78 mm. *Siphon:* 0.79 mm. *Anal Saddle:* 0.27 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to lightly pigmented, lighter on ocular area, darkened on collar. *Antenna:* moderately long; uniformly darker than head capsule. *Thorax* and *Abdomen:* hairs and tubercles moderately to strongly pigmented. *Segment VIII:* 9–15 comb scales, not uncommonly several may be connected at base by narrow proximal sclerotization but majority never arising from distinct comb plate; free portion of median scale spinelike, shorter than attached in dorsal aspect, with fringes in less than basal half. *Siphon:* index about 2.6–3.4; moderately to lightly pigmented, darkened on basal ring; 8–16 pecten teeth, not uncommonly some out of line or in partial double row. *Anal Segment:* saddle moderately widely incomplete; lightly to moderately pigmented, darker basally and dorsally; marginal spicules practically undeveloped.

MATERIAL EXAMINED.—1,670 specimens; 577 ♀; 189 ♂; 239 pupae; 665 larvae; 17 individual rearings (15 larval, 2 pupal).

SYSTEMATICS.—*A. hebrideus* is very similar to "*scutellaris*" from New Guinea and the Philippines and apparently also to the true *scutellaris* from the Aroe Islands (Aru). However, *hebrideus* differs from all these in constant details of the claspette of the male genitalia, as indicated in the diagnosis. I have made no attempt to find characters in the immature stages or in the adult ornamentation, since there is a great deal of variation in all these populations in all stages; a detailed comparative quantitative study would be necessary to evaluate the differences properly.

A. hebrideus is a very interesting form with a remarkable distribution (figs. **311, 312**). Its nearest relative is undoubtedly the "*scutellaris*" of New Guinea. The similarity between these 2 forms is so close that one would be inclined to regard *hebrideus* as a race or subspecies of "*scutellaris*" were it not for the fact that there is a wide gap between the 2 forms in the Solomons which are occupied by *quasiscutellaris* and the fact that nowhere do *"scutellaris"* and *hebrideus* come in contact. It is quite apparent that *hebrideus* has been spread widely through the agency of western Polynesians in a manner similar to *polynesiensis* by eastern Polynesians. As indicated below, it is widespread in the New Hebrides and the Santa Cruz group and then occurs westward only on outlying Polynesian islands, on Rennell and Bellona south of the Solomons, on Ontong Java and Nuguria north of the Solomons, and finally on Wuvulu Island north of the middle of New Guinea. All these outlying populations agree in the distinctive characters of the claspette of the male genitalia, and all are markedly different in this respect from the populations of the *scutellaris* group in the nearest large Melanesian islands. It is of interest that *hebrideus* does not occur on Sikiana (Stewart) Island, north of the eastern Solomons, where only *varuae* has been reported.

It is possible that the original stock of *hebrideus* was not native to the New Hebrides–Santa Cruz area; it may have been introduced by Polynesians, or possibly by Melanesians before them, from the Louisiade Archipelago or the eastern peninsula of New Guinea. However, it is possible that it may have reached this area by natural means from the same source before the advent of man by way of an island arc (no longer in existence) south of the Solomons. This does not seem very probable, as there seems to be no great similarity between the 2 areas in mosquito species which would be much more likely to use such a route than treehole-breeders with a short flight range. However, this possibility cannot be dismissed lightly, since there are indications that such a route has been used by other animals. I have not seen any material of the *"scutellaris"* from the Louisiade Archipelago or the eastern peninsula of New Guinea. Before the problem of *hebrideus* can be clarified, material from this area must be studied critically. There are several other possibilities regarding the nature and origin of *hebrideus*. The original stock may have been introduced from New Guinea by the route north of the Solomons; there is no evidence to support this at present. *A. hebrideus* may be native to the New Hebrides or/and the Santa Cruz group and may have reached the area by way of the Solomons arcs with the intermediate populations now wiped out and replaced by *quasiscutellaris*. Finally, *hebrideus* may be a species of recent hybrid origin, as is *polynesiensis*, through human transport of various stocks within or from outside the area. For the present I regard *hebrideus* as originally endemic to the Santa Cruz–New Hebrides area.

A. hebrideus is quite variable in most characteristics of all stages, as is true not only in other widespread dominant species of the group (such as *polynesiensis* and *marshallensis*) but also in similar ubiquitous plastic adaptable species spread by human agency in other genera of mosquitoes. In addition to individual variation, there are considerable differences between the different populations, particularly those on isolated islands. I have made no attempt to analyze the differences, since in most instances the samples of the populations are not adequate. Perhaps the most striking adult difference is in specimens from the Santa Cruz Islands in which the labium has a distinct light ventral streak, but this character occurs sporadically in other populations.

I have found no specimens which could be considered to be intermediate between *hebrideus* and some other sympatric species in its range. It appears, therefore, that *hebrideus* behaves in nature as a good species in respect to its sympatric congeners. Perry (1950*b*) reported a few successful laboratory crosses between *hebrideus* females and *pernotatus* males, but consisting entirely of females and fertile backcrosses of a few of these females to *pernotatus* males; the reciprocal crosses were all unsuccessful. The F_1 hybrid progeny showed only maternal characters in the adults; the larvae exhibited various abnormalities and some integradation in the anal saddle, pecten teeth, and comb scales. In the backcross generation only a few males survived and only 1 female emerged unsuccessfully. The males appeared to show intergradation in abdominal markings but were closer in this respect to *hebrideus;* the male genitalia, to judge by Perry's rough figures, were essentially similar to those of *pernotatus*. It is significant that in the numerous collections of these 2 species on Espiritu Santo, where they are sympatric and sometimes found breeding in the same treehole, no intermediates in any stage have ever been found. All the hybrids obtained by Perry were very weak, and it is very unlikely that, even if crossing took place in nature, the hybrids could compete successfully with the parental stocks.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *hebrideus* are commonly found in treeholes, in coconut husks and shells, and very commonly in all types of artificial containers. A single collection is known from taro leaf axils. Females attack man readily and are persistent diurnal biters.

A. hebrideus is sometimes a semidomestic pest and may be involved in the transmission of dengue (Daggy, 1944), although Perry (1948) suggests that its role is at most a minor one. *A. hebrideus* apparently is not a vector of filariasis, as it occurs in the area of the periodic nocturnal form. Byrd and St. Amant (1959:56–57) report 3.45 per cent of 377 *hebrideus* infected with *Wuchereria bancrofti* on Espiritu Santo, but with no specimens showing development of larval filariae beyond the fourth day.

DISTRIBUTION (figs. 311, 312).—*Wuvulu Island* (1°43 S., 142°50 E.). *Nuguria Island* (3°18 S., 154°44 E.). *Solomon Islands:* Ontong Java; Bellona; Rennell. *Santa Cruz Islands:* Nupani (Reef Islands); Naelo (Reef Islands); Temotu; Santa Cruz; Tikopia. *Torres Islands:* Toga (Salaun *in* Rageau and Vervent, 1958:17). *Banks Islands:* Vanua Lava. *New Hebrides:* Espiritu Santo; Ulilapa; Malo; Pentecost; Vao; Malekula; Ambrym; Tangoa; Leleppa; Efate; Tana; Futuna; Aneityum. Not known elsewhere.

10. Aedes (Stegomyia) hoguei Belkin, n. sp.

Figs. 311, 312, 333, 334

TYPES.—*Holotype:* ♂ (Brown, 4242) with genitalia slide (570715-1), Hutuna, Rennell Island, Solomon Islands, Nov. 28, 1955, E. S. Brown (BMNH). *Paratypes:* 2 ♂ with genitalia slides (570715-3, 570521-24), 1 ♂ on slide, 1 pupal skin (all Brown, 4242), same data as holotype.

FEMALE.—*Wing:* 3.03 mm. *Proboscis:* 1.9 mm. *Forefemur:* broken off. *Abdomen:* about 2.4 mm. *Head:* eyes moderately separated, frontal scaling extensive; median silvery line relatively broad, reaching erect scales; orbital silvery line partially developed; lateral silvery line narrow, expanded dorsomesad posteriorly; labium with some whitish scales ventrally, probably with distinct streak; apical palpal segment silvery for more than distal half. *Thorax:* median silvery line apparently normal; lateral prescutal line apparently not developed; supraalar silvery line apparently complete, with broad scales posteriorly; posterior dorsocentral line not discernible; prescutellar line distinct, with golden or light coppery scales; median scutellar lobe with numerous dark scales; pleural scaling in narrow streaks, forming distinct diagonal lines, *apn* streak very narrow, upper *stp* narrow, not extending to *ssp* face, lower *mep* large and not connected to upper which is very narrow. *Legs:* forecoxa with broad almost complete median band of dark scales; midcoxa with large apical patch of dark scales; remainder of legs broken off but probably as in the male as follows, (1) foretarsal segments 1 and 2 with a few basal dorsal white scales in 1 specimen, absent in others, (2) midtarsal segment 1 with a few basal dorsal white scales in 1 specimen, absent in others, (3) hindtarsal light scaling restricted, segment 4 silvery for about 0.6, segment 5 completely silvery. *Wing:* costa apparently without basal silvery spot. *Abdomen:* tergites II-VI with arcuate lateral silvery markings, the dorsal parts submedian and not connected by transverse bands; tergite IV with a few scattered unconnected dorsolateral white scales; tergite VII with a straight submedian transverse lateral silvery line, not connected dorsally.

MALE.—Essentially as in the female. *Palpus:* about as long as proboscis. *Legs:* markings described above under female. *Abdomen:* tergal markings in patches rather than arcuate lines, tergite VI with a few white scales dorsally.

MALE GENITALIA (fig. 333).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded or slightly truncate in the middle; lateral tergal lobe indistinct, hidden from above, with 4,5 bristles. *Sidepiece:* moderately long; dorsal bristles long; mesal dorsal area with sparse rather long thin hairs extending to at least middle of sidepiece. *Claspette:* simple; short but prominent, slender, without distinct apicosternal angle; distal 0.25 of sternal margin with a row of about 4–8 short heavy sharply pointed specialized setae; lateral surface with short, slender hairs extending to or basad of most basal specialized bristle; apex with longest hairs about 0.75 of claspette length; mesal surface with patch of long subapical hairs. *Clasper:* relatively slender, distinctly expanded subapically; hairs not numerous; apical spicules moderate; spiniform moderate, slender, subapical.

PUPA (fig. 333).—*Abdomen:* 2.55 mm. *Trumpet:* 0.39 mm. *Paddle:* 0.56 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key. *Cephalothorax:* very lightly pigmented, darker on mesonotum. *Trumpet:* uniformly lightly pigmented, pinna from about 0.6. *Metanotum:* darkened.

Abdomen: lightly pigmented, somewhat darker on basal segments. *Paddle:* uniformly very lightly pigmented, midrib slightly darker.

LARVA (fig. 334).—*Head:* 0.7 mm. *Siphon:* 0.68 mm. *Anal Saddle:* 0.23 mm. Known only in a moderately hairy form; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to darkly pigmented, darkened on collar. *Antenna:* moderately long; pigmentation uniformly darker than on head capsule. *Thorax* and *Abdomen:* hairs and tubercles moderately to strongly pigmented; hairs without conspicuous barbs; hair 13-P present. *Segment VIII:* 10–12 comb scales; free portion of scale spinelike, rather broad and minutely fringed at base. *Siphon:* index about 2.0–2.5; moderately to lightly pigmented, darkened on basal ring; 8,9 pecten teeth, widely spaced and with a single strong subbasal anterior denticle. *Anal Segment:* saddle moderately widely incomplete; moderately to lightly pigmented, darkened at base; marginal spicules very short and slender, grouped.

MATERIAL EXAMINED.—25 specimens; 2 ♀; 3 ♂; 6 pupae; 14 larvae; no individual rearings.

SYSTEMATICS.—*A. hoguei* is a peculiar form, sharing characteristics with several unrelated species. The abdominal and tarsal ornamentation of the adults is suggestive of *horrescens* and *cooki,* the male genitalia are very similar to *varuae*, and the immature stages are most similar to *upolensis*.

The association of the stages of *hoguei* is presumptive only, for no individual rearings are available. It seems very unlikely that more than 2 species of the group would occur on Rennel Island; therefore it is probable that the association is correct.

It is by no means certain that *hoguei* is indigenous to Rennell. It is possible that it is native on one of the islands of the Banks or Torres groups and has been introduced to Rennell. The possibility exists also that it is a form of hybrid origin, possibly recent, with 1 of the parents apparently *varuae* and the other an unknown dark form. In the Banks group there is such a dark form resembling *pernotatus,* but it is known only in the female (see sp. 21, Vanua Lava form). For the present I consider that *hoguei* is endemic to Rennell.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *hoguei* are apparently seldom found in association with *hebrideus.* The 3 known collections were made in coconut shells (de Beaux, R1, R14, R15) and did not include *hebrideus.* However, the majority of the known adults have been reared from a mixed collection, with *hebrideus* predominating (E. S. Brown, 4242). Nothing is known of the habits of the adults; apparently they do not bite readily, as biting collections are unknown. Therefore, this species is probably of no economic importance.

DISTRIBUTION (figs. 311, 312).—*Solomon Islands:* Rennell. Not known elsewhere.

11. Aedes (Stegomyia) horrescens Edwards

Figs. 311, 312, 335, 336

1935. *Aedes* (*Stegomyia*) *scutellaris* var. *horrescens* Edwards, B. Ent. Res. 26:128–129. *TYPE: holotype ♂ (Paine, 81*d*), marked as type by Edwards, with attached genitalia mount and associated larval and pupal skins on slide, Ura, Taveuni, Fiji, from treehole in forest, Apr. 28, 1934, R. W. Paine (BMNH).

Aedes (*Stegomyia*) *horrescens* of Farner and Bohart (1945:45); Stone and Farner (1945:158, in part); Marks (1954); Iyengar (1955:29); Laird (1956:80); Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *scutellaris horrescens* of Knight, Bohart, and Bohart (1944:39, 55).

FEMALE.—*Wing:* 3.0 mm. *Proboscis:* 2.08 mm. *Forefemur:* 1.93 mm. *Abdomen:* about 2.46 mm. *Head:* eyes rather narrowly separated, frontal scaling extensive; median silvery line narrow, reaching erect scales; orbital silvery line not developed; lateral silvery line moderate, expanded dorsomesad caudally; labium with ventral light streak; apical palpal segment silvery for more than distal half. *Thorax:* median silvery line narrow; lateral prescutal light line not developed; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral and prescutellar light lines not developed; median scutellar lobe with numerous dark scales apically; pleural scaling in relatively narrow streaks, forming distinct diagonal lines, *apn* streak rather broad, upper *stp* narrow and not extending on *ssp* face, lower *mep* patch moderately large and usually connected to narrow upper streak. *Legs:* forecoxa with very broad median band of dark scales; midcoxa with numerous apical dark scales; midfemur without anterior silvery line; hindfemur with anterior silvery line long and narrowed apically, ventral surface with distinct light streak to near apex; foretarsus and midtarsus with large silvery markings on segments 1,2 and sometimes a few whitish scales on 3; hindtarsal segment 4 silvery for less than 0.67, segment 5 all silvery. *Wing:* costa with conspicuous basal silvery spot. *Abdomen:* tergites II-VII with arcuate lateral silvery markings, the dorsal parts submedian and not connected by transverse bands; dorsum of tergites IV-VI usually with some scattered light scales indicating incomplete transverse submedian light bands.

MALE.—Essentially as in the female. *Palpus:* about as long as proboscis. *Legs:* tarsal silvery scaling more restricted. *Abdomen:* tergites III-V usually with more or less complete transverse submedian silvery bands; tergite VII with very broad transverse silvery band.

MALE GENITALIA (fig. **335**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite more or less rounded in the middle; lateral tergal lobe prominent but hidden from above, with 3–6 hairs, spicules strong. *Sidepiece:* moderately long; mesal dorsal area with sparse thin hairs extending to about middle of sidepiece and to mesal surface. *Claspette:* simple; short and prominent; apex truncate and with a continuous row of thickened specialized bristles; lateral surface with short hairs. *Clasper:* relatively slender, with slight subapical expansion; hairs few; apical spicules not prominent; spiniform moderately long and slender, subapical.

PUPA (fig. **335**).—*Abdomen:* 3.11 mm. *Trumpet:* 0.45 mm. *Paddle:* 0.69 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented a yellowish brown, mesonotum darker. *Trumpet:* uniformly rather darkly pigmented. *Metanotum:* darkened. *Abdomen:* uniformly moderately pigmented, darker on anterior segments. *Paddle:* uniformly moderately pigmented, midrib darker and brighter; apex rather strongly produced.

LARVA (fig. **336**).—*Head:* 0.76 mm. *Siphon:* 0.82 mm. *Anal Segment:* 0.33 mm. Only hairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, lighter on ocular area, dark on collar. *Antenna:* moderately long; usually darker in basal half. *Thorax* and *Abdomen:* tubercles and hairs strongly pigmented; hairs strongly barbed; degree of hairiness quite variable. *Segment VIII:* 10–16 comb scales; free portion of scale quite broad in dorsal aspect, with numerous conspicuous lateral spicules and a short apical spine. *Siphon:* index about 2.2–2.5; very strongly pigmented, darkened on basal ring, lighter toward apex; 12–22 pecten teeth, majority close-set and with very strong basal anterior denticles. *Anal Segment:* saddle complete; moderately to strongly pigmented, darkened at base and dorsoapically; marginal spicules strongly developed, sharply pointed.

MATERIAL EXAMINED.—237 specimens; 32 ♀; 24 ♂; 53 pupae; 128 larvae; 16 individual larval rearings.

SYSTEMATICS.—Although *horrescens* is a very distinct species, it has been confused in the past with the hairy forms of both *pseudoscutellaris* and *polynesiensis,* and doubt has been cast on its taxonomic status as a species. The male genitalia are strikingly different from any other known species, but the females can be mistaken for *cooki* or even *polynesiensis.* The pupa is somewhat similar to *rotumae* and *pseudoscutellaris,* while the larva shares a number of characters with *cooki, polynesiensis,* and *rotumae.*

A. horrescens is undoubtedly indigenous to the northern islands of the Fiji group and has a restricted distribution, although apparently it has been spread to some extent through human agency. The most likely original home of *horrescens,* on the basis of present knowledge, appears to be Taveuni.

A single male from Makongai has the basal mesal lobe characteristic of *horrescens,* but the specialized apical bristles are not as well developed as usual.

BIONOMICS AND DISEASE RELATIONS.—*A. horrescens* breeds principally in treeholes but will also utilize coconut shells and occasionally artificial containers. It appears to be principally a bush species. *A. horrescens* has been found to be associated in the more open coastal situations with *polynesiensis* but never with *pseudoscutellaris,* although possibly both may occur on Vanua Levu. No specific information is available about the habits of adult *horrescens,* and the relation of this species to the transmission of filariasis is unknown.

DISTRIBUTION (figs. **311, 312**).—*Fiji:* Taveuni; Makongai; Vanua Mbalavu (Nambavatu). Not known elsewhere; this species does not occur on Viti Levu; the "*horrescens*" reported from this island by Manson-Bahr and Muggleton (1952:304–305) is *pseudoscutellaris.* Other tentative identifications and unpublished reports of *horrescens* from elsewhere in the South Pacific (Samoa, Tonga, Tahiti, and so on) are based on hairy forms of *polynesiensis.*

12. Aedes (Stegomyia) marshallensis Stone & Bohart

Figs. **311**, **312**, **337**, **338**

1944. *Aedes* (*Stegomyia*) *marshallensis* Stone and Bohart, Ent. Soc. Wash., Proc. 46:218–219. *TYPE: holotype ♂ (NMS Ser. 31-A3), Airok Island, Ailinglaplap Atoll, Marshall Islands, June 6, 1944, D. A. Treat (USNM, 56983).

Aedes (*Stegomyia*) *marshallensis* of Farner and Bohart (1945:49); Stone and Farner (1945:161); Bohart and Ingram (1946:21–22); Marks (1954:352); Iyengar (1955:29); Laird (1956:80); Bohart (1957:50–51); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 2.77 mm. *Proboscis:* 1.87 mm. *Forefemur:* 1.77 mm. *Abdomen:* about 2.32 mm. *Head:* extremely variable in coloration, all the normally dark decumbent scales may be whitish, erect scales often all yellowish; eyes moderately separated, frontal scaling extensive; median silvery line usually broad, reaching erect scales, indistinct in light-colored specimens; orbital silvery line usually almost complete; lateral silvery line very broad, indistinct in light-colored specimens; labium without ventral light streak; apical palpal segment with silvery scaling usually restricted to distal half or less, sometimes in patches. *Thorax:* extremely variable in coloration, the normal dark scaling may be pale yellowish or light coppery; median silvery line rather broad anteriorly, much shorter than in other South Pacific species, never reaching prescutellar area; lateral prescutal line not developed; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral and prescutellar light lines not developed; median scutellar lobe with or without apical dark scales; pleural scaling in relatively narrow streaks, forming distinct diagonal lines, *apn* streak quite broad, upper *stp* narrow and usually not extending on *ssp* face, lower *mep* patch large and connected to upper. *Legs:* coloration variable, normally dark scales may be light; forecoxa and midcoxa with or without dark scales; forefemur with apical silvery spot very small; midfemur without anterior silvery line; hindfemur extremely variable in coloration, with short anterior silvery line and no distal light ventral line or with most of anterior and ventral surfaces silvery or whitish; foretarsus and midtarsus with very small silvery markings on segments 1,2; hindtarsus with very restricted silvery markings, segments 4,5 never more than one-half silvery. *Wing:* costa with very small basal silvery spot. *Abdomen:* tergal scaling variable; tergite I sometimes with light scales laterad; tergites II-VII with variable silvery markings, II with large basolateral patch, III-VII with more or less arcuate lateral lines with submedian dorsal extensions which are connected by transverse subbasal or premedian bands, II sometimes with basal or subbasal transverse light band.

MALE.—Essentially as in the female. *Palpus:* slightly shorter than proboscis, light scaling on segment 2 usually very restricted. *Legs:* tarsal silvery markings even more restricted.

MALE GENITALIA (fig. 337).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in the middle; lateral tergal lobe more or less prominent, hidden from above, with 6–10 hairs, spicules strong. *Sidepiece:* moderately long; dorsal bristles moderate; mesal dorsal area with sparse short thin hairs in basal half, not extending on mesal surface. *Claspette:* complex; very strongly developed; with conspicuous sternal mesal fingerlike process bearing about 5,6 specialized setae; a very large tergal expanded portion densely covered with long thin hairs, longer in tergomesal area. *Clasper:* moderately slender, with distinct subapical expansion, hairs few; apical spicules very prominent; spiniform moderately long and thick. The figure of the claspette is incorrectly oriented; the fingerlike process should be sternal.

PUPA (fig. 337).—*Abdomen:* 3.05 mm. *Trumpet:* 0.46 mm. *Paddle:* 0.67 mm. Chaetotaxy as figured, hairs lightly to moderately pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, ventral surface lighter. *Trumpet:* uniformly light bright yellowish brown; pinna from about 0.67. *Abdomen:* very lightly pigmented, anterior segments darker. *Paddle:* uniformly very lightly pigmented, midrib darker and brighter.

LARVA (fig. 338).—*Head:* 0.73 mm. *Siphon:* 0.76 mm. *Anal Segment:* 0.26 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to lightly pigmented, darkened on collar. *Antenna:* relatively short and broad; slightly darker than head capsule, particularly at extreme base. *Thorax* and *Abdomen:* hairs and tubercles lightly to strongly pigmented. *Segment VIII:* 6–12 comb scales; free portion of majority of comb scales strongly fringed for more than basal half, apex usually with 2 short spines. *Siphon:* index about 2.8–3.5; moderately pigmented; slightly darkened at base; 5–15 pecten teeth, usually rather widely spaced. *Anal Segment:*

saddle moderately widely incomplete; lightly pigmented, slightly darkened toward base; marginal spicules practically undeveloped.

MATERIAL EXAMINED.—97 specimens; 48 ♀; 8 ♂; 9 pupae; 32 larvae; no individual rearings.

SYSTEMATICS.—*A. marshallensis* is a clearly marked species in the adult stage, with the male genitalia particularly distinctive. In common with other central Micronesian species, the light markings of the hindtarsus are reduced. The larva is generally quite similar to *albopictus, hebrideus, quasiscutellaris,* and *gurneyi* and the pupa to all but the first of these.

A. marshallensis is another of the adaptable plastic species spread through human agency. It shows a great deal of striking variation, particularly in the coloration of the adults, as noted in the diagnosis. I have not studied the different populations critically, but it is evident even in a superficial examination that marked differences in coloration are characteristic of populations on different islands. The northern Gilbert Islands populations (Apamama, Tarawa) are particularly striking, with the general coloration very pale, usually yellowish or light coppery instead of black, and the hindfemur very extensively pale. No males are available for these populations, but there is no reason to doubt that they are a form of *marshallensis,* for they conform well in other respects with the other populations. It is very likely that the coloration in this form is temperature-dependent, as has been shown experimentally by Marks (1954:387–410) for *pseudoscutellaris.*

A. marshallensis is not native to the Marshall Islands. To my knowledge, there is no endemic species of mosquito on any coral atoll anywhere in the world. The original home of *marshallensis* is undoubtedly the eastern Carolines and almost certainly Kusaie, the easternmost of the volcanic islands of the group, where this species has been collected on Hill 541 and Hill 750. It has been spread by the Micronesians to the eastern Caroline atolls and to the Marshalls and the Gilberts, which are all coral atolls.

BIONOMICS AND DISEASE RELATIONS.—According to Bohart (1957:51), the immature stages are found in treeholes, coconut shells, hollows at the base of (fallen) coconut fronds, barrels, and wells. The females are said to bite man readily during the day. Nothing is known of the disease relations of *marshallensis.*

DISTRIBUTION (figs. 311, 312).—*Caroline Islands:* Kusaie; Pingelap (atoll). *Marshall Islands:* widely distributed (Bohart 1957:51). *Gilbert Islands:* Tarawa; Apamama.—*Note: A. marshallensis* has not been reported from the Southern Gilbert Islands, which fall within the South Pacific area considered here. I have not found any mosquito collections from these islands. It has been suggested (Marks, 1954, map) that *marshallensis* occurs in the Southern Gilberts. Manson-Bahr and Muggleton (1952:317, 318) indicate the presence of *polynesiensis* and nonperiodic filariasis in the Southern Gilberts, while Iyengar (1954*b*, maps 3, 4) shows nonperiodic filariasis in these islands but makes no suggestion as to the vector. It seems probable that *marshallensis* will be found in the Southern Gilbert Islands when their mosquito fauna is surveyed.

13. Aedes (Stegomyia) pernotatus Farner & Bohart

Figs. 311, 312, 339, 340

1944. *Aedes* (*Stegomyia*) *pernotatus* Farner and Bohart, Biol. Soc. Wash., Proc. 57:118–119. *TYPE: holotype ♂ (KLK, 946), Segond Channel area, Espiritu Santo, New Hebrides, from treehole containing leaves, Aug. 15, 1943, Ingram and Skorupa (USNM, 57178).

Aedes (*Stegomyia*) *pernotatus* of Farnar and Bohart (1945:45–46); Stone and Farner (1945:161); Perry (1946:17); Marks (1954:352); Iyengar (1955:29); Laird (1956:80); Rageau (1958*a*:877); Rageau and Vervent (1958:18); Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *scutellaris* var. *pseudoscutellaris* of Daggy (1944:293).
Aedes (*Stegomyia*) *variegatus* var. *hebrideus* in part of Buxton and Hopkins (1927).

FEMALE.—*Wing:* 2.46 mm. *Proboscis:* 1.6 mm. *Forefemur:* 1.66 mm. *Abdomen:* about 2.16 mm. *Head:* eyes moderately separated, frontal scaling extensive; median silvery line narrow, reaching erect scales; orbital silvery line partially developed; lateral silvery line narrow; labium with a poorly defined ventral light streak; apical palpal segment largely silvery dorsally. *Thorax:* median silvery line narrow; lateral prescutal light line not developed; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral line more or less distinct, with some silvery scales; prescutellar light line not developed; median scutellar lobe with a few dark apical scales; pleural scaling in relatively narrow streaks, forming distinct diagonal lines, *apn* streak rather broad, upper *stp* narrow and not extending on *ssp* face, lower *mep* patch small, usually detached from upper. *Legs:* forecoxa and midcoxa with a few dark scales; midfemur without anterior silvery line; hindfemur with anterior silvery line moderately long, lower surface without light streak distally; foretarsus and midtarsus with large distinct silvery markings on segments 1–3; hindtarsal segment 4 silvery on basal 0.75–0.8, segment 5 all silvery. *Wing:* costa with conspicuous basal silvery spot. *Abdomen:* tergites II-VII with arcuate lateral silvery markings, the dorsal part submedian, not connected by transverse dorsal bands, a few sublateral dorsal scales sometimes on VI.

MALE.—Essentially as in the female. *Palpus:* very distinctly shorter than proboscis, about 0.75 of its length. *Legs:* silvery scaling on segment 3 of foretarsus and midtarsus much more restricted.

MALE GENITALIA (fig. 339).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in the middle; lateral tergal lobe indistinct, hidden from above, with 7–10 hairs, spicules indistinct. *Sidepiece:* rather short; dorsal bristles strong; mesal dorsal area with rather short slender hairs extending to mesal surface and beyond middle of sidepiece but absent from basal 0.25. *Claspette:* complex; strongly developed but short; a tergomesal fingerlike process bearing 5,6 short thickened specialized setae with attenuate curved apices, tergal and mesal surfaces of process without bristles; body of claspette truncate, with dense vestiture of moderately long hairs throughout. *Clasper:* moderately stout, with very slight subapical expansion; hairs few; apical spicules distinct; spiniform long, moderately thin, subapical.

PUPA (fig. 339).—*Abdomen:* 2.46 mm. *Trumpet:* 0.37 mm. *Paddle:* 0.56 mm. Chaetotaxy as figured, hairs moderately to lightly pigmented; diagnostic characters as in the key. *Cephalothorax:* lightly pigmented, mesonotum darker. *Trumpet:* uniformly moderately pigmented; pinna from about 0.67. *Metanotum:* darkened. *Abdomen:* very lightly pigmented, anterior segments slightly darkened. *Paddle:* practically unpigmented except for very light midrib.

LARVA (fig. 340).—*Head:* 0.71 mm. *Siphon:* 0.69 mm. *Anal Saddle:* 0.25 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, lighter on ocular area, darkened on collar. *Antenna:* moderately long; distinctly darker than head capsule, lighter on apex. *Thorax* and *Abdomen:* tubercles and hairs lightly to strongly pigmented. *Segment VIII:* 8–14 comb scales; majority of scales with very strong basal denticles on free portion but no fine fringes. *Siphon:* index about 2.5–3.0; moderately to strongly pigmented, darkened on basal ring; 6–14 pecten teeth, majority widely spaced. *Anal Segment:* saddle complete; moderately pigmented, slightly darkened at base and dorsoapically; marginal spicules very slightly developed.

MATERIAL EXAMINED.—304 specimens; 82 ♀; 55 ♂; 21 pupae; 146 larvae; 7 individual rearings (all larval).

SYSTEMATICS.—*A. pernotatus* has a characteristic claspette in the male genitalia which, however, is not unlike that found in *aobae*. Females of *pernotatus* are sometimes difficult to differentiate from *polynesiensis*, since the white markings on segment 3 of the foretarsus and midtarsus are occasionally reduced or completely absent. The pupa is most similar to *aobae* and *futunae*, while the larva is not unlike a nonhairy *pseudoscutellaris* except for the development of the comb scales.

Experimental crosses of *pernotatus* with *hebrideus* are discussed under the latter. While there is a considerable amount of variation in *pernotatus*, none of the forms collected in nature could be interpreted as intermediate between these 2 species. There is some indication of differentiation of populations in the various islands in the New Hebrides, but the samples of these are too small to evaluate the constancy of the characters.

Three specimens from Vanua Lava in the Banks group to the north of the New Hebrides resemble *pernotatus* but apparently belong to a distinct form, which is discussed below under sp. 21, Vanua Lava form.

BIONOMICS AND DISEASE RELATIONS.—

The immature stages of *pernotatus* are found chiefly in treeholes. They have been reported also from coconut husks and shells and from wooden frames but not in other types of artificial containers. *A. pernotatus* is a wild species, and females have not been collected biting man in nature. In the laboratory only occasional specimens can be induced to take a human-blood meal. This species appears to be of no economic importance.

DISTRIBUTION (figs. **311, 312**).—*New Hebrides:* Espiritu Santo; Aore; Malo; Pentecost; Malekula; Efate; Aneityum. Not known elsewhere.

14. Aedes (Stegomyia) polynesiensis Marks

Figs. **311, 312, 341, 342**

1951. *Aedes* (*Stegomyia*) *polynesiensis* Marks, Ann. Trop. Med. Parasitol. 45:138. *TYPE: holotype ♂ (Paine, 67*f*) with attached genitalia mount and associated larval and pupal skins on slide, Ura, Taveuni, Fiji, "from barrels used for breeding *Megarhinus*" (= *Toxorhynchites*), Oct., 1933, R. W. Paine (BMNH).

Aedes (*Stegomyia*) *polynesiensis* of Marks (1954); Iyengar (1955:29); Laird (1956:79); Rageau (1958*a*:877; 1959); Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *pseudoscutellaris* of Farner and Bohart (1944:122; 1945:41–44, in part); Bohart and Ingram (1946:12–14); Marks (1951*a*).

Aedes (*Stegomyia*) *scutellaris pseudoscutellaris* in part of Knight, Bohart, and Bohart (1944:39, 55).

Aedes (*Stegomyia*) *scutellaris* var. *pseudoscutellaris* of Edwards (1932:165, in part); Mumford and Adamson (1933:445); Taylor (1934:20, in part); Paine (1935, 1943:19–21, in part).

Aedes (*Stegomyia*) *variegatus* var. *pseudoscutellaris* of Edwards (1926:103, in part); Buxton and Hopkins (1927).

Aedes (*Stegomyia*) *horrescens* of authors reported from Samoa, Tonga, Tahiti, and so on.

Stegomyia pseudoscutellaris of Bahr (1912, in part); O'Connor (1923).

Stegomyia scutellaris of Theobald (1907:179, in part, from Pitcairn Island).

FEMALE.—*Wing:* 3.06 mm. *Proboscis:* 2.05 mm. *Forefemur:* 2.1 mm. *Abdomen:* about 2.43 mm. *Head:* eyes moderately separated, frontal scaling extensive; median silvery line narrow, reaching erect scales; orbital silvery line partially developed; lateral silvery line variable; labium with or without ventral light streak, sometimes extensively pale ventrally; apical palpal segment usually silvery on at least distal half. *Thorax:* median silvery line variable, from very narrow to moderate; lateral prescutal light line not developed, at most 2,3 pale scales near scutal angle; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral line often distinct, with silvery or whitish scales; prescutellar light line usually not developed; median scutellar lobe with numerous apical dark scales; pleural scaling in relatively narrow streaks, forming distinct diagonal lines, *apn* streak long and narrow, upper *stp* narrow but a few detached scales often present on *ssp* face, lower *mep* patch moderate and usually detached from upper. *Legs:* dark scaling on forecoxa and midcoxa variable; midfemur without anterior silvery line; hindfemur with anterior silvery line long, lower surface with or without distal light streak; foretarsus and midtarsus with moderate silvery markings on segments 1,2, sometimes a few white scales on segment 3 of foreleg; hindtarsal segment 4 silvery on about basal 0.70, segment 5 all silvery. *Wing:* costa with small basal silvery spot. *Abdomen:* tergites II-VII with slender arcuate lateral silvery markings, the dorsal part submedian and not connected above, no indication of transverse bands.

MALE.—Essentially as in the female. *Palpus:* varied in length but always distinctly shorter than proboscis.

MALE GENITALIA (fig. **341**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite slightly rounded or truncate in the middle; lateral tergal lobe not very prominent, hidden from above, with 4–6 hairs, spicules moderate. *Sidepiece:* long; dorsal bristles strong; mesal dorsal area with sparse, very short, thin hairs restricted to basal half and extending slightly mesad. *Claspette:* simple; rather long; without apicosternal angle and without specialized setae on sternal margin; lateral surface with numerous hairs extending to nearly point of attachment, hairs short basad, progressively longer distad; apex with long bristles, longest about 0.75 of lobe length. *Clasper:* very slender, with slight subapical expansion; hairs few; apical spicules moderate; spiniform long, slender, subapical.

PUPA (fig. **341**).—*Abdomen:* 3.49 mm. *Trumpet:* 0.46 mm. *Paddle:* 0.74 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* strongly pigmented a yellowish brown; lighter ventrally. *Trumpet:* uniformly darkly pigmented a bright yellowish brown; pinna from about 0.7. *Abdomen:* uniformly rather darkly pigmented, lighter distally. *Paddle:* uniformly moderately pigmented, midrib darker and brighter.

LARVA (fig. **342**).—*Head:* 0.82 mm. *Siphon:* 0.76 mm. *Anal Saddle:* 0.29 mm. Both hairy and nonhairy forms known, with all intermediates; chaetotaxy figured for nonhairy form, hairy form in general as figured for *pseudoscutellaris* and *horrescens;* diagnostic characters as in the key, applicable to hairy, nonhairy, and intermediate forms. *Head:* moderately to strongly pigmented, slightly lighter on ocular area, darkened on collar. *Antenna:* moderately long; distinctly darker than head capsule except at extreme apex. *Thorax* and *Abdomen:* hairs and tubercles moderately to strongly pigmented; hairs strongly barbed in hairy forms. *Segment VIII:* 8–16 comb scales; free portion of majority of comb scales slender, spinelike, with fine fringes in less than basal half. *Siphon:* index about 2.5–3.2; moderately to strongly pigmented, darkened on basal ring; 8–16 pecten teeth, majority usually rather widely spaced. *Anal Segment:* saddle complete; moderately pigmented, darkened basally; marginal spicules variable, short and inconspicuous in nonhairy form, strongly developed in hairy.

MATERIAL EXAMINED.—1,675 specimens; 849 ♀; 280 ♂; 87 pupae; 459 larvae; 24 individual larval rearings.

SYSTEMATICS.—*A. polynesiensis* is very similar to *pseudoscutellaris,* from which it has been separated only recently. The only reliable characters to separate *polynesiensis* from *pseudoscutellaris* have been negative ones: the absence of specialized bristles on the sternal border of the claspette of the male genitalia and the absence of a distinct lateral prescutal light line in both sexes. Both characters are somewhat variable in *pseudoscutellaris.* In the larval stage Marks (1951*b*:138) used differences in relative length of the dorsal and ventral anal gills; this character I find extremely variable. In the course of the present study, apparently reliable characters to separate the 2 forms have been found in the larva and the pupa. As indicated in the key to the larvae, in *polynesiensis* the most caudal hair of the ventral brush is branched, while in *pseudoscutellaris* it is single, even in very hairy forms in which other hairs are strongly branched. In the pupa, hair 1 of abdominal segment II is secondarily branched in *polynesiensis,* primarily only in *pseudoscutellaris.* In both instances, the diagnostic characters were determined from only a few individual rearings but were found to be remarkably constant in all the remaining available material of immature stages of both forms.

The taxonomic status of *polynesiensis* is open to question. Marks (1954) regards it as a full species. Rozeboom and Gilford (1954) and Woodhill (1954) crossed *polynesiensis* from Samoa and Tahiti, respectively, with *pseudoscutellaris,* which occurs only on Fiji, and obtained fertile progeny with intermediate adult characteristics; in both instances, there was a reduced egg fertility in the F_1 generation. In subsequent generations of the hybrids, which were studied by Rozeboom and Gilford, the egg fertility approached that of the parental stocks. In mating selection experiments, these workers found that *polynesiensis* females were readily inseminated by *pseudoscutellaris* males (51 per cent) as compared to their own males (72 per cent), while *pseudoscutellaris* females were less readily inseminated by *polynesiensis* males (20 per cent) and even by their own males (43 per cent). These experimental crosses show only that there is a partial genetic and reproductive barrier between the 2 forms in question and that, under the particular experimental conditions, hybridization will occur between the populations studied; they do not settle the taxonomic status of *polynesiensis.* The 2 forms are allopatric except in the Fiji group. No hybridization experiments have been made with these sympatric populations. As far as I have been able to determine, on Fiji *polynesiensis* has the same types of breeding places as *pseudoscutellaris;* I have several records of *polynesiensis* and *horrescens* from the same collection, but it is not known if these were found in a single habitat. There appear to be no intermediates between *polynesiensis* and either of the other 2 forms in nature; however, this matter needs clarification through numerous individual rearings, since there appears to be considerable variation in the male genitalic and prescutal scaling characters of *pseudoscutellaris.* Some of these variants could possibly be hybrids. My impression is that *polynesiensis* behaves in nature as a perfectly distinct species, and I am treating it as a full species for the present. The question of the taxonomic status of the 2 forms is far from being settled, however.

There is a strong possibility that *polynesiensis* is a species of recent hybrid origin, possibly between *pseudoscutellaris* and *upolensis;* the site of origin is impossible to determine, but Samoa or the Lau group of Fiji appear to be the most likely localities. On the other hand, *polynesiensis* may have been formed through isolation prior to the advent of man on one of the islands in the central Polynesian area, or possibly even in the Society Islands. This problem cannot be resolved without extensive collections from natural breeding sites in the interior of the various islands of the area as well as cytogenetic studies and experimental crosses. At any rate, it is quite evident that *polynesiensis* has been widely distributed by Polynesians from its original center. For the present I consider *polynesiensis* to have been originally endemic to Samoa. Through most of its range it is the only species of the group, but toward the west it occurs sympatrically with other members. In the Samoan group, *polynesiensis* and *upolensis* now are found on at least two of the main islands. On the isolated island of Wallis (Uea), either a peculiar population of *polynesiensis* or an endemic undescribed form (or both) is present but cannot be characterized, as males are unknown; these forms are treated separately below as sp. 22, Wallis form. In the isolated Horne (Futuna) group, *polynesiensis* is known together with the endemic *futunae.* And finally, in the Fiji group, it occurs sympatrically with *pseudoscutellaris* and *horrescens,* the latter 2 being apparently largely allopatric. *A. polynesiensis* apparently has not yet penetrated into Rotuma and the Tonga group; if it has, it has not been able to get established or compete with the endemic species, *rotumae* and *tongae.* On the island of Niue, the endemic *cooki* appears to be a species of hybrid origin between *polynesiensis* and *tongae.*

A. polynesiensis is an extremely adaptable, plastic, and variable species. Individual, ecological, and geographical variations are all evident, but I have made no attempt to study the different variants and populations. Although a great deal of material is available for study, there are very few individual rearings, or even reliable notes on breeding sites, to enable one to correlate and evaluate the variations. In the larval stage various degrees of hairiness are known; treehole-breeders are particularly prone to strong hairiness. The most hairy larvae are superfically very strikingly different from the nonhairy forms and can be easily mistaken on superficial examination for those of *horrescens* and *pseudoscutellaris,* which are usually strongly hairy; this has led to erroneous reports of *polynesiensis* as *horrescens,* in particular. Rosen and Rozeboom (1954) reported on some studies on the variation in hairiness in *polynesiensis, pseudoscutellaris,* and *horrescens.* Unfortunately, the larva they figure as the extreme hairy type of *polynesiensis* is actually that of a hairy *upolensis,* which is readily separable from the former by the development of hair 13 on the prothorax and the incomplete saddle of the anal segment.

BIONOMICS AND DISEASE RELATIONS.—*A. polynesiensis* is a semidomestic species with an extremely wide range of breeding habitats. Its original breeding places were probably treeholes, and it still uses these widely wherever it occurs. It is very commonly found in coconut shells and husks, is frequently found in canoes, and utilizes artificial containers of various types. An unusual feature of the species is its ability to breed in restricted accumulations of water on the ground; it has been found breeding in crabholes at least occasionally. This tolerance and plasticity in utilization of breeding sites is undoubtedly largely responsible for the success of the species and its wide dispersal by Polynesians in the South Pacific.

Females of *polynesiensis* have become adapted to man for their blood source. The original hosts were undoubtedly birds, and possibly bats, since these were the only warm-blooded vertebrates available in the area before the advent of man. Biting activity of *polynesiensis* is largely diurnal but shows a distinct peak in late afternoon and a lesser one in early morning.

A. polynesiensis is probably the most important vector of nonperiodic filariasis wherever it occurs in Polynesia. It is not necessarily the only vector, however. On some isolated islands, such as the Horne group, it does not appear to be as common as the local endemic member of the *scutellaris* group and may be of little importance in the transmission of filariasis. It does not occur in the Tonga group and on Niue and Rotuma; here filariasis is transmitted probably by local endemic species of the *scutellaris* group. In Fiji not only *polynesiensis* but also the related *pseudoscutellaris,* as well as *fijiensis* of the *kochi* group, transmit filariasis; the relative importance of these in the various islands and areas within individual islands remains to be determined.

DISTRIBUTION (figs. **311, 312**).—*Fiji:* Vanua Levu; Taveuni; Wai Lailai (Yasawa group); Viti

Levu; Vanua Mbalavu; Makongai; Totoya; Mango; Moala; Lau group; Lakemba; Karoni; Oneata; Mothe; Katafanga; Yangasa; Namuka; Vanua Vatu; Kimbombo; Munia; Tuvutha; probably many other islands. *Horne Islands* (Hoorn, Futuna): Alofi. ? *Wallis Islands:* Uea; see also sp. 22, Wallis Island form. *Ellice Islands:* Lakena; Nanomea; Nanomana; Nui; Vaitupu; Funafuti; no males available, adults and larvae appear to be *polynesiensis*. *Tokelau Islands:* Atafu; Nukunomo; Fakaofo (Laird, 1959). *Samoa:* Swains; Savaii; Upolu; Tutuila; Manua. *Northern Cook Islands:* Pukapuka; Motukatava; Motuko; probably present on other islands. *Southern Cook Islands:* Aitutaki; Rarotonga; Mauke. *Society Islands:* Borabora; Raiatea; Huahine; Tubai Manu; Moorea; Tetiaroa; Tahiti; Mehetia. *Austral (Tubuai) Islands:* Rimatara; Rurutu; Tubuai; Raivavae. *Marquesas Islands:* Eiao; Nuku Hiva; Ua Huka; Hiva Oa; Tahu Ata; Motane; Fatu Hiva. *Tuamotu Archipelago:* Makatea; Toau; Fakarava; Anaa; Hao; Taravai; Mangareva; Katin. *Pitcairn Island* (Theobald, 1907:179). Not known elsewhere.

15. Aedes (Stegomyia) pseudoscutellaris (Theobald)

Figs. **311**, **312**, **343**, **344**

1910. *Stegomyia pseudoscutellaris* Theobald, Entomologist 43:156–158. *TYPE: lectotype ♀, Suva, Viti Levu, Fiji, F. Jepson, 14; 1 of 2 remaining syntypes, by present selection (BMNH).

Aedes (*Stegomyia*) *pseudoscutellaris* of Farner and Bohart (1945:41–44, in part); Marks (1951*b*:138; 1954); Iyengar (1955:29); Laird (1956:80); Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *scutellaris pseudoscutellaris* in part of Knight, Bohart, and Bohart (1944:39, 55).

Aedes (*Stegomyia*) *scutellaris* var. *pseudoscutellaris* of Edwards (1932:165, in part); Taylor (1934:20, in part); Paine (1935, 1943:19–21, in part).

Aedes (*Stegomyia*) *variegatus* var. *pseudoscutellaris* of Edwards (1926:103, in part).

Aedes (*Stegomyia*) *horrescens* of Manson-Bahr and Muggleton (1952:304–305).

Stegomyia pseudoscutellaris in part of Bahr (1912).

FEMALE.—*Wing:* 2.08 mm. *Proboscis:* 1.83 mm. *Forefemur:* 1.73 mm. *Abdomen:* about 2.33 mm. *Head:* eyes moderately separated, frontal scaling extensive; median silvery line very narrow, reaching erect scales; orbital silvery line strongly developed but incomplete; lateral silvery line rather narrow; labium with or without ventral light streak; apical palpal segment usually silvery on at least distal half. *Thorax:* median silvery line usually very narrow; lateral prescutal line always more or less developed, with at least 5 silvery scales at scutal angle; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral line more or less distinct anteriorly, with golden or silvery scales; prescutellar line not developed or at most with 2,3 silvery scales; median scutellar lobe with numerous dark scales apically; pleural scaling in narrow streaks, forming distinct diagonal lines, *apn* streak long and narrow, upper *stp* very long and narrow, lower *mep* patch rather large and detached. *Legs:* forecoxa with broad median band of dark scales; midcoxa with large apical patch of dark scales; midfemur without anterior silvery line; hindfemur with anterior silvery line long, lower surface without light streak distally; foretarsus and midtarsus with large silvery markings on segments 1,2; hindtarsal segment 4 silvery on about basal 0.7, segment 5 all silvery. *Wing:* costa with moderate basal silvery spot. *Abdomen:* tergites II-VII with slender arcuate lateral silvery markings, the dorsal parts postmedian and not connected transversely on any segment.

MALE.—Essentially as in the female. *Palpus:* slightly shorter than proboscis.

MALE GENITALIA (fig. **343**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite slightly rounded or truncate in the middle; lateral tergal lobe not very prominent, hidden from above, with 4-6 hairs, spicules strong. *Sidepiece:* long; dorsal bristles strong; mesal dorsal area with sparse short hairs restricted to basal half and not extending mesad. *Claspette:* simple; rather long; without apicosternal angle; sternal margin with a row of 4–6 distinctly flattened sharply pointed specialized setae in distal 0.25; lateral surface with short thin hairs extending to nearly point of attachment, apical 0.2 with longer heavier hairs; apex with long hairs, longest about 0.75 of lobe length. *Clasper:* slender, with slight subapical expansion; hairs few; apical spicules moderate; spiniform long, slender, subapical.

PUPA (fig. 343).—*Abdomen:* 2.75 mm. *Trumpet:* 0.39 mm. *Paddle:* 0.61 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented a dull blackish brown, lighter ventrally. *Trumpet:* uniformly dark blackish brown; pinna from about 0.67. *Abdomen:* moderately pigmented a dull blackish brown, darker anteriorly. *Paddle:* uniformly pigmented a light dull blackish brown, midrib darker.

LARVA (fig. 344).—*Head:* 0.77 mm. *Siphon:* 0.96 mm. *Anal Saddle:* 0.35 mm. Both hairy and nonhairy (laboratory colony) forms known; chaetotaxy figured for hairy form; chaetotaxy of nonhairy form in general as figured for *polynesiensis;* diagnostic characters for both forms as in the key. *Head:* moderately pigmented, slightly lighter on ocular area, darkened on collar. *Antenna:* unusually long, distinctly wider in basal third; darker and blacker than head capsule, somewhat lighter distally. *Thorax* and *Abdomen:* hairs and tubercles strongly pigmented; hairs strongly barbed. *Segment VIII:* 8–14 comb scales; majority of comb scales with long slender spinelike free portion with only fine fringes at base. *Siphon:* index about 3.0–3.5; usually extremely darkly pigmented, spicules sometimes prominent but always short; 8–14 pecten teeth, majority widely spaced. *Anal Segment:* saddle complete; usually very darkly pigmented, sometimes lighter than siphon; marginal spicules apparently always rather short, slender.

MATERIAL EXAMINED.—334 specimens; 117 ♀; 60 ♂; 6 pupae; 151 larvae; 2 individual larval rearings.

SYSTEMATICS.—*A. pseudoscutellaris* is very similar to *polynesiensis,* but the 2 forms can be fairly readily differentiated in all stages; their relationships are discussed above under *polynesiensis.* I find that the most distinctive and reliable character to separate *pseudoscutellaris* from *polynesiensis* is the unbranched condition of the hindmost pair of hairs of the ventral brush of the anal segment of the larva. In addition, the comb scales appear to be distinctive and the ventral anal gill is proportionately longer; however, these characters appear to be quite variable. The ventral brush hair, on the other hand, remains single even in the extremely hairy forms of *pseudoscutellaris* and is branched even in the least hairy *polynesiensis* larvae that I have seen.

Among a number of larval skins from a subculture of the London colony of *pseudoscutellaris* used by Rozeboom and Gilford (1954) in crossbreeding experiments with *polynesiensis,* I find 1 specimen which has the ventral brush hair branched as in *polynesiensis* and, in addition, a similar type of comb scales. At least 1 other larval skin appears to be *polynesiensis.* Several possible explanations for this anomaly are suggested: (1) this character may not be as reliable as it appears to be in the rest of the material I have seen; (2) the original colony or the subculture was contaminated and contained both forms; (3) an error occurred in the preparation and labeling of the slides.

A. pseudoscutellaris is not known outside Fiji. Its range within the group does not seem to overlap with *horrescens,* although it is possible that both species occur on Vanua Levu.

BIONOMICS AND DISEASE RELATIONS.—Very little specific information about the bionomics of *pseudoscutellaris* is available at present because of the confusion of this species with *horrescens* and *polynesiensis.* Very few collections of immature stages of *pseudoscutellaris* have been available for this study, but the larval habitat is known for several collections of adults which appear to be typical of this species. In general it appears that *pseudoscutellaris* utilizes the same types of habitats as *polynesiensis* and that the 2 forms are sometimes collected in the same area; however, it is not known if immature stages are found together in the same individual breeding places. On the basis of the habitat notes available to me, it can be said that *pseudoscutellaris* breeds in various types of treeholes, bamboo, native gongs (lali), and crabholes.

It has been noted by various investigators that *pseudoscutellaris* adults are not as vigorous as those of *polynesiensis.* However, at least on 2 occasions, successful laboratory colonization of *pseudoscutellaris* has been obtained. It seems probable that different strains vary in vigor as well as ability to feed on man, for Manson-Bahr and Muggleton (1952:304–305) had difficulty rearing and feeding the hairy treehole forms of *pseudoscutellaris,* which they identified as *horrescens,* while the London colony of presumably nonhairy *pseudoscutellaris* was established and maintained without difficulty from material collected apparently in the same area.

In former investigations on the transmission of filariasis on Fiji, no distinction was made between *pseudoscutellaris* and *polynesiensis.* At the present there is no published information on the relative importance of the 2 forms as vectors of *W. bancrofti.*

DISTRIBUTION (figs. **311, 312**).—*Fiji:* Vanua

Levu; Viti Levu; Kandavu; Lau group; probably occurs on other islands as well but apparently not sympatrically with *horrescens.* Not known elsewhere.

16. Aedes (Stegomyia) quasiscutellaris Farner & Bohart

Figs. **311**, **312**, **345**, **346**

1944. *Aedes* (*Stegomyia*) *quasiscutellaris* Farner and Bohart, Biol. Soc. Wash., Proc. 57:120–121. *TYPE: holotype ♂ (JNB, 241), genitalia intact, Poha-Bonegi area, Guadalcanal, Solomon Islands, from foxhole, Mar. 3, 1944, S. Civinski and E. J. McCormick, Jr. (USNM, 57179).

Aedes (*Stegomyia*) *quasiscutellaris* of Farner and Bohart (1945:47–49); Stone and Farner (1945:161); Marks (1954:352); Iyengar (1955:29); Laird (1956); Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *scutellaris scutellaris* in part of Knight, Bohart, and Bohart (1944:39, 55).

Aedes (*Stegomyia*) *scutellaris* in part of Edwards (1932:165); Taylor (1934:20).

Aedes (*Stegomyia*) *variegatus* of Edwards (1926:101–102, in part); Paine and Edwards (1929:305–306).

FEMALE.—*Wing:* 2.86 mm. *Proboscis:* 2.0 mm. *Forefemur:* 1.91 mm. *Abdomen:* about 2.66 mm. *Head:* eyes widely separated, frontal scaling extensive; median silvery line broad, reaching erect scales; orbital silvery line poorly developed; lateral silvery line broad; labium with ventral light streak usually strongly developed; apical palpal segment silvery on most of dorsal surface. *Thorax:* median silvery line rather broad; lateral prescutal line not developed to strongly developed anteriorly (in Bougainville populations), scales silvery; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral and prescutellar light lines distinct, usually with silvery, golden, or light coppery scales; median scutellar lobe with relatively few dark scales apically; pleural scaling in rather broad streaks, forming distinct diagonal lines, *apn* streak rather broad, upper *stp* rather broad and rarely with a few scales on *ssp* face, lower *mep* patch moderate to large, detached or connected to upper. *Legs:* forecoxa and midcoxa with variable dark scaling; midfemur without anterior silvery line; hindfemur with anterior silvery line long, lower surface without light streak distally; foretarsus and midtarsus with large silvery markings on segments 1,2 and a few white scales on segment 3 of midleg; hindtarsal segment 4 silvery in basal 0.7 dorsally, segment 5 all silvery. *Wing:* costa without basal silvery spot. *Abdomen:* tergites II-VI with slender arcuate lateral silvery markings, the dorsal parts submedian and connected on III-VI by usually complete transverse bands which are subbasal in the middle; tergite VII with submedian transverse silvery band.

MALE.—Essentially as in the female. *Labium:* with very conspicuous ventral light streak. *Palpus:* about as long as proboscis. *Abdomen:* tergite II with an incomplete transverse silvery band; all transverse silvery bands farther removed from base of segments.

MALE GENITALIA (fig. **345**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite truncate or slightly rounded in middle; lateral tergal lobe more or less prominent but hidden from above, with 4–6 hairs, spicules weak. *Sidepiece:* moderate in length; dorsal bristles strong; mesal dorsal area with sparse rather long thin hairs extending to beyond middle but not on mesal surface. *Claspette:* complex; strongly developed but short; apex diagonally truncate laterad and expanded but without fingerlike process; disc of expansion largely without hairs, mesal margin with thickened setae, tergal and lateral with more slender bristles. *Clasper:* moderately stout, with slight subapical expansion; hairs few; apical spicules distinct; spiniform moderately long and slender, subapical.

PUPA (fig. **345**).—*Abdomen:* 3.43 mm. *Trumpet:* 0.48 mm. *Paddle:* 0.69 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented a yellowish brown, darker on mesonotum. *Trumpet:* uniformly pigmented a moderate bright yellowish brown; pinna from about 0.65. *Matanotum:* darkened. *Abdomen:* moderately pigmented a slightly yellowish brown, darker anteriorly. *Paddle:* moderately pigmented a slightly yellowish brown, midrib darker and brighter.

LARVA (fig. **346**).—*Head:* 0.83 mm. *Siphon:* 0.85 mm. *Anal Segment:* 0.32 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately pigmented, collar darkened. *Antenna:* rather short; somewhat darker than head capsule, particularly at base. *Thorax* and *Abdomen:* hairs and tubercles moderately to strongly pigmented. *Segment VIII:* 6–14 comb scales; free portion of median scale distinctly widened at base and shorter than attached portion in dorsal aspect. *Siphon:* index about 2.25–3.00; moderately to strongly pigmented, sometimes darkened on basal ring; 6–12 pecten teeth, all widely spaced except at base. *Anal Segment:* saddle moderately widely incomplete; moderately to lightly pigmented, darkened at base; marginal spicules usually completely undeveloped.

MATERIAL EXAMINED.—3,443 specimens; 921 ♀; 776 ♂; 474 pupae; 1,272 larvae; 37 individual rearings (35 larval, 2 pupal).

SYSTEMATICS.—*A. quasiscutellaris* is difficult to differentiate from *hebrideus* in all stages but the male. The majority of the adults I have seen lack the spot of silvery scales at the base of vein C of the wing; these scales are usually distinct in the majority of other members of the group. The prescutal light line, used by Marks (1954:383) to differentiate this form, is not developed in the majority of the specimens I have seen. I have not been able to find reliable characters to separate the larvae of *quasiscutellaris* and *hebrideus;* those given in the key are subject to considerable variation in the different populations of both species.

A. quasiscutellaris is a very plastic, adaptable, and highly variable species, which appears to be in the process of evolving into more or less distinct forms within the Solomons. A great deal of individual, ecological, and geographical variation is evident, but the material available to me is unsuitable for an analysis of the various populations, chiefly because of the lack of individual rearings from all islands except Guadalcanal. The variation in the prescutal light line of the mesonotum of the adults is quite striking; some individuals show an almost complete line of light or silvery scales, others have a small patch at the anterior end near the lateral part of the anterior promontory, and the majority lack light scales completely. Specimens from Bougainville in general have a well-developed light line, those from the New Georgia group appear to lack it completely, while on Guadalcanal the line occurs sporadically and rather uncommonly but is never strongly developed. In all populations the male genitalia show little variation.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *quasiscutellaris* are commonly found in treeholes, coconut husks and shells, and all types of artificial containers. A few collections have been made in pandanus leaf axils. The occasional presence of immature stages in ground pools is probably owing to flushing from normal breeding sites. Marks (1954:378) cites *quasiscutellaris* as one of the species of the group which has an "avidity for human blood," but this is certainly not true on Guadalcanal, where this species is very abundant around native villages as well as in the bush but very seldom bites man. This seems to be true in several places elsewhere in the Solomons as well, for during World War II the marked contrast in biting habits between *hebrideus* and *quasiscutellaris* gave the first indication that 2 different forms were involved. However, it is quite possible that in some localities *quasiscutellaris* may attack man readily.

Nothing is known of the vector propensities of *quasiscutellaris,* but this species is not likely to be of any importance in disease transmission, because it appears to use man as a blood source only occasionally.

DISTRIBUTION (figs. **311, 312**).—*Solomon Islands:* Bougainville; Treasury; Gizo; Wanawana; New Georgia; Roviana; Rendova; Russell; Florida; Tulagi; Guadalcanal; Malaita. Not known definitely elsewhere; a record from Nissan (Green Island) by Laird (1952:153) may be an introduction of *quasiscutellaris* from the Solomons or, more probably, a misidentification of another member of the *scutellaris* group, since this form is said to bite readily in the shade.

17. Aedes (Stegomyia) rotumae Belkin, n. sp.

Figs. **311, 312, 347, 348**

TYPES.—*Holotype:* ♂ (Bonnet, 17-0) with genitalia slide (570517-3), Oinafa village, Rotuma Island, from treehole, Aug. 4, 1956, D. Bonnet (USNM, 64796). *Allotype:* ♀ (Bonnet, 15-4A) with associated pupal skin, same data as holotype except bred from partially burned coconut half (USNM). *Paratypes:* 13 ♀, 9 ♂, 32 pupae, 117 larvae, all same locality and collector as holotype, as follows: 1 ♂ (Bonnet, 12-1) with associated pupal skin, 8 larvae (Bonnet, 12-0), treehole in large "Hefau" tree, Aug. 4, 1956; 2 larvae (Bonnet, 13-0), step cut in coconut palm, Aug. 4, 1956; 1 ♀ (Bonnet, 14-0), taken biting at night in chief's house, Aug. 3–4, 1956; 3 ♀ (Bonnet, 15-1A, 2A, 3A) with associated pupal skins, 1 ♂ (Bonnet, 15-5A) with associated pupal skin, 1 ♂ (Bonnet, 15-1), 15 pupae, 43 larvae (Bonnet, 15-0), same data as allotype; 2 ♀, 3 ♂, 5 pupae, 20 larvae (Bonnet, 17-0), same data as holotype; 15 larvae (Bonnet, 18-0), from tin can in bush area at edge of village, Aug. 4, 1956; 3 ♀, 1 ♂ (Bonnet, 20-0), net sweepings in bush area back of village, Aug. 4, 1956; 2 ♀ (Bonnet, 21-2, 6) with associated pupal skins, 2 ♀ (Bonnet, 21-3, 5) with associated larval and pupal skins, 1 ♂ (Bonnet, 21-1) with associated pupal skin, 1 ♂ (Bonnet, 21-3A) with associated larval and pupal skins, 1 pupal skin, 26 larvae (Bonnet, 21-0), mixed collection from treehole, coconut halves, and tin cans in bush area behind village, Aug. 5, 1956.

Aedes (*Stegomyia*) sp. in *scutellaris* group of Marks (1954:353, pl. 18); Iyengar (1955:29).

Aedes (*Stegomyia*) *pseudoscutellaris* in part of Farner and Bohart (1945:44).

Aedes (*Stegomyia*) *variegatus*, var. near *pseudoscutellaris* of Edwards (1929*b*:338).

FEMALE.—*Wing:* 3.08 mm. *Proboscis:* 1.86 mm. *Forefemur:* 2.0 mm. *Abdomen:* about 2.42 mm. *Head:* eyes rather narrowly separated, frontal scaling restricted; median silvery line narrow, reaching erect scales; orbital silvery line not developed at all; lateral silvery line relatively narrow; labium with indistinct ventral light streak; apical palpal segment with silvery scaling restricted to distal half and sharply separated from dark scaling. *Thorax:* median silvery line relatively broad anteriorly; lateral prescutal light line not developed; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral and prescutellar lines not developed; median scutellar lobe with relatively few dark scales apically; pleural scaling in rather broad streaks, forming distinct diagonal lines, *apn* streak rather broad, upper *stp* broad but not extending on *ssp* face, lower *mep* patch completely absent, upper *mep* streak broad. *Legs:* forecoxa and midcoxa with variable amount of dark scaling; midfemur without anterior silvery line; hindfemur with anterior silvery line moderate in length, lower surface without light streak distally; foretarsal segments 1,2 with moderate silvery markings, midtarsal segments 1,2 similar but markings on 2 reduced; hindtarsal segment 4 silvery for more than 0.75, segment 5 entirely silvery. *Wing:* costa with small but distinct basal silvery spot. *Abdomen:* tergites II-VII with progressively larger subbasal lateral broad silvery patches, not arcuate lines, patches produced dorsad but without transverse connections.

MALE.—Essentially as in the female. *Palpus:* about as long as proboscis. *Abdomen:* tergites IV-VI with incomplete dotted transverse silvery bands, some indication of band also on III.

MALE GENITALIA (fig. 347).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded or slightly truncate in the middle; lateral tergal lobe prominent but partially hidden from above, with 5-7 hairs, spicules strong. *Sidepiece:* rather short and broad; dorsal bristles moderate; mesal dorsal area with numerous long hairs extending from base to near apex and extensively on mesal surface. *Claspette:* simple; prominent but short; sternal surface truncate, oval, with 3–5 strongly flattened specialized setae in about middle of mesal margin; remainder of sternal surface with long thin apically curved hairs; tergal apex with longer straight hairs. *Clasper:* heavy, slightly widened toward apex but not expanded; hairs rather numerous; apical spicules very long and conspicuous; spiniform short and heavy, subapical.

PUPA (fig. 347).—*Abdomen:* 3.32 mm. *Trumpet:* 0.47 mm. *Paddle:* 0.67 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately to rather darkly pigmented, ventral surface lighter. *Trumpet:* uniformly moderately pigmented a slightly yellowish brown, darkened anteriorly. *Abdomen:* moderately pigmented a light yellowish brown, darkened anteriorly. *Paddle:* uniformly moderately yellowish brown, midrib darker and brighter.

LARVA (fig. 348).—*Head:* 0.78 mm. *Siphon:* 0.71 mm. *Anal Saddle:* 0.26 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately to strongly pigmented, lighter on ocular area, darkened on collar. *Antenna:* moderately long; usually distinctly lighter at base than beyond, remainder darker than head capsule. *Thorax* and *Abdomen:* hairs and tubercles moderately to strongly pigmented; hairs without conspicuous barbs. *Segment VIII:* 8–12 comb scales; treehole larvae have the free portion of scale with multiple spines, coconut larvae usually have a single short apical spine and widened basal portion with numerous strong spicules. *Siphon:* index about 2.0–2.5; moderately to very strongly pigmented; 8–12 pecten teeth, majority widely spaced. *Anal Segment:*

saddle complete; lightly to moderately pigmented, darkened at base; marginal spicules short but distinct, especially dorsad.

MATERIAL EXAMINED.—179 specimens; 15♀; 11♂; 33 pupae; 120 larvae; 12 individual rearings (3 larval, 9 pupal).

SYSTEMATICS.—*A. rotumae* is a very interesting species which resembles *upolensis* from Samoa in the adult stage in the complete absence of the lower mesepimeral patch of silvery scales. The male genitalia are distinctive but show some resemblance to *horrescens*. The pupa is also somewhat similar to *horrescens*, and *pseudoscutellaris* as well, while the larva resembles *horrescens* and *polynesiensis*.

A. rotumae is one of the 2 known endemic species of mosquitoes on the island of Rotuma. This island, together with several adjoining islets, is extremely isolated and is very seldom visited. It is of interest that *polynesiensis* does not occur there.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *rotumae* have been collected in treeholes (Bonnet, 12, 13, 17), in a coconut shell (Bonnet, 15), and in a tin can (Bonnet, 18). The only other collection (Bonnet, 21) was a mixed one from all 3 types of habitats. A single female (Bonnet, 14) was taken biting man at night, and 1 male and 3 females were swept from a bush area (Bonnet, 20). Since no *polynesiensis* have been collected on Rotuma and filariasis is prevalent on the island, it seems likely that *rotumae* is the vector.

DISTRIBUTION (figs. **311**, **312**).—*Rotuma Island*. Not known elsewhere.

17a. Aedes (Stegomyia) scutellaris (Walker)

Fig. 331

1858. *Culex variegatus* Doleschall, Natkundig. Tijdschr. v. Nederland.-Indië 17:77. TYPE: ♀ ?, Amboina (VIENNA, lost).—Preoccupied by *Culex variegatus* Schrank, 1781 and *Culex variegatus* E. Blanchard, 1852; see Dyar and Shannon (1925:74).

1859. *Culex scutellaris* Walker, Linn. Soc. London, J. Proc. Zool. 3:77. *TYPE: ♀, Aru Islands (Aroe), A. R. Wallace (BMNH); only remaining specimen, bearing green type label and notation by E. A. Waterhouse "one of Walker's series so named"; this is probably one of the syntypes of *scutellaris*, since Walker probably had before him females and not males, as indicated in the description.—Synonymy by Edwards (1922*b*:464).

1861. *Culex zonatipes* Walker, Linn. Soc. London, J. Proc. Zool. 5:229. *TYPE: ♀, Dorey, New Guinea, A. R. Wallace (BMNH), only remaining specimen, bearing green type label and notation "identified as the type by E. A. Waterhouse." —Synonymy by Edwards (1922*b*:464).

Aedes (*Stegomyia*) *scutellaris* of Dyar and Shannon (1925:74); Edwards (1932:165, in part); Taylor (1934:20); Lee (1944*a*:68, in part); Stone and Farner (1945:161); Stone (1947:85, in part); Iyengar (1955:29, in part); Stone, Knight, and Starcke (1959).

Aedes (*Stegomyia*) *scutellaris scutellaris* of Knight, Bohart, and Bohart (1944:39, 55, in part); Marks (1954); and authors.

Aedes (*Stegomyia*) *variegatus* in part of Edwards (1922*b*:464; 1924:370–371); and authors.

Aedes (*Stegomyia*) *zonatipes* in part of Bohart and Ingram (1946:26–27).

FEMALE.—The supposed type specimen mentioned above is in too poor a condition to describe in detail; labium without ventral light streak; lateral prescutal light line not developed; midfemur without anterior silvery line; hindfemur with anterior silvery line only slightly tapered distally; hindtarsus broken off; abdominal tergites IV-VI with incomplete dotted silvery transverse bands.

MALE.—Not seen.

MALE GENITALIA (fig. 331).—Dobo, Aroe Is. (Aru), *ex* larva in coconut shell, Jan. 23, 1923 (Brug and de Rook, 6225, USNM); remounted specimen, ventral surface uppermost, strongly flattened. Apparently quite similar to *"scutellaris"* from New Guinea; clasper relatively heavy, slightly swollen before apex, spiniform rather short; claspette in general as in *hebrideus,* specialized setae 5,6 about 0.6 of length of longest apical bristles and distinctly longer than the very slender ventral mesal hairs.

PUPA and LARVA.—Not definitely known.

SYSTEMATICS.—I have examined the type females of *scutellaris* (Walker, 1859) from Aru and *zonatipes* (Walker, 1861) from New Guinea. They are in very poor condition but are undoubtedly members of the *scutellaris* group and probably conspecific with the *"scutellaris"* of New Guinea of recent authors. Whether or not these are truly conspecific with the true *scutellaris* of Aru Island remains to be determined by a study of material of all the stages from the respective type localities.

It has generally been assumed that *hebrideus* is conspecific with *scutellaris.* As indicated under the discussion of the former, I find small but constant differences in the male genitalia of the 2 forms and consider them distinct for the present.

DISTRIBUTION.—*A. scutellaris* of authors has been reported from *Malaya, Indonesia, Philippines, Palau, Caroline Islands, Moluccas* and *New Guinea;* the subspecies *katherinensis* Woodhill, 1949 is known from northeast *Australia.* This species does not occur in the South Pacific; the form reported as *scutellaris* from this area is *hebrideus.*

18. Aedes (Stegomyia) tongae Edwards

Figs. **311, 312, 349, 350**

1926. *Aedes* (*Stegomyia*) *variegatus* var. *tongae* Edwards, B. Ent. Res. 17:103. *TYPE: holotype ♂, marked as type by Edwards, with attached genitalia mount, Haapai, Tonga, Feb. 26, 1925, G. H. E. Hopkins (BMNH).

Aedes (*Stegomyia*) *tongae* in part of Farner and Bohart (1945:44–45); Marks (1954:352); Iyengar (1955:29); Laird (1956:80); Stone, Knight, and Starcke (1959); not including specimens from Solomon Islands and Santa Cruz.

Aedes (*Stegomyia*) *scutellaris tongae* in part of Knight, Bohart, and Bohart (1944:39, 55).

Aedes (*Stegomyia*) *scutellaris* var. *tongae* in part of Edwards (1932:165); Taylor (1934:20).

Aedes (*Stegomyia*) *variegatus* var. *tongae* in part of Buxton and Hopkins (1927:103, 104).

FEMALE.—*Wing:* 3.2 mm. *Proboscis:* 2.21 mm. *Forefemur:* 2.15 mm. *Abdomen:* about 2.67 mm. *Head:* eyes rather narrowly separated, frontal scaling restricted; median silvery line narrow, reaching erect scales; orbital silvery line not developed or with only a few scales; lateral silvery line rather narrow; labium with indistinct ventral light streak; apical segment of palpus largely silvery above. *Thorax:* median silvery line narrow except at anterior promontory; lateral prescutal line not developed; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral line conspicuously developed anteriorly, with yellowish white scales; prescutellar line usually poorly developed, with yellowish and whitish scales anteriorly; median scutellar lobe with numerous dark scales apically; pleural scaling in rather narrow streaks, forming distinct diagonal lines, *apn* streak long and usually strongly broadened caudad, upper *stp* narrow and without scales on *ssp* face, lower *mep* patch moderate and detached. *Legs:* forecoxa with large caudal median patch of dark scales; midcoxa with numerous dark scales apically; midfemur without anterior silvery line; hindfemur with anterior silvery line long, ventral surface without light streak distally; foretarsus and midtarsus with rather large silvery markings on segments 1,2; hindtarsal segment 4 silvery on less than basal 0.5, segment 5 usually all silvery, rarely with some dark scales ventrally. *Wing:* costa with a small but conspicuous basal silvery spot. *Abdomen:* tergites II-VII with arcuate lateral silvery markings, slender on II,III, broadened and angulate caudolaterad on IV-VII, with premedian prolongations extending considerable distance dorsad, frequently connected by scattered scales forming dotted premedian or subbasal bands on III-VI, always on VII.

MALE.—Essentially as in the female. *Palpus:* slightly shorter than proboscis. *Abdomen:* tergites III-VI usually with complete transverse silvery bands.

MALE GENITALIA (fig. **349**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in the middle; lateral tergal lobe usually prominent, more or less visible from above, with 8–10 hairs, spicules strong. *Sidepiece:* rather long; dorsal bristles strong; mesal dorsal area with sparse short thin hairs extending to about middle of sidepiece and to mesal surface. *Claspette:* simple; rather short but prominent, slender, without apical sternal angle; distal third of sternolateral margin with a row of about 5,6 long apically attenuated, straight, more or less distinctly thickened, specialized setae; lateral surface with numerous heavy hairs extending basad to almost level of most basal specialized bristle; apex with numerous hairs not much longer than 0.5 of lobe length; mesal surface subapically with numerous hairs. *Clasper:* rather slender, with slight subapical expansion; hairs few; apical spicules prominent; spiniform moderately long and slender, subapical.

PUPA (fig. 349).—*Abdomen:* 3.25 mm. *Trumpet:* 0.47 mm. *Paddle:* 0.69 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; the single available whole pupa has most of the diagnostic hairs missing but appears to be similar to that of *pseudoscutellaris. Cephalothorax:* apparently moderately pigmented, darkened on mesonotum. *Trumpet:* uniformly moderately pigmented; pinna from about 0.8. *Metanotum:* darkened. *Abdomen:* rather lightly pigmented a slightly yellowish brown, darker anteriorly. *Paddle:* a light yellowish brown, midrib darker and brighter.

LARVA (fig. 350).—*Head:* 0.76 mm. *Siphon:* 0.68 mm. *Anal Saddle:* 0.27 mm. Apparently both hairy and nonhairy forms are known but I have seen only the latter; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately pigmented, lighter on ocular area, darkened on collar. *Antenna:* moderate to rather long; uniformly darker than head capsule. *Thorax* and *Abdomen:* hairs moderately to strongly pigmented. *Segment VIII:* 8–14 comb scales; free portion of comb scale rather variable but usually with strong lateral basal spicules extending at least halfway from base, sometimes with denticles. *Siphon:* index about 2.0–2.5; moderately to strongly pigmented, darkened on basal ring, lighter apically; 10–18 pecten teeth, usually widely spaced. *Anal Segment:* saddle complete; lightly to moderately pigmented, darkened dorsally; marginal spicules rather long, slender, most numerous dorsad.

MATERIAL EXAMINED.—137 specimens; 62 ♀; 45 ♂; 1 pupa; 29 larvae; no individual rearings.

SYSTEMATICS.—*A. tongae* is a rather clearly marked species. The females differ from those of other eastern species of the *scutellaris* group in the South Pacific in the greater extent of abdominal white markings. This is not always a reliable character, for there is a great deal of variation in *tongae*, and some *horrescens, cooki*, and even *polynesiensis* occasionally approach the condition in *tongae*. The male genitalia are of the type found in *cooki, upolensis, hoguei*, and *varuae* but usually can be readily separated by the characters given in the key. The pupa is known only from a single damaged specimen which appears to be similar to *pseudoscutellaris*, as far as can be determined. The larva shares a number of characters with *pseudoscutellaris* and *pernotatus* but apparently can be separated in most instances by the branched condition of hair 5 of the mesothorax.

Variation in *tongae* is rather marked, particularly in the extent of abdominal tergal light bands in the adults. Unfortunately the available material is very scanty, and practically no information is available on the source of the material. Specimens from the Vavau group appear to be more variable and in some respects suggestive of *cooki*.

A. tongae is endemic and restricted to the Tonga group. The reports of this species from the Santa Cruz Islands and Sikiana pertain to *varuae* and the male genitalia illustrated by Marks (1954:371) are those of *varuae*, not *tongae*.

BIONOMICS AND DISEASE RELATIONS.—Very little is known of the bionomics of *tongae*. I can find no accurate information on the breeding places of the few larval collections I have seen, but apparently these were made in cisterns, artificial containers, and coconuts. In an unpublished list of the mosquitoes of Tonga, mention is made of "*horrescens*"; this I take as an indication of the presence of a hairy form of *tongae* in treeholes (Tonga, 1957).

Since *tongae* is the only member of the *scutellaris* group reported to date from Tonga and apparently bites man readily, it is generally assumed to be the vector of the nonperiodic filariasis on the islands of this group. However, a member of the *kochi* group (*oceanicus*) is also prevalent and may possibly act as a vector.

DISTRIBUTION (figs. 311, 312).—*Tonga:* Vavau; Haapai; Tongatabu. Not known elsewhere; records of *tongae* from the Solomons, Santa Cruz, Society Islands, and elsewhere in the South Pacific refer to other members of the *scutellaris* group, *varuae* and *polynesiensis* chiefly.

19. Aedes (Stegomyia) upolensis Marks
Figs. 311, 312, 351, 352

1957. *Aedes* (*Stegomyia*) *upolensis* Marks, Ann. Trop. Med. Parasitol. 51:51–57. TYPE: holotype ♂, (P. 1505) Afiamalu, Upolu Island, Samoa, from tree fern stump at 2,100 ft. elevation, Jan. 19, 1956, T. E. Woodward (BMNH).

Aedes (*Stegomyia*) *upolensis* of Stone, Knight, and Starcke (1959).
Aedes (*Stegomyia*) *polynesiensis* in part of Rosen and Rozeboom (1954, hairy larva from Samoa, fig. 4).

FEMALE.—*Wing:* 3.25 mm. *Proboscis:* 2.16 mm. *Forefemur:* 2.13 mm. *Abdomen:* about 3.25 mm. *Head:* eyes rather narrowly separated, frontal scaling restricted; median silvery line very narrow, reaching erect scales; orbital silvery line with only a few scales mesally; lateral silvery line rather broad; labium with or without ventral light streak; apical segment of palpus silvery on less than distal half dorsally. *Thorax:* median silvery line narrow; lateral prescutal light line not developed; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral and prescutellar light lines not developed; median scutellar lobe with few dark scales apically; pleural scaling in rather narrow streaks, forming distinct diagonal lines, *apn* streak somewhat broadened, upper *stp* narrow and without scales on *ssp* face, lower *mep* patch usually completely absent. *Legs:* forecoxa with a large median band of dark scales; midcoxa with a small apical patch of dark scales; midfemur without anterior silvery line; hindfemur with anterior silvery line long, ventral surface without light streak distally; foretarsus and midtarsus with moderate silvery markings on segments 1,2, rarely a few white scales on base of segment 3 of midtarsus; hindtarsal segment 4 silvery on basal 0.60–0.70, segment 5 completely silvery dorsally. *Wing:* costa with small but conspicuous basal silvery spot. *Abdomen:* tergites II-VII with large lateral silvery patches, arcuate and extending to base on II,III, rather straight and transversely submedian on IV-VII, not connected above except sometimes on VI,VII.

MALE.—Essentially as in the female; palpus distinctly longer than proboscis.

MALE GENITALIA (fig. 351).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in the middle; lateral tergal lobe rather distinct but not prominent, visible from above, with 4,5 bristles. *Sidepiece:* rather long; dorsal bristles moderate; mesal dorsal area with sparse short thin hairs extending to about middle of sidepiece. *Claspette:* simple; distal half of sternolateral margin with an indistinct row of 3–6 short, poorly differentiated apically curved specialized setae; lateral surface with numerous long curved hairs extending to or basad of most basal specialized seta; apex tergally with hairs about as long as entire lobe; mesal surface with few subapical hairs. *Clasper:* relatively slender, distinctly expanded subapically; hairs few; apical spicules prominent; spiniform rather long, slender, subapical.

PUPA (fig. 351).—*Abdomen:* 3.13 mm. *Trumpet:* 0.4 mm. *Paddle:* 0.57 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented a dull blackish brown, lighter ventrally. *Trumpet:* uniformly moderately pigmented; pinna from about 0.75. *Abdomen:* moderately pigmented a dull blackish brown, darker anteriorly. *Paddle:* uniformly lightly pigmented, midrib dark; fringe appears to be more extensive and longer than in any other South Pacific species; paddle hair also unusually long.

LARVA (fig. 352).—*Head:* 0.75 mm. *Siphon:* 0.73 mm. *Anal Saddle:* 0.29 mm. Both hairy and nonhairy forms known; chaetotaxy of hairy form as figured, that of nonhairy essentially similar to *polynesiensis* except for diagnostic characters as in the key. *Head:* moderately to strongly pigmented, lighter on ocular area, darkened on collar. *Antenna:* moderate in nonhairy form, elongate and wider at base in hairy forms; darker than head capsule. *Thorax* and *Abdomen:* hairs and tubercles strongly pigmented; hairs strongly barbed in hairy forms; hair 13-P present. *Segment VIII:* 8–16 comb scales, markedly different in hairy and nonhairy forms; in hairy forms free portion with a very long distal spine, often with attached portions connected by sclerotizations, more conspicuous distad under the free portion; in nonhairy forms free portion sometimes much shorter, often widened and with conspicuous spicules, apparently never with basal platelike sclerotization. *Siphon:* index about 2.7–3.2; moderately to very strongly pigmented; spicules strongly developed in hairy forms; 8–16 pecten teeth, usually widely spaced and with very slender main shaft. *Anal Segment:* saddle very narrowly incomplete; moderately to strongly pigmented; marginal spicules distinct, short in nonhairy, usually long and slender in hairy forms

MATERIAL EXAMINED.—45 specimens; 13 ♀; 14 ♂; 3 pupae; 15 larvae; no individual rearings.

SYSTEMATICS.—*A. upolensis* adults can be easily differentiated from all other known members of the group except *rotumae* by the complete absence of the lower mesepimeral patch of scales or the presence of at most 3 scales in this area. In all the specimens from Tutuila these scales are completely absent, but Marks (1957*a*:51–53) reports 1 scale in a male and 3 in a female, both from Upolu. The genitalia are somewhat similar to those of *pseudoscutellaris,* but the hairs on the lateral surface of the claspette are not as extensive. The pupa appears to be most similar to *polynesiensis* and *hoguei,* and the larva shares with the latter the unusual condition of the presence of hair 13 of the prothorax.

The Tutuila specimens differ rather markedly from the Upolu material in that the specialized setae of the claspette of the male genitalia are less strongly developed and in that the larva is of the hairy type. In other respects these populations appear to be entirely similar.

The hairy larva of this species from Tutuila was figured as the extreme hairy type of *polynesiensis* by Rosen and Rozeboom (1954).

BIONOMICS AND DISEASE RELATIONS.—On Upolu the immature stages of this species were collected in a hole in the top of a tree fern stump. I have not been able to find any record of the habitat of the larvae collected on Tutuila. Marks (1957*a*:55) states that on Upolu this is a rain forest species which will bite man in the vicinity of its breeding places. On Tutuila *upolensis* was collected in association with *polynesiensis*. Nothing is known of the disease relations or economic importance of this species.

DISTRIBUTION (figs. 311, 312).—*Samoa:* Savaii; Upolu; Tutuila; Manua. Not known elsewhere.

20. Aedes (Stegomyia) varuae Belkin, n. sp.

Figs. 311, 312, 353, 354

TYPES.—*Holotype:* ♂ (Bonnet, 71-1) with associated larval and pupal skins, Lawaii, Graciosa Bay, Santa Cruz Island, from coconut half in partial shade, near hospital, Aug. 30, 1956, D. Bonnet (USNM, 64797). *Allotype:* ♀ (Bonnet, 65-0), Malo, Temotu Island, Santa Cruz group, from water in tridacna shell in full sunlight, Aug. 29, 1956, D. Bonnet (USNM). *Paratypes:* 1 ♂ (Bonnet, 71-0) with genitalia slide (570520-14), same data as holotype; 5 ♂, 12 pupae, 2 larvae (Bonnet, 65-0), same data as allotype; 5 pupae, 11 larvae (Bonnet, 76-0), same data as holotype except from rain barrel near hospital.—This species is named for the brigantine "Varua" of the Robinson-Peabody Museum Expedition to the Southwest Pacific, 1956.

Aedes (*Stegomyia*) *tongae* in part of Farner and Bohart (1945:44–45); Marks (1954:352, including figs.); Iyengar (1955:29); Laird (1956:80); Stone, Knight, and Starcke (1959); specimens from the Solomon Islands and Santa Cruz.

Aedes (*Stegomyia*) *scutellaris tongae* in part of Knight, Bohart, and Bohart (1944:39, 55).

Aedes (*Stegomyia*) *scutellaris* var. *tongae* in part of Edwards (1932:165).

Aedes (*Stegomyia*) *variegatus* var. *tongae* in part of Edwards (1926:103, specimens from Sikiana); Buxton and Hopkins (1927:103).

FEMALE.—*Wing:* 2.73 mm. *Proboscis:* 1.83 mm. *Forefemur:* 1.76 mm. *Abdomen:* about 2.43 mm. *Head:* eyes moderately separated, frontal scaling extensive; median silvery line moderate to broad, reaching erect scales; orbital silvery line usually well developed, sometimes complete; lateral silvery line broad; labium with conspicuous ventral light streak; apical segment of palpus silvery on less than distal half. *Thorax:* median silvery line rather broad; lateral prescutal light line not developed; supraalar silvery line complete, with broad scales posteriorly; posterior dorsocentral light line poorly developed or not at all, at most with light coppery scales; prescutellar light line strongly developed, with silvery scales anteriorly and light golden posteriorly; median scutellar lobe with very few dark scales apically; pleural scaling in rather broad streaks, forming distinct diagonal lines, *apn* streak broad, upper *stp* rather broad but usually without scales on *ssp* face, lower *mep* patch moderate and detached; *pra* area usually with several silvery scales below bristles. *Legs:* forecoxa with extensive dark scaling in middle; midcoxa with small apical patch of dark scales; forefemur with very small knee spot; midfemur without anterior silvery line; hindfemur with anterior silvery line usually long, ventral surface with very conspicuous, usually silvery, streak distally; foretarsus and midtarsus with small silvery markings on segments 1,2; hindtarsal segment 4 with variable amount of light scaling, often interrupted mesad, from less than 0.5 to over 0.7; hindtarsal segment 5 all silvery above, frequently extensively dark below and on posterior face. *Wing:* costa with very small basal silvery spot, sometimes apparently not developed. *Abdomen:* tergites II-VI with rather broad arcuate lateral silvery markings, the dorsal portions of which are subbasal and are connected across the top to form transverse subbasal more or less complete bands on IV-VI, a few median dorsal silvery scales on III; tergite VII with a complete broad submedian transverse silvery band.

MALE.—Essentially as in the female. *Palpus:* about as long as proboscis. *Legs:* tarsal silvery markings more restricted than in female. *Abdomen:* tergal light bands not developed, arcuate markings shorter and broader.

MALE GENITALIA (fig. 353).—As figured; diagnostic characters as in the key. *Segment IX:* tergite rounded in the middle; lateral tergal lobe rather prominent but hidden from above, with 2–5 hairs, spicules strong. *Sidepiece:* moderately long; dorsal bristles strong; mesal dorsal area with sparse short thin hairs extending to about middle of sidepiece and to mesal surface. *Claspette:* simple; rather short but prominent, somewhat widened, without apical sternal angle; distal third of sternolateral margin with a row of 6–8 short, thick, very conspicuous specialized setae with apices abruptly pointed; lateral surface with a few very slender hairs extending sometimes to level of most basal specialized bristle; apex with few hairs, longest about 0.75 of lobe, very few hairs extending on mesal surface. *Clasper:* rather slender, with distinct subapical expansion; hairs few; apical spicules prominent; spiniform long and moderately slender, subapical.

PUPA (fig. 353).—*Abdomen:* 3.22 mm. *Trumpet:* 0.44 mm. *Paddle:* 0.65 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately dull brown, lighter ventrally; hairs lightly to moderately pigmented. *Trumpet:* moderately pigmented; pinna from about 0.67. *Abdomen:* rather light blackish brown, darker anteriorly; hairs moderately to strongly pigmented. *Paddle:* uniformly lightly pigmented, midrib darker.

LARVA (fig. 354).—*Head:* 0.76 mm. *Siphon:* 0.73 mm. *Anal Saddle:* 0.26 mm. Only nonhairy form known; chaetotaxy as figured; diagnostic characters as in the key. *Head:* moderately pigmented, lighter on ocular area, darkened on collar. *Antenna:* moderate in length; concolorous with head capsule except for darker base. *Thorax* and *Abdomen:* hairs and tubercles moderately to strongly pigmented. *Segment VIII:* 6–12 long comb scales, several of which are usually connected at base by sclerotizations which are not in the form of a distinct comb plate. *Siphon:* index about 2.0–2.6; moderately pigmented, darker on basal ring, lighter and yellowish apically; 7–12 pecten teeth widely spaced and with long slender main shaft. *Anal Segment:* saddle widely incomplete; moderately pigmented, slightly darkened at base; marginal spicules short but distinct.

MATERIAL EXAMINED.—117 specimens; 15 ♀; 20 ♂; 46 pupae; 36 larvae; 1 individual larval rearing.

SYSTEMATICS.—This species has been confused in the past with *tongae*, which is restricted to the Tonga group, about 1,300 miles to the southeast. Buxton and Hopkins (1927:103) suggested that the Tongans transported this mosquito on their voyages. Although *varuae* resembles *tongae*, it is very definitely a distinct species, and its larva especially is different from *tongae*. The adults have stronger abdominal white bands than *tongae* and approach the condition in *hebrideus*, *quasiscutellaris*, and *gurneyi*. The male genitalia of *varuae*, which have been figured accurately but as those of *tongae* by Marks (1954:371), are somewhat similar to the latter but are readily differentiated. The pupae are not unlike those of the species with strong abdominal tergal bands (*hebrideus*, *quasiscutellaris*, *gurneyi*, and *marshallensis*), and the larva shows many similarities with these forms, as well as with *albopictus*.

The place of origin of *varuae* is probably one of the islands in the Santa Cruz group; it may have been formed through hybridization, but at present the parental stocks cannot be identified. This species apparently can compete successfully with the highly adaptable *hebrideus*, which occurs throughout the group. It is of interest that *varuae* is the only species of the *scutellaris* group found on Sikiana Island, where it was undoubtedly introduced from one of the Santa Cruz Islands. Sikiana is an atoll with a miscellaneous assemblage of introduced species.

BIONOMICS.—The immature stages of *varuae* have been collected in a tree fern stump (Bonnet, 38), in a groove in the trunk of a fallen tree (Bonnet, 78), in a coconut half (Bonnet, 71), in a pandanus leaf on the ground (Bonnet, 100), in a tridacna shell (Bonnet, 65, 98), and in rain barrels (Bonnet, 33, 76). On 2 occasions immature stages of *hebrideus* were associated with *varuae* (76, 78). Apparently this species varies in its blood-feeding habits; on the Robinson–Peabody Museum Expedition, no biting females were taken, while earlier collections consisted of specimens attracted to man.

DISTRIBUTION (figs. **311, 312**).—*Solomon Islands:* Sikiana (Sikaiana, Stewart). *Santa Cruz Islands:* Naelo (Reef group); Temotu; Santa Cruz; Vanikoro. Not known elsewhere; confused in past with *tongae.*

21. Aedes (Stegomyia) sp., Vanua Lava form

Figs. **311, 312**

Three damaged females from Vanua Lava Island in the Banks group, north of the New Hebrides (Oct., 1929, L. E. Cheesman; BMNH), are suggestive of *pernotatus* in the absence of transverse light bands in the middle of the abdominal tergites. They differ in details of ornamentation from *pernotatus* and appear to represent a distinct species. Because of the poor condition of the females and the absence of other stages, this form remains undescribed.

22. Aedes (Stegomyia) sp., Wallis form

Figs. **311, 312**

Aedes (Stegomyia) polynesiensis in part of Marks (1954:375); Iyengar (1955:29); Rageau (1958*a*:877; 1959); Stone, Knight, and Starcke (1959).

Aedes (Stegomyia) pseudoscutellaris in part of Farner and Bohart (1945:41–44); Stone and Farner (1945:161).

In several collections from Wallis, presumably the large island of Uea (K. L. Knight, 924, 926, 929; USNM), females of the *scutellaris* group generally resemble *polynesiensis,* but several appear to be more or less distinct in the reduction of the white scaling on hindtarsal segment 4 and in the possession of an extremely narrow median longitudinal silvery line on the mesonotum. The single pupa is indistinguishable from *polynesiensis.* Several of the larvae resemble *polynesiensis* but are distinct in having a very narrowly interrupted saddle on the anal segment and short basally fringed comb scales; other larvae appear to be typical *polynesiensis.* Unfortunately no males are known. It seems probable that 2 forms are present on Wallis Islands, as in the Horne (Hoorn, Futuna) group, one being *polynesiensis* and the other an endemic form. This interesting situation cannot be resolved until individual rearings are obtained and males are studied.

Genus ARMIGERES Theobald

1901. *Armigeres* Theobald, J. Trop. Med. 4:235, July 15, no included species; Monog. Culicidae 1:98, 322, Nov. 23. TYPE SPECIES: *Culex obturbans* Walker, 1860, Celebes; the first of 2 subsequently included nominal species, selection of Brunetti (1914:55).

1901. *Desvoidya* Blanchard, Soc. de Biol., Compt. Rend. 53:1046, Dec. 6 TYPE SPECIES: automatically *Culex obturbans* Walker, 1860, Celebes.—Invalid substitute for *Armigeres* Theobald, 1901 not *Armiger* Hartmann, 1840.

1912. *Blanchardiomyia* Brunetti, Indian Mus., Rec. 4:440. TYPE SPECIES: automatically *Culex obturbans* Walker, 1860, Celebes.—Invalid substitute for *Desvoidya* Blanchard, 1901 not *Desvoidia* Meade, 1892.

1914. *Neosquamomyia* Taylor, Roy. Ent. Soc. London, Trans. 1914(62):186. TYPE SPECIES: *N. breinli* Taylor, 1914, New Guinea; monobasic.

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Medium-sized to rather large species; usually not highly ornamented. *Head:* eyes distinctly separated above antennae; decumbent scales of vertex largely broad, dense, a few narrow scales on occiput may be present; erect scales restricted to caudal portion of vertex and to occiput; orbital bristles not numerous; labium varied in development, sometimes apical portion compressed and recurved ventrad; palpus varied in length, from about 0.2 to 0.75 of proboscis; antenna about as long as proboscis, flagellar whorls well developed. *Thorax:* anterior portion of mesonotum sometimes produced over head; acrostichals and dorsocentrals apparently absent, prescutellars reduced, postnotals rarely present; paratergite broad, with scales but no hairs; *apn* usually (?) large, rather closely approximated middorsally, at least in subgenus *Armigeres;* upper edge of meron nearly or quite in line with base of hindcoxa in subgenus *Armigeres;* pleuron extensively scaled, *pst* completely covered with scales, *psp* always with scales; all normal pleural bristles present except *sp* always, lower *mep* sometimes, and, in *Leicesteria, psp. Legs:* claws of foreleg usually toothed. *Wing:* venation normal. *Abdomen:* unusually long, not bristly; tergite I and laterotergite completely scaled. *Genitalia:* segment VIII partially retractile; cercus short; 3 spermathecae, one larger.

MALES.—Essentially as in the females. *Palpus:* as long as or longer than proboscis, upturned, very slender, and without conspicuous bristles. *Antenna:* about as long as to distinctly shorter than proboscis; flagellum strongly plumose, segments 12 and 13 elongate. *Legs:* usually only claws of foreleg enlarged. *Abdomen:* without strong bristles.

MALE GENITALIA.—Relatively short. *Segment IX:* apparently variously developed. *Sidepiece:* usually with numerous hairs and bristles on tergomesal surface; mesal surface with membrane from base to apex except for claspette. *Claspette:* developed as a small lobe appressed to mesal surface, usually with varied number of spiniforms apically. *Clasper:* variously developed; usually with several spiniforms forming an apical or inner comb. *Phallosome:* aedeagus complex, variously developed, with teeth or processes. *Proctiger:* basal lateral sclerotization strongly developed; paraproct usually not ending in spine; cercal hairs not developed.

PUPAE.—Generic characters not evident, only 2 species of subgenus *Armigeres* described; in general similar to subgenus *Stegomyia* of *Aedes;* hair 8-C a considerable distance caudad of trumpet level; 1-II widely separated, about in line with hairs 1 on II-VII; 5-VI,VII very small; 4-VIII short, multiple; paddle small, with long hairlike marginal spicules.

LARVAE.—Only a few species described, apparently in general quite similar to *breinli. Head:* rather long, collar poorly developed, hairs 4-6-C placed far forward, 9-C strongly developed. *Antenna:* usually short and without spicules; hair 1-A very small. *Thorax:* quite narrow; large hairs with few branches, usually 1-3b. *Abdomen:* very long and narrow; large hairs as on thorax. *Segment VIII:* comb in a small patch or irregular row of small scales. *Siphon:* widely unsclerotized at base ventrally; pecten not developed, hair 1-S in distal third or beyond. *Anal Segment:* saddle incomplete; hair 1-X not on saddle; hairs 2,3-X both branched; ventral brush rather poorly developed, with about 10-12 hairs, distinctly paired or unpaired; gills very long, sausage-shaped.

EGGS.—Probably laid above water line in small containers as reported for "*obturbans*" by Galliard (1936*b*).

SYSTEMATICS.—*Armigeres* is a complex genus which is very poorly understood at present. Since only 1 species is known in the South Pacific and since I have had access to material representing only a few species of the nominate subgenus, I have made no attempt to review the characteristics of the genus as a whole. Edwards (1932:183) pointed out that there are some widely divergent groups included in his concept of *Armigeres*. It seems to me that his groups A and B of the subgenus *Armigeres* do not belong in the genus at all.

The affinities of *Armigeres* are not clear without detailed study. Edwards (1932:183) mentions the apparent close similarity with the subgenera *Stegomyia* and *Pseudarmigeres* (as *Dunnius*) of *Aedes*. There is a suggestion of the sabethines in the general appearance of the adults as well as in the small meron, which, in at least some species, is nearly if not quite in line with the base of the hindcoxa; the *apn* lobes are also large and rather close together on the midline, and at least 1 species has postnotal hairs.

The single known South Pacific species is a member of the *malayi* complex, which is quite similar to *kuchingensis* Edwards, 1915 and *subalbatus* (Coquillett, 1898) of the Indomalayan and Oriental regions. The latter forms have been considered in the past to be conspecific with *obturbans,* the type species of the genus (Stone and Thurman, 1958; Thurman, 1959).

BIONOMICS AND DISEASE RELATIONS.—The immature stages of species of *Armigeres* are found only in small containers of water; they have been reported chiefly from bamboo, fallen leaves and spathes, coconut shells, *Curcuma* flowers, *Nepenthes* pitchers, treeholes, and artificial containers. The water in the breeding sites is often extremely foul. Two species have been found to breed in small ground pools containing human excreta. The eggs are apparently laid above the water line and withstand drying for a considerable period (Galliard, 1936*b*).

The females of several species are vicious biters and attack man both at night and in the daytime. Most species occur in forested areas and bite in the shade. *A. "obturbans"* is a semidomestic species which has been reported to be naturally infected with the larvae of *Wuchereria bancrofti* and *W. malayi* (Horsfall, 1955:545), but it is not regarded at present as an important vector of filariasis. The disease relations of other species are unknown.

DISTRIBUTION (fig. **355**).—*Armigeres* is primarily Oriental in distribution but is widespread and well represented in the Indomalayan and Australasian regions. One species occurs in Japan. In the South Pacific the only species, *breinli,* has been found in the Solomons and the Santa Cruz group.

KEYS TO SPECIES

See keys to tribe Aedini, pp. 318–321

1. Armigeres (Armigeres) breinli (Taylor)

Figs. **355-357**

1914. *Neosquamomyia breinli* Taylor, Roy. Ent. Soc. London, Trans. 1914(62):186–187. TYPE: lectotype ♀, Milne Bay, Papua, New Guinea, Breinl; selection of Lee, 1944*a*:218 (SYDN, 235).

Armigeres (*A.*) *breinli* of Taylor (1919:828); Edwards (1924:368); Lee (1944*a*:84; 1944*b*:217–219); Knight, Bohart, and Bohart (1944:59); Iyengar (1955:31); Stone, Knight, and Starcke (1959).

Armigeres (*A.*) *malayi* var. *breinli* of Paine and Edwards (1929:305), Edwards (1932:185); Taylor (1934:22).

FEMALE.—*Wing:* 3.81 mm. *Proboscis:* 2.41 mm. *Forefemur:* 2.66 mm. *Abdomen:* about 3.65 mm. A large mosquito with small thorax, long proboscis and legs, and extremely long abdomen; clypeus with scales. *Head:* eyes rather widely separated; decumbent scales of vertex dark except for white orbital line which is extended about halfway down to antennae between eyes and a caudal median white-scaled patch among and in front of erect scales; erect scales dark, rather short and numerous on occiput; on sides orbital light-scaled line expanded at about level of middle of *apn,* from level of lower end of *apn* all scaling white; clypeus with a pair of large lateral patches of broad but elongate appressed white scales; labium cylindrical, dark-scaled; palpus about 0.22 of proboscis, 5-segmented, segments 1 and 2 ankylosed, 3 short, 4 elongate, 5 very small but distinct, scaling dark, some long bristles; antenna almost as long as proboscis; torus with large patch of small broad white scales and a few dark scales above; flagellar segment 1 with a few white scales at base; bristles in flagellar whorls long but not numerous. *Thorax:* integument dark brown; mesonotum with dense vestiture of narrow bronzy scales, longer and broader on prescutellar area, latter without bare space, with a variable amount of white scaling, narrow along anterior border sometimes as far as scutal angle, both narrow and quite broad in front of wing root, pale or white scales laterad of prescutellars and in the middle caudal part of prescutellar area, sometimes a more or less complete or interrupted white border all the way around; acrostichals and dorsocentrals completely absent; only 1–3 pairs of posterior prescutellars; supraalars numerous; scutellar scaling dense, variable in color, usually largely dark but sometimes extensively pale or white; paratergite short and broad, with numerous white scales which are rather broad and semierect; *apn* large, rather narrowly separated on middorsal line; meron small, its upper edge about in line with base of hindcoxa or only slightly above; pleural scaling largely broad and pure white; *apn* with narrow dark scales above and large patch of white scales below; *ppn* extensively scaled, with narrow dark scales above followed by large patch of white scales in middle and a few in the lower anterior corner; *ppl* with extensive patch of white scales continuous with the completely white-scaled *pst; pcx* without scales; *psp* with small patch of white scales behind bristles; *ssp* with small streak of white scales against *stp; stp* with large upper and small lower posterior patches of white scales; *pra* without scales; *mep* with upper median patch of white scales; pleural bristles largely light in color except for dark ones on *apn, ppn,* and some on *pra; ppn* bristles numerous but restricted to upper posterior angle and in a rather even single arcuate row; *psp* bristles present; 1 very strong lower *mep. Legs:* coxae with white scales; trochanters with scaling largely whitish or pale; forefemur and midfemur largely dark-scaled but with a complete broad white-scaled line from base to apex on ventroposterior surface; hindfemur extensively white-scaled on all surfaces, on anterior white scaling reaching apex, on posterior to about middle, remainder dark above and white below; tibiae and tarsi entirely dark-scaled; claws of foreleg and midleg subequal, all with basal spicules and large premedian or subbasal tooth, those of hindleg with basal spicules only. *Wing:* dorsal vein scales all dark, squame scales small, plume scales moderately long and slender, not strongly outstanding; remigium with a few short hairs, hardly projecting beyond scales; base of Sc ventrally with scales but no conspicuous hairs; base of plical area without scales ventrally; alula with marginal fringe of short hairs or narrow scales; upper calypter with complete fringe of much longer hairs; vein Sc long, ending distad of furcation of Rs. *Haltere:* knob with bronzy scales above, pale below. *Abdomen:* tergites dark-scaled dorsally; tergite I almost completely dark-scaled, a few white scales laterally, hairs short, not numerous; laterotergite completely covered with white scales; tergites II-VII with large basolateral white patches; tergite VIII with broad basal transverse white-scaled band; sternites II-VII largely white-scaled, III with apical, IV-VII with basal and apical transverse dark-scaled bands; sternite VIII with dark and pale scales. *Genitalia:* segment VIII partially retracted, rather long; cercus short and broad, dark-scaled; postgenital plate short, produced but rounded; 3 spermathecae, one slightly larger.

MALE.—Essentially as in the female. *Labium:* with rather long hairs, particularly near base ventrally. *Palpus:* slightly longer than proboscis, very slender, with a few bristles at apex and scattered on sides; segments 4 and 5 subequal, porrect. *Antenna:* flagellar whorls very long and dense; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg and hindleg small, equal, and simple; claws of midleg enlarged, unequal, larger with submedian tooth, smaller, simple. *Abdomen:* tergite VIII with basal band of white scales; tergite VII often with scattered white scales dorsally.

MALE GENITALIA (fig. **356**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite unusually developed, a strong sclerotized basal ring connected to sternite, in center a sclerotized plate bifurcate apically, forks distally with patch of fine hairs, remainder of tergite membranous dorsally; sternite very large, separating the 2 sidepieces very widely, a conspicuous longitudinal apodeme on each side from basal ring to edge of sidepiece, a postmedian patch of 8-10 thin hairs. *Sidepiece:* the 2 sidepieces widely separated from each other sternally; short, moderately broad; scales restricted to lateral and ventral surfaces; dorsal surface with thin long bristles at base followed mesad by shorter hairs, apex with long heavy bristles followed basomesad by progressively shorter hairs ending in dense patch of straight hairs, a large bare patch on middle of dorsal surface; mesal surface with membrane from base to insertion of clasper. *Claspette:* small, appressed to mesal surface of sidepiece; apex with patch of spiniforms, variable in size and number, usually about 12. *Clasper:* relatively short; outer surface convex, inner nearly straight; spiniforms usually 12 or more, forming a comb on inner surface from apex to about middle. *Phallosome:* aedeagus small, complex, swollen at base, a small narrow median basal sclerite; distal portion with paired dorsal process; ventral paramere well developed;

basal piece very strongly developed, apparently joined to dorsal basal angle of swollen portion of aedeagus as well as to paramere. *Proctiger:* basal lateral sclerotization extremely strongly developed, with a dorsal bar, a median greatly swollen portion, and a broad sternal process from which arises the sclerotized paraproct; latter without tooth apically; cercal setae not developed.

PUPA (fig. 356).—*Abdomen:* 4.75 mm. *Trumpet:* 0.72 mm. *Paddle:* 0.82 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, unevenly darkened; hairs lightly to moderately pigmented; hair 1-C small; 3-C strongly developed; 8-C well behind trumpet insertion. *Trumpet:* markedly broadened and strongly diagonally truncate apically; moderately and brightly pigmented; tracheoid indistinct. *Metanotum:* darkened. *Abdomen:* very elongate; with rather distinct sublateral longitudinal tergal and sternal folds, area laterad appearing as broad flange; pigmentation rather strong anteriorly and on bars and lighter laterally and caudally; hairs strongly pigmented; segment VIII very short; hair 1-I large, strong but sparsely dendritic; 9-I-VI very weak; 9-VII and 6-VI very strong, heavy; all other hairs on II-VIII very weak except 2,3-II, 3-III, 5-IV, 9-VIII. *Paddle:* very small; poorly pigmented except at base; midrib distinct basally only; external buttress not developed; long fringe of fine hairlike spicules on external and internal margins; hair 1-P weak, rather short, usually double.

LARVA (fig. 357).—*Head:* 0.77 mm. *Siphon:* 1.09 mm. *Anal Saddle:* 0.26 mm. Chaetotaxy as figured; diagnostic characters as in the key; body very long and narrow, superficially very similar to *Uranotaenia quadrimaculata. Head:* rather elongate; foramen magnum very large, collar indistinct; pigmentation moderate, lighter on ocular areas, black around foramen magnum; hairs moderately to darkly pigmented; 4-6-C far cephalad; 9-C very strongly developed, strongest hair on head, directed caudad. *Antenna:* very short, cylindrical, slightly curved; rather strongly pigmented, lighter distally; spicules not developed; hair 1-A minute, single, very thin and inconspicuous, in basal 0.4. *Thorax:* very narrow; integument without distinct spicules; larger hairs and tubercles moderately to strongly pigmented; larger hairs single or with a few branches. *Abdomen:* very long; integument without distinct spiculation; hairs short, only 1,6,13 strongly developed and strongly pigmented. *Segment VIII:* comb usually in an irregular row of about 4–7 short, heavy, simple spinelike scales, latter sometimes with denticles at base; hairs 1,2,4-VIII very small. *Siphon:* forming a very shallow angle with body; widely unsclerotized at base; index about 2.3–3.2; lightly pigmented; hair 1-S very small, near apex; no pecten; trachea very large. *Anal Segment:* saddle very small, lightly to moderately pigmented, without marginal spicules; hair 1-X small, far removed from saddle; 2,3-X both branched, relatively short; ventral brush usually with 10,11 hairs, only a few distinctly paired, all short and without grid at base; gills greatly enlarged, sausage-shaped.

MATERIAL EXAMINED.—1,562 specimens; 426 ♀; 121 ♂; 203 pupae; 812 larvae; 14 individual larval rearings.

SYSTEMATICS.—*A. breinli* is an extremely variable species in all stages, particularly in the amount of light scaling in the adults, in the development of spiniforms in the male genitalia, and in the shape of the comb scales in the larva. Only one plastic species appears to be involved throughout the reported range. This species seems to be closely associated with man and to have been spread through his agency. The material from the South Pacific differs in some details from New Guinea specimens; however, it is so variable that detailed study of many individual rearings would be required to determine whether or not these as well as other populations should be recognized as subspecies, or possibly even as distinct species.

A. malayi from the Indomalayan region is very similar to *breinli.* I have not seen enough material of the former to reach a decision as to the taxonomic status of the 2 forms.

BIONOMICS AND DISEASE RELATIONS.—In the South Pacific the immature stages of *breinli* have been collected only in coconut shells and husks. The larvae are usually extremely numerous in shells which contain a great deal of decaying coconut meat. They have a characteristic eel-like movement, in addition to the normal type of locomotion. Females are strongly attracted to man and are frequently collected in the daytime in the shaded areas around native villages, as well as in uninhabited forested areas. One collection was made on Guadalcanal some six miles inland at the site of an abandoned village. *A. breinli* is potentially a dangerous species, since it may reach very high populations around native villages and attacks man very readily. On Guadalcanal a small number of females secured in daytime-biting collections proved to be negative for developmental stages of *Wuchereria bancrofti* (Schlosser, 1949:740).

DISTRIBUTION (fig. 355).—*Solomon Islands:* Bougainville; Treasury; Santa Isabel; Kolombangara; Arundel; New Georgia; Rendova; Roviana; Russell; Florida; Guadalcanal; Malaita; Ulawa. *Santa Cruz Islands:* Nupani (Reef Islands); Temotu. Also reported from *New Guinea* and the *Bismarcks.*

TRIBE SABETHINI

FEMALES.—*Head:* eyes contiguous or narrowly separated above antennae; frontal area with tuft or scales sometimes present; decumbent scales all broad, rarely a few narrow scales among erect scales; erect scales rather short, confined to a single occipital row, usually long, sometimes absent; median pair of orbital bristles usually strongly differentiated from others; clypeus small, prominent, usually rounded in front, sometimes with hairs or scales; proboscis exposed at base, not deeply inserted; labium varied in development, often with numerous basal bristles; labella usually long and very slender, distinctly segmented, and with scales at base; palpus less than about 0.35 of proboscis, apparently with 1–4 segments; antenna shorter than proboscis, normal; flagellar segment 1 not markedly longer than segment 2; whorl bristles of flagellum usually long. *Thorax:* mesonotum moderately arched; scutellum distinctly lobed, lateral lobe sometimes produced into sharp lateral angle; postnotum often keeled and with bristles or scales but also frequently bare and smooth; paratergite varied, always bare; *apn* lobes often but not always large and approximated in front; *pra* not separated by a suture from *stp;* meron varied, often but not always small and with its upper edge in line with base of hindcoxa; mesonotal vestiture varied, often with broad scales; scutellum usually with broad scales only; mesonotal bristles usually reduced, acrostichals, dorsocentrals, supraalars, and prescutellars often small, sometimes completely absent; pleural scaling varied; pleural bristles reduced; *apn* bristles usually only on anterior surface; *ppn* at most with 2,3 bristles; *ppl* bristles varied but not extending on anteroventral surface; *sp* bristles or scales nearly always present; *psp* bristles always absent; *stp* with bristles usually restricted to lower caudal angle, upper at most 2; *pra* bristles few or absent; only upper *mep* bristles present, no lower bristles. *Legs:* bristles short; hindfemur very slender; hindtibia markedly shorter than hindtarsal segment 1; tarsal segment 4 on all legs distinctly longer than segment 5; claws all small, simple, rarely only 1 claw on hindleg; pulvilli not developed. *Wing:* wing membrane with distinct microtrichia; vein scales varied; cell R_2 always longer than vein R_{2+3}; vein Rs usually without basal spur, at most with slight indication of spur; vein R_{4+5} right-angled at base, without spur; vein 1A usually ending distad of branching of Cu, rarely proximad; vein R without distinct dorsal remigial bristles; vein Sc without distinct bristles at base ventrally; alula with marginal and sometimes in addition dorsal scales; upper calypter with or without hairs or scales. *Abdomen:* tergites and sternites largely scaled; laterotergite varied, with or without scales; bristles often short and inconspicuous except on tergite I laterally and distally; tip of abdomen truncate. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail, undescribed for most genera; segment VIII well developed, not retracted; cercus shorter than postgenital plate; 3 spermathecae, median one larger (*Malaya, Tripteroides*).

MALES.—Essentially similar to the females. *Palpus:* varied in length; 5-segmented when long, apparently with 2–4 segments when short. *Antenna:* from distinctly shorter to about as long as proboscis; flagellar whorl bristles as in female or much longer and denser; flagellar segments 12 and 13 subequal to others or elongate. *Legs:* claws varied, sometimes enlarged or toothed on foreleg and midleg.

MALE GENITALIA.—*Segment VIII:* usually well developed. *Segment IX:* varied; tergite with pair of lateral lobes or a single median lobe; sternite sometimes very long and broadly connected to tergite, without bristles or hairs. *Sidepiece:* extremely varied; with or without mesal membrane; more or less distinct basal mesal lobe usually (always?) present. *Claspette:* not developed but the basal mesal lobe appears to be its homolog. *Clasper:* extremely varied in New World forms; simple in Old World species; with apical spiniform. *Phallosome:* aedeagus varied; rarely (*Maorigoeldia*) a complex sclerotization dorsad and dorsolaterad of aedeagus; usually only ventral paramere developed; basal piece well developed, articulating principally with basal lateral angle of tergite IX in Old World species. *Proctiger:* usually strongly developed; basal lateral sclerotization distinct; paraproct strongly sclerotized, with 1 or more apical teeth; cercal setae usually present, sometimes absent.

PUPAE.—*Cephalothorax:* middorsal ridge moderate; all hairs present; hair 1-C always strongly developed; 8,9-C far behind trumpet base, usually strongly developed and well separated. *Trumpet:* widely separated and inserted far back, usually much closer to wing base than middorsal line; usually short; apex usually truncate at only slight diagonal line; tracheoid and slit not developed; no distinct tubercle at base. *Abdomen:* hair 1-I varied, large, multiple, sparsely dendritic or with simple branches, sometimes reduced to single hair; all normal hairs present; hair 9-II-VI small, removed from caudolateral angle, lateral or ventral in position; 9-VII,VIII both large, multiple, 9-VII dorsal and 9-VIII ventral in insertion; hair 8 ventral, rarely dorsal. *Terminal Segments:* hairs 1-IX,X both absent; female cercus not distinct. *Paddle:* midrib present or absent; external portion of paddle often much wider than mesal; hairs 1,2-P both always absent.

LARVAE.—*Head:* varied in shape, usually rounded in front; labrum not separated by suture dorsally; collar usually moderately developed; ventral part of head capsule on midline never very long; posterior tentorial pit varied in position; maxillary suture often complete; cephalic border of labial sclerite usually truncate or slightly produced, sometimes with short sharp spicules; aulaeum not produced cephalad, with long filiform spicules largely restricted to sides; mental plate well developed, usually broader than long; mouthbrushes with numerous slender filaments, usually pectinate on apices; maxilla well developed, sometimes with long apical "horn" or articulated spines, palpus long; mouthbrushes never reduced to 10 flattened filaments on each side; hair 2-C always absent; 3-C always ventral in position, near hair 0; hairs 16,17-C apparently absent. *Antenna:* simple; always short or very short; without spicules; usually all hairs short and inconspicuous. *Thorax:* spiracular sensilla usually not apparent; notched organ not developed; none of the hairs plumose or palmate but several often strongly stellate, frequently 1 or more spiniform; chaetotaxy extremely varied; hair 13-P usually present in Old World species. *Abdomen:* spiracular sensilla often not apparent; dorsal sensilla distinct; tergites without sclerotizations other than those at base of hairs or comb scales; none of the hairs palmate or plumose but several often strongly stellate (0,1,2,5,9,11, 13,14) or spiniform (1,2,5,6,11,13); chaetotaxy extremely varied; hair 14-I sometimes present; 14-II-VII and 0-II-VII often strongly developed; 12-I apparently always absent. *Segment VIII:* comb extremely varied, rarely absent, comb plate sometimes developed; hairs 1-4-VIII often strongly displaced dorsad, sometimes also hair 5. *Siphon:* varied; acus always absent; pecten present or absent; body of siphon always with at least 1 pair of hairs in addition to hairs 1,2-S, usually many such hairs; sometimes with true spines dorsally in addition to ventrolateral pecten teeth; valves always short; stirrup-shaped piece very poorly developed, median rod very slender; trachea usually well developed. *Anal Segment:* saddle always incomplete and without acus, not emarginate caudoventrad; median dorsal caudal process not developed; chaetotaxy varied, accessory hairs not developed; ventral brush reduced to 1 pair of hairs free from saddle or attached; gills usually well developed.

EGGS.—Poorly known; see under genera below.

SYSTEMATICS.—The sabethines form a very distinct and very large tribe of the Culicinae which is still very poorly known, even in the New World, where it has been suspected of playing an important role in the transmission of sylvan yellow fever. In the Old World, where it has not been suspected of disease transmission and where only a few species bite man, it had attracted very little attention prior to World War II.

The tribe as a whole is difficult to characterize in the adult stage but is clearly marked in the larva by the characteristic development of the ventral brush and the siphon and by the position of hair 3 on the ventral side of the head capsule. The pupa is suggestive of the Aedini but is easily recognized by the development and position of hairs 9-VII,VIII and the absence of paddle hairs. A number of resemblances are also apparent in the adult and larval stages with the Toxorhynchitini and in the adult stage with the Ficalbiini and Culisetini, but the true affinities of the group cannot be determined satisfactorily at present.

The internal classification of the tribe is in a chaotic condition. It has been based almost entirely on very superficial external adult characters and, to a lesser extent, on male genitalia. Larval and pupal characters have been neglected almost entirely; it is becoming increasingly evident, however, that they will be of the greatest value in arriving at a natural classification of the group. Until these stages are adequately described for a greater percentage of species, there seems to be little justification for attempting a major reclassification.

The tribe is represented by a much larger number of types and species in the New World; it appears at first glance that this may have been its site of origin as well as differentiation. It is my impression that the Sabethini evolved and utilized the plant habitats in the New World much as the Aedini did in the Old World, both with little competition from other groups. In the Old World the Sabethini have been really successful only in utilizing *Nepenthes* pitchers, an extremely specialized habitat where they have had little competition from other groups. In the New World some generalized, many annectent, and many specialized types occur and have been recognized as distinct genera. In the Old World, on the other hand, except for the few aberrant and specialized forms placed in *Malaya, Topomyia,* and *Maorigoeldia,* all the known species are placed in the rather generalized genus *Tripteroides.* This situation, together with the presence on New Zealand of *Maorigoeldia,* probably the most primitive sabethine known, suggests the alternative interpretation that the Sabethini are of very ancient Old World origin and that they have been largely replaced there by the more recently evolved, plant-breeding Aedini.

The Old World sabethines fall into 2 distinct divisions: (1) *Malaya* and *Topomyia,* without hairs or scales on the upper calypter and vein 1A ending before or about at level of fork of Cu, and (2) *Maorigoeldia* and *Tripteroides,* with a marginal fringe of hairs or hairlike scales on the upper calypter and vein 1A ending distinctly distad of the fork of Cu.

The tribe is represented by 17 species in the South Pacific, 1 each in *Malaya* and *Maorigoeldia* and 15 in the dominant *Tripteroides.* All the species except *Tripteroides solomonis* appear to be definitely endemic to the area; the latter may be a recent human introduction but is provisionally considered to be endemic.

BIONOMICS AND DISEASE RELATIONS.—The sabethines are almost entirely restricted to breeding places in dead and living plant material. A few species have been reported from snail shells and rockholes, and several have become adapted to breeding in artificial containers. Some species are extremely specific as to the host plant. The eggs are apparently laid either on or above the water surface. The aquatic cycle is usually long, and most species are difficult to rear under artificial conditions in the laboratory. Predaceous forms are known in several groups; in all of these, the maxilla has a long horn or greatly enlarged articulated spines. The larvae of the majority of (if not all) species lie on their backs at the bottom of the breeding site and seldom come to the surface. Several species have been reported to crawl out of the water onto the sides of the breeding container.

Sabethine adults are sylvan mosquitoes that are seldom collected, as relatively few species will come to feed on man or will venture far from their restricted breeding sites. The period of activity varies, but many species are diurnal. Nothing is known of their mating habits. The majority of species fly with the hindlegs held over the back.

Some New World sabethines have been found to be naturally infected with the yellow fever and related viruses and have been shown to transmit them experimentally (Horsfall, 1955:35–36), but none of the Old World species are even suspected of transmitting human or animal diseases. Few species feed on man. In the South Pacific only *Tripteroides solomonis* may be considered to be a pest locally.

DISTRIBUTION (fig. 358).—The sabethines are largely tropical in distribution, with only a few species occurring in temperate regions. The tribe is represented by several genera and many species in the Neotropical region (Lane, 1953:811–1098). In the Old World only 4 genera are recognized: *Malaya,* occurring from West Africa to the Solomons and north to Okinawa; *Topomyia,* reported from the Oriental and Indomalayan regions and recently from New Guinea; *Maorigoeldia* restricted to New Zealand; and *Tripteroides,* the dominant genus, chiefly Indomalayan, Australasian, and South Pacific and occurring also in the Oriental region and southern portion of the Palaearctic but not in the Ethiopian. The tribe has not been reported from the Malagasy region. In the South Pacific, sabethines are known from the Solomons, Santa Cruz Islands, New Hebrides, Loyalties, New Caledonia, Rotuma Island, Fiji, and possibly Samoa.

KEYS TO GENERA AND SUBGENERA

(Keys to tribes, pp. 118–122)

ADULTS

1. Labium hairy, jointed and swollen in apical third; upper calypter without marginal fringe; vein 1A ending at about level of fork of Cu (1. *solomonis*) . . . . MALAYA, p. 489

Labium normal, slender, not jointed or swollen in apical third; upper calypter with marginal fringe of hairs or hairlike scales; vein 1A ending well beyond level of fork of Cu 2

2(1). Acrostichal bristles well developed; *ppn* bristles at least 3 (1. *argyropus*) . . . . MAORIGOELDIA, p. 492

Acrostichal bristles usually absent, at most 1 pair near anterior promontory; *ppn* bristles at most 2 (TRIPTEROIDES, p. 495) 3

3(2). Ornamented forms; vertex of head with azure blue scales, abdomen or pleuron with metallic silvery scales . . . . subgenus TRIPTEROIDES, p. 497

Nonornamented forms; vertex of head without azure blue scales, abdomen and pleuron without metallic silvery scales 4

4(3). Wing veins without narrow dorsal plume scales, all dorsal scales short and broad . . . . subgenus RACHISOURA, p. 520

Wing veins with narrow and elongate dorsal plume scales ..... subgenus RACHIONOTOMYIA, p. 506

MALE GENITALIA

1\. Phallosome complex; aedeagus surrounded tergally and laterally by distinct separate sclerotizations (1. *argyropus*) ..... MAORIGOELDIA, p. 492

Phallosome simple: aedeagus not surrounded by distinct separate sclerotizations 2

2(1). Aedeagus very broad and broadly emarginate in the middle apically in tergal aspect; sidepiece with 1,2 thickened bristles on mesal surface distad of basal mesal lobe (1. *solomonis*) ..... MALAYA, p. 489

Aedeagus narrowed or produced apically and without broad apical emargination; sidepiece without thickened bristles on mesal surface distad of basal mesal lobe (TRIPTEROIDES, p. 495) 3

3(2). Ninth tergite lobe with 3 broad leaflike setae (PURPURATUS GROUP) ..... in part, subgenus TRIPTEROIDES, p. 497

Ninth tergite lobe without such broad leaflike setae 4

4(3). Dorsal surface of sidepiece with bristles confined largely to distal half; sidepiece always very short, hardly longer than wide ..... in part, subgenus TRIPTEROIDES, p. 497

Dorsal surface of sidepiece with bristles numerous in basal half; sidepiece usually at least twice as long as wide (except 1. *solomonis*) 5

5(4). Aedeagus short and rather broad, length at most 2.0 of width at middle; paraproct ending in 2 or more denticles ..... subgenus RACHIONOTOMYIA, p. 506

Aedeagus very slender, length more than 3.0 of width at middle; paraproct ending in a single large tooth ..... subgenus RACHISOURA, p. 520

PUPAE

1\. Hair 2-III-V on posterior border mesad of hair 1 2

Hair 2-III-V removed cephalad of caudal border of tergite (TRIPTEROIDES, p. 495) . 3

2(1). Hair 6-VII cephalad of hair 9 and thickened; paddle without midrib or apical process (1. *solomonis*) ..... MALAYA, p. 489

Hair 6-VII caudomesad of hair 9 and weak; paddle with midrib and distinct apical process (1. *argyropus*) ..... MAORIGOELDIA, p. 492

3(1). Hair 1-C single; dorsal sensillum present on abdominal segments III,IV only ..... subgenus RACHISOURA, p. 520

Hair 1-C double or triple; dorsal sensillum present on abdominal segments III-V ... 4

4(3). Hair 3-VII very long, projecting distinctly beyond posterior margin of tergite VIII ..... subgenus TRIPTEROIDES, p. 497

Hair 3-VII relatively short, not reaching posterior margin of tergite VIII ..... subgenus RACHIONOTOMYIA, p. 506

LARVAE

1\. Hairs 5,6-P both very large and multiple (1. *solomonis*) ..... MALAYA, p. 489

Hairs 5,6-P never both large and multiple, usually both single or only 5-P with a few branches 2

2(1). Comb a large triangular patch of 100 or more scales (1. *argyropus*) ..... MAORIGOELDIA, p. 492

Comb in a single more or less regular row, scales free or attached to a plate (TRIPTEROIDES, p. 495) 3

3(2). Maxillary sutures not reaching posterior tentorial pits, widely spaced and nearly straight; maxilla longer than wide and with articulated spines usually as long as shaft ..... subgenus RACHISOURA, p. 520

Maxillary sutures reaching posterior tentorial pits, divergent caudad and more or less sinuous; maxilla broader than long, if articulated spines present then at most 0.6 of shaft length 4

4(3). Comb scales arising from a sclerotized plate 5

Comb scales free 6

5(4). Comb scales at least 20 on each side (PURPURATUS GROUP) ..... in part, subgenus TRIPTEROIDES, p. 497

Comb scales at most 10 on each side (ATRIPES and FLORIDENSIS GROUPS) ..... in part, subgenus RACHIONOTOMYIA, p. 506

6(4). Hair 6-M spiniform (BIMACULIPES GROUP) ..... in part, subgenus TRIPTEROIDES, p. 497

Hair 6-M long, slender and attenuate (CALEDONICUS and ARGENTEIVENTRIS GROUPS) ..... in part, subgenus RACHIONOTOMYIA, p. 506

Genus MALAYA Leicester

1908. *Malaya* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):258. *TYPE SPECIES: *M. genurostris* Leicester, 1908, Malaya; monobasic.—Not preoccupied by *Malaia* Heller, 1892.

1909. *Grahamia* Theobald, Grt. Brit. Colon. Off., Colon. Rpt., Misc. Ser. 237:23, May. *TYPE SPECIES: *G. trichorostris* Theobald, 1909, Ashanti (Gold Coast); monobasic.

1909. *Harpagomyia* de Meijere, Tijdschr. v. Ent. 52:165, Dec. TYPE SPECIES: *H. splendens* de Meijere, 1909, Java; monobasic.

FEMALES.—*Head:* eyes distinctly separated above antennae; frontal area distinct, sometimes with tuft or scales; erect scales not developed; clypeus bare, narrow, ovoid, appearing as dorsal basal part of proboscis; labium jointed at about 0.65, distal part swollen and bent upward, whole labium hairy and with a row of long dorsal bristles on each side, scales scanty; labellum distinctly segmented, with 2 pairs of long curled bristles, basal segment scaled; palpus apparently 2-segmented, projecting slightly beyond clypeus, apparently without scales; antenna at least as long as proboscis; flagellar segments subequal, first somewhat longer, few bristles in whorls. *Thorax: apn* lobes very large, approximated but not contiguous; meron small, its upper margin about in line with hindcoxa or slightly above; postnotum bare; paratergite very broad, joined to *pra* caudad; mesonotum with narrow dark bronzy scales, with or without median longitudinal silvery line; scutellum with broad flat scales only; acrostichal bristles absent except small ones at extreme anterior end, dorsocentrals at most a few, prescutellars few; pleural scales all broad; *ppn* scales flat, light or dark; flat translucent silvery scales on *apn, ppl, ssp,* most of *stp* except lower anterior part, and at least upper anterior part of *mep;* a few erect translucent to silvery scales on metapleuron below spiracle; *apn* bristles strongly developed; 1–3 *ppn* bristles; 1–3 *ppl* bristles; usually 1–3 *sp* bristles, apparently completely absent in *solomonis; stp, pra* bristles completely absent; upper *mep* bristles usually 5–10. *Legs:* coxae with silvery scales; trochanters and base of femora light; remainder of legs dark-scaled except for usual lighter areas on femora; all femora slender. *Wing:* vein 1A ending near or before fork of vein Cu; dorsal plume scales few, narrow; alula with marginal hairs or scales; upper calypter without hairs or scales. *Haltere:* knob dark-scaled. *Abdomen:* tergites dark-scaled, with apicolateral silvery patches on I,II,IV,V; laterotergite completely silvery-scaled; sternites II-V entirely silvery-scaled; other silvery markings may be present. *Genitalia:* not studied; as in tribe (Edwards, 1941:35).

MALES.—Essentially as in the females; antenna and palpus entirely similar; claws not enlarged.

MALE GENITALIA.—Small, not prominent. *Segment VIII:* largely retracted. *Segment IX:* tergite short, shallowly emarginate on caudal margin; lateral tergal lobe broad, poorly defined, with strong bristles; sternite long. *Sidepiece:* short, simple; scales not numerous; basal mesal lobe poorly defined, indicated chiefly by about 4 heavy bristles. *Clasper:* simple, gradually tapered; spiniform rather short, broad. *Phallosome:* simple; aedeagus simple, broad and more or less cylindrical, apex with dorsal shelflike projection and appearing broadly emarginate in tergal aspect. *Proctiger:* basal lateral sclerotization very conspicuous; paraproct with 1,2 dorsal apical teeth; cercal setae apparently not developed.

PUPAE.—Essentially as in *Tripteroides* (*Tripteroides*) except that trumpet inserted farther away from wing base; hair 2 mesad of 1 and near posterior border on III-VII; hair 6-VII strongly developed; no distinct midrib on paddle.

LARVAE.—In general as in *Tripteroides. Head:* broader than long; posterior tentorial pit a considerable distance cephalad of caudal border; maxillary suture strongly concave laterad; hairs 4-6-C all cephalad of antennal bases; 12-14-C all removed caudad from anterior border; 15-C near middle. *Thorax:* hair 1-P removed from 2,3; 5-7-P on common tubercle, 5,6 very large multiple tufts; 13-P apparently absent; large lateral multiple hairs with broad base and densely barbed branches. *Abdomen:* hair 2 small, mesad of hair 1 on I-VII; hair 3 also mesad of 1 on III,IV; 6-I-II multiple, with broad base and strongly barbed branches, markedly different from hair 6 on other segments; 1-II-VII, 5-I-VI, 9-I,II, 13-I-VI all large, more or less stellate, with long attenuate branches. *Segment VIII:* comb of numerous scales in at least 2 rows. *Siphon:* pecten of a few teeth, usually in basal 0.5; hair 1-S a submedian pair; a ventral postmedian row of several hairs (1a-S); a pair of subdorsal rows of several hairs (2a-S). *Anal Segment:* saddle small; hair 1-X long.

EGGS.—Not described.

SYSTEMATICS.—The development of the proboscis of *Malaya* is a unique feature in the Culicidae. In general adult morphology the similarity with *Topomyia* is amazing, but the 2 genera are very different in the male genitalia. The larvae and pupae of *Malaya* and *Topomyia* share a number of characters but are quite distinct.

Malaya appears to be an ancient derivative from a generalized sabethine stock which also gave rise to *Topomyia*. Its specializations seem to be confined to the proboscis of the adults and are associated with the unusual method of feeding.

BIONOMICS AND DISEASE RELATIONS.—*Malaya* species breed largely in the leaf axils of various plants, but a few forms have been found in treeholes and water-filled nests of arboreal ants. The adults of those species whose feeding habits are known obtain regurgitated liquids by thrusting the specialized proboscis into the external buccal cavity of food-laden ants (see Horsfall, 1955:355–356). This genus therefore cannot be involved in disease transmission.

DISTRIBUTION (fig. 358).—*Malaya* has the widest distribution of the 4 Old World genera of the Sabethini. It occurs from West Africa to the Solomons and from Okinawa to Australia. It has not been reported from the Malagasy region. In the South Pacific it has been found only on Bougainville.

KEYS TO SPECIES

See keys to tribe Sabethini, pp. 487–488

1. Malaya solomonis (Wharton)

Figs. **358-360**

1947. *Harpagomyia solomonis* Wharton, Linn. Soc. N. S. Wales, Proc. 72:63–64. TYPE: holotype ♂ with associated larval and pupal skins, Bougainville, Solomon Islands, from "axils of a lily-like plant with long narrow leaves" (probably *Sararanga*), Dec., 1944, J. R. Covell (QUEEN).

Malaya solomonis of Stone, Knight, and Starcke (1959).
Harpagomyia solomonis of Iyengar (1955:25).

FEMALE.—*Wing:* 2.67 mm. *Proboscis:* 1.0 mm. *Forefemur:* 1.83 mm. *Abdomen:* about 1.53 mm. *Head:* a broad silvery patch in front on middle of vertex, not continued cephalad between eyes, a silvery patch on each side below, remainder dark-scaled; clypeus light brown to yellowish; basal portion of proboscis light yellowish, swollen portion darkened. *Thorax:* a narrow median longitudinal line of broad flat silvery scales from anterior promontory to about level of wing root; midlobe of scutellum with silver scales, a few brown ones at base laterad, lateral lobe with dark brown scales; *ppn* with dark brown scales, appearing metallic in dorsal aspect; *mep* scales confined to upper half; *sp* bristles not seen, according to Wharton at most 2 fine bristles present. *Abdomen:* no silver scales on tergites VI-VIII.

MALE.—Essentially as in the female; scaling of midlobe of scutellum largely dark brown, a few silver scales sometimes present in middle; *ppn* scales light, silvery; an occasional light scale on tergite VI.

MALE GENITALIA (fig. **359**).—As figured; diagnostic characters as in the key; apparently indistinguishable from *leei* Wharton, 1947 except possibly as follows. *Segment IX:* tergite lobe with about 9–11 bristles in partial double row. *Sidepiece:* basal mesal lobe with 4 thickened bristles and numerous long hairs; mesal postmedian area with 1 strongly thickened bristle and 2,3 less thickened bristles; 1 long subapical sternal bristle.

PUPA (fig. **359**).—*Abdomen:* 2.76 mm. *Trumpet:* 0.28 mm. *Paddle:* 0.5 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* very lightly pigmented, darkened dorsally on mesonotum; hairs lightly pigmented except for 1-C which is darker. *Trumpet:* bright light yellowish brown. *Metanotum:* darkened. *Abdomen:* uniformly lightly pigmented caudad, darkened cephalad and on middorsal line to end of segment V; larger single hairs somewhat darker than integument, others concolorous; hair 5-VI extremely long, at least reaching caudal margin of tergite VIII. *Paddle:* extremely lightly pigmented, practically invisible in mounts; no indication of midrib; marginal spicules not evident except on internal margin.

LARVA (fig. **360**).—*Head:* 0.62 mm. *Siphon:* 0.65

mm. *Anal Saddle:* 0.16 mm. Chaetotaxy as figured; diagnostic characters as in the key; uniformly lightly pigmented throughout; in life pale tan in color. *Head:* hairs 4-6-C close together, 5 almost as long as 4,6. *Antenna:* hair 1-A single, rather long, reaching to apex of shaft. *Thorax:* hair 0-P long; 8-M large, multiple. *Abdomen:* hairs large, conspicuous. *Segment VIII:* comb scales very numerous, in large patch, anterior short and fringed, posterior elongate and fringed. *Siphon:* index about 5.0–6.0; pecten of 3–5 frayed elongate spines; hair 1-S large, usually 4,5b; 2-S conspicuous, expanded and flattened distad, apex narrowed and hooked; accessory ventral hairs (1a-S) as figured, in a more or less uniform midventral line; accessory subdorsal hairs (2a-S) as figured, the proximal 3 thickened. *Anal Segment:* saddle with a conspicuous subdorsal lateral patch of long fringed spicules; hair 1-X usually 3-5b, long, branches of even length; 2-X usually 5-7b, long; 4-X long, single; gills very long, subequal, apically rounded.

MATERIAL EXAMINED.—14 specimens; 3 ♀; 3 ♂; 2 pupae; 6 larvae; no individual rearings.

SYSTEMATICS.—*M. solomonis* appears to be closely related to *leei* (Wharton, 1947) from New Guinea. The affinities of these 2 species are difficult to determine, since the immature stages of all species other than *solomonis* are insufficiently described. There is considerable variation in the silvery scaling of *solomonis,* but it is distinctly different from all the other known species. I can find no indication of spiracular bristles, not even alveoli, in the 6 adults I have examined, but Wharton (1947:63) states that as many as 2 fine bristles may be present.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *solomonis* are known only from the leaf axils of "a lily-like plant with narrow leaves, grows 3–7 feet high" (J. R. Covell) and "an arum-like plant in swamp" (A. B. Gurney, 378, 427). The plant involved in both instances is probably a species of *Sararanga,* of the family Pandanaceae (Wharton, 1947:64). Nothing is known of the habits of the adults.

DISTRIBUTION (fig. 358).—*Solomon Islands:* Bougainville. Not known elsewhere.

Genus MAORIGOELDIA Edwards

1930. *Maorigoeldia* Edwards, B. Ent. Res. 21:302. *TYPE SPECIES: *Culex argyropus* Walker, 1848, New Zealand; original designation.—As subgenus of *Rachionotomyia.*

FEMALE.—In general as in *Tripteroides;* ornamented. *Head:* eyes narrowly separated; no scales or bristles on frons; erect scales long; a continuous row of long orbital bristles caudad of frontal pair; clypeus small, prominent, rounded in front, bare; proboscis normal, dark-scaled, a little longer than abdomen; palpus about 0.15 of proboscis, at least 3-segmented, probably with 4 segments, marked with white scales near base dorsally; antenna about 0.8 of proboscis; torus with short hairs; flagellar segment 1 deeply inserted in torus, distinctly longer than segment 2, with distinct patch of scales; bristles in flagellar whorls long and rather numerous. *Thorax: apn* lobes small, widely separated; meron large, its upper margin distinctly above base of hindcoxa; postnotum without bristles or scales; paratergite long and narrow; acrostichals, dorsocentrals, prescutellars, and supraalars all numerous and strong; *ppn* bristles usually 3,4; *sp* bristles usually 2–4; always 1,2 upper *stp* bristles; *pra* bristles 2–4, heavy. *Legs:* ornamented; hindleg with 2 claws. *Wing:* vein 1A ending well beyond fork of Cu; cell R_2 about 2.5 of length of vein R_{2+3}; scaling very dense, plume scales rather broad; alula and upper calypter both with fringe of hairs or hairlike scales. *Abdomen:* tergite I scaled in center only; laterotergite without scales. *Genitalia:* not studied.

MALE.—Essentially as in the female. *Palpus:* about 0.20 of proboscis; 4-segmented, segment 4 short. *Antenna:* about 0.6 of proboscis; bristles in flagellar whorls moderately dense and very long; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg and midleg enlarged, unequal, and simple; both claws of hindleg present, small.

MALE GENITALIA.—Prominent. *Segment VIII:* sternite strongly produced caudad as triangular lobe. *Segment IX:* tergite and sternite both strongly developed; tergite with prominent median caudal lobe with very numerous bristles. *Sidepiece:* basal mesal lobe strongly developed. *Clasper:* simple. *Phallosome:* complex; a conspicuous complex sclerotization dorsad and dorsolaterad of aedeagus. *Proctiger:* very broad; cercal sclerite strongly developed; cercal setae conspicuous.

PUPA.—In general as in *Tripteroides* (*Tripteroides*). *Cephalothorax:* hair 1-C double; 8-C very long. *Abdomen:* hair 9-III-VI near caudolateral angle; 6-II-VI more caudal than in *Tripteroides;* 6-VII mesad and caudad of hair 9; 2-III-V mesad of hair 1 and near caudal border; 2-VII laterad and near hair 1. *Paddle:* strongly produced on apex.

LARVA.—*Head:* longer than wide; posterior tentorial pit near caudal border; maxillary suture complete, nearly straight; labial sclerite rather narrow; mental plate very wide; hairs 4-6-C close together at about antennal level, 5 and 6 strongly developed; 11-13-C close together; 15-C nearer cephalic than caudal border. *Thorax:* no stellate or spiniform hairs; hairs 1-3-P removed from midline, not on common tubercle; 5-7-P on small common tubercle; 9,10,12 all long, subequal, on common tubercle; 13,14-P apparently both present; 8-M, 7-T long, multiple. *Abdomen:* no stellate or spiniform hairs; hairs 1-III-VII, 6-I-VI, 13-I-V strongly developed, single or double; all other hairs rather small except 3-VII; hair 2 at about level and mesad of 1 on III-VI, laterad on VII; hair 6 essentially similar on I-VI; 7-I,II long. *Segment VIII:* comb scales in a large patch of 60 or more; hairs 1,2-VIII very close together, hair 1 laterad of 2. *Siphon:* pecten of 4–6 teeth; ventrolateral hairs in continuous long paired rows, 1-S not differentiated; dorsolateral hairs in long paired rows. *Anal Segment:* saddle without spicules.

EGG.—Ovoid; laid singly on water surface; in hatching egg splits lengthwise near ventral surface (Graham, 1929:232–235).

REMARKS.—For systematics, bionomics, and distribution, see below under *argyropus,* the only known species.

KEYS TO SPECIES

See keys to tribe Sabethini, pp. 487–488

1. Maorigoeldia argyropus (Walker)

Figs. **358, 361, 362**

1848. *Culex argyropus* Walker, List Dipt. Insects Brit. Mus. 1:2. *TYPE: holotype ♀, New Zealand; identified as the type by E. A. Waterhouse (BMNH).

Tripteroides (*Maorigoeldia*) *argyropus* of Edwards (1932:75); Taylor (1934:11); Lee (1944*a*:17); Stone, Knight, and Starcke (1959).
Tripteroides (*Maorigoeldia*) *argyropa* of Lee (1946:229–230).
Tripteroides argyropus of Miller (1950:45); Miller and Phillipps (1952:27–28).
Rachionotomyia (*Maorigoeldia*) *argyropus* of Edwards (1930*b*:302).
Rachionotomyia argyropus of Edwards (1924:360); Graham (1929:227–243; 1939:213).
Uranotaenia (?) *argyropus* of Theobald (1901*b*:264–266).

FEMALE.—*Wing:* 4.25 mm. *Proboscis:* 2.84 mm. *Forefemur:* 2.67 mm. *Abdomen:* about 2.83 mm. *Head:* dark-scaled dorsally except for conspicuous narrow orbital light bluish line; with light bluish scales ventrolaterad; palpus with broad white dorsal white-scaled band near base. *Thorax:* mesonotum with narrow curved brown scales, light in front, darker caudad; a conspicuous broad lateral line of silvery white or light bluish scales, narrow and appressed cephalad of scutal angle, broad caudad, decumbent about halfway to wing root then outstanding; scutellar scales all small, broad, and dark; pleuron with a conspicuous continuous narrow line of similar silvery scales from lower part of *apn* diagonally to lower part of *mep*, somewhat broadened caudad, scales broad and decumbent; *ppl* and upper part of *pcx* with similar broad silvery decumbent scales; small patches of similar broad silvery scales in lower caudal part of *stp* and in front of upper *mep* bristles. *Legs:* coxae and trochanters light and with silvery scales; remainder of legs dark-scaled except for conspicuous silvery white or light bluish markings as follows, (1) more or less complete postmedian and apical rings on femora, (2) anterior apical patch on tibiae, largest on hindleg, (3) dorsal patch on apex of segment 3 and entire segment 4 on foretarsus, (4) at least dorsum of midtarsus from apex of segment 2 distad, (5) from apex of segment 3 distad on hindtarsus. *Abdomen:* tergites dark-scaled except for apicolateral patches of silvery white or light bluish metallic scales, large on II, small on III-VII; sternites largely dark-scaled.

MALE.—Essentially as in the female; light scaling more prominent on head, thorax, legs, and abdomen. *Palpus:* shorter. *Antenna:* with longer and more numerous bristles in flagellar whorls; flagellar segments 12 and 13 elongate, subequal.

MALE GENITALIA (fig. **361**).—As figured; diagnostic characters as in the key. *Segment VIII:* sternite strongly produced caudad as a triangular lobe. *Segment IX:* strongly developed; tergite long and broad, with a broad median truncate lobe divided by a minute emargination in the middle, on each side of which are numerous setae in several rows, setae longer laterad; sternite long and broad. *Sidepiece:* moderately long; scales moderately numerous laterally and ventrally; dorsal surface with numerous hairs and bristles extending to near base, 3–6 thickened bristles in a longitudinal median row; basal mesal lobe strongly developed, with numerous bristles and hairs. *Clasper:* simple and rather short; slightly tapered distally; distal part with several minute setae; spiniform slightly broadened distally. *Phallosome:* complex; aedeagus small, broad at base, distal part narrowed and parallel-sided in tergal aspect; a conspicuous complex sclerotization dorsad and dorsolaterad of aedeagus, with a complete broad tergal bridge, a small median inner sclerite in form of groove developed from sternoapical part of tergal bridge; base of aedeagus and dorsal sclerotization apparently with a common intermediate sclerite joining the ventral paramere. *Proctiger:* very broad; basolateral sclerotization very strongly developed; paraproct with 2,3 small apical denticles; cercal sclerite strongly developed, cercal setae about 6-8, conspicuous.

PUPA (fig. **361**).—*Abdomen:* 3.25 mm. *Trumpet:* 0.7 mm. *Paddle:* 0.88 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* uniformly strongly pigmented. *Trumpet:*

very strongly uniformly pigmented. *Abdomen:* uniformly strongly pigmented, intersegmental membranes light. *Paddle:* lightly to moderately pigmented; midrib strongly developed; very short marginal spicules evident only on internal margin.

LARVA (fig. 362).—*Head:* 1.42 mm. *Siphon:* 1.24 mm. *Anal Saddle:* 0.18 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly strongly pigmented; hairs strongly pigmented; mental plate large, sides evenly curved, 14–16 teeth on each side of slightly enlarged prominent median tooth. *Antenna:* uniformly moderately pigmented. *Thorax:* larger hairs and tubercles strongly pigmented, small hairs very difficult to see in mounts; hairs 13,14-P may be incorrectly placed. *Abdomen:* segments I-IV said to be white in life, caudal yellow (Graham, 1929:235); larger hairs and tubercles strongly pigmented, small hairs difficult to see. *Segment VIII:* comb scales in a very large patch, all spatulate, caudal ones markedly so, fringe short and inconspicuous. *Siphon:* index about 2.5–3.0; very strongly pigmented, apex lighter; pecten of 3–6 simple long spines. *Anal Segment:* saddle moderately to strongly pigmented; marginal spicules not developed; gills subequal, long, rounded apically.

MATERIAL EXAMINED.—30 specimens; 7 ♀; 13 ♂; 3 pupae; 7 larvae; no individual rearings.

SYSTEMATICS.—*M. argyropus* is a very distinctive sabethine, which shows strong affinities with *Tripteroides* but has so many peculiar features that it should be placed in a distinct genus. It is certainly as well marked as any New World sabethine genus. In the adult stage it can be immediately recognized by the presence of acrostichal bristles; the larva and pupa, as shown above, are easily separated from *Tripteroides.* In several respects *argyropus* is the most primitive sabethine known. The material of the immature stages available for study is very poor; it is probable that I have made a number of errors in the description and in the figures.

BIONOMICS AND DISEASE RELATIONS.—The natural breeding sites of *argyropus* are not known. Immature stages have been collected only in artificial containers "in or near native bush" (Graham, 1929). It appears that the most likely natural sites would be treeholes. Edwards (1924:360) suggests that "this is perhaps the species referred to by Miller as breeding in epiphytic Astelias on the North Auckland peninsula," but Graham (1929:232) indicates that Miller (1920:36) stated definitely that the species he found was *notoscriptus.* I have not seen the specimens in question or Miller's paper, but it does not appear likely that *notoscriptus* would be found in such a habitat, and it is possible that *argyropus* was involved.

Adults of *argyropus* have been found resting on tree trunks in the bush. Females are stated to be persistent biters, but little reliance can be placed on early reports on this species (Theobald, 1901*b*:265) or, for that matter, on the voluminous notes on bionomics and descriptive matter by Graham (1929:227–243).

DISTRIBUTION (fig. 358).—*New Zealand:* North Island (Auckland, Wellington); South Island (Nelson). Not known elsewhere.

Genus TRIPTEROIDES Giles

1904. *Tripteroides* Giles, J. Trop. Med. 7:369. *TYPE SPECIES: *Runchomyia philippinensis* Giles, 1904, Philippines; original designation.
For complete synonymy, see under subgenera.

FEMALES.—*Head:* eyes contiguous, no frontal scales or distinct tuft; erect scales present, varied; orbital bristles varied; clypeus small, prominent, rounded in front, bare or with scales; proboscis varied in length, never strongly swollen, usually entirely dark-scaled; palpus varied in length and segmentation, often very short, usually entirely dark-scaled. *Thorax: apn* lobes varied, widely separated; meron varied, its upper edge in line with or more or less above base of hindcoxa; postnotum bare or with hairs; paratergite varied, usually broad; acrostichal bristles absent except at extreme anterior end, dorsocentrals and prescutellars often reduced or absent, supraalars often very short; *ppn* bristles varied or absent; *sp* bristles always present; upper *stp* bristles usually absent, rarely a few hairs, lower present or absent; *pra* bristles present. *Legs:* varied in ornamentation, often completely dark-scaled; hindleg with only 1 claw in some species. *Wing:* vein 1A ending well beyond fork of Cu; scaling varied; alula and upper calypter both with fringe of hairs or hairlike scales. *Abdomen:* tergite I and laterotergite scaling varied; bristles inconspicuous on apical border except on caudal tergites and laterad. *Genitalia:* not studied.

MALES.—Essentially as in the females. *Palpus:* varied; from about as long as proboscis to less than 0.1 its length. *Antenna:* varied; usually distinctly more plumose than in female; flagellar segments 12 and 13 elongate. *Legs:* foreclaws and sometimes midclaws enlarged and unequal or equal, toothed or simple; hindclaws 2 or 1.

MALE GENITALIA.—Usually relatively small and not very prominent. *Segment VIII:* sternite not produced into a caudal lobe. *Segment IX:* tergite usually with distinct lateral tergal lobes, rarely with median lobe with relatively few bristles. *Sidepiece:* short; with simple basal mesal lobe with bristles; no other lobes. *Clasper:* relatively simple; spiniform small, apical or subapical. *Phallosome:* simple; aedeagus with or without distinct teeth. *Proctiger:* paraproct strongly developed, always with at least 1 tooth; cercal setae usually present, sometimes very inconspicuous or apparently absent.

PUPAE.—*Cephalothorax:* hair 1-C very long or relatively short; all other hairs except 4,6-C usually strongly developed. *Trumpet:* widely separated, base close to wing pad. *Abdomen:* hair 1-I varied, dendritic to single; 2-III-VII removed from caudal border; 6-VII varied in position and development; 9-VII sometimes spiniform, usually multibranched. *Paddle:* never with fringe of long marginal filamentous spicules; midrib present or absent.

LARVAE.—*Head:* varied in shape; posterior tentorial pit varied in position; maxillary suture varied; maxilla sometimes with enlarged apical articulated spines or "horns"; chaetotaxy varied. *Thorax:* chaetotaxy extremely varied; stellate and spiniform hairs developed or not; hairs 13,14-P apparently always present; 9-12-P,M,T on common tubercles. *Abdomen:* chaetotaxy varied; hair 12-I apparently always absent; hairs 0,1,2,5,11,13 often stellate or spiniform. *Segment VIII:* comb scales in a single row, free or attached to comb plate; hair 1-VIII mesad of hair 2, others varied in position. *Siphon:* pecten nearly always developed; dorsolateral and ventrolateral accessory hairs usually both present; hairs 1,1a-S always strong.

EGGS.—Baisas and Ubaldo-Pagayon (1953, pls. 9, 10) figure elongate eggs probably of this genus.

SYSTEMATICS.—Even after the exclusion of *Maorigoeldia*, *Tripteroides* remains a complex and heterogeneous genus difficult to characterize. I am now recognizing 3 subgenera: *Tripteroides* for the ornamented species, *Rachisoura* for nonornamented species with predaceous larvae with incomplete, widely separated maxillary sutures, and *Rachionotomyia* for all the other nonornamented species. The latter is a very complex and heterogeneous subgenus, from which additional species may eventually be segregated. *T. mabinii* Baisas & Ubaldo-Pagayon, 1953 from the Philippines may require a distinct subgenus. Its larva resembles *Rachisoura* species but has several peculiar characters, and the adults are ornamented as in the subgenus *Tripteroides*.

As indicated above under discussion of the tribe, *Tripteroides* and *Maorigoeldia* are 2 distinct genera of 1 of the 2 divisions of the tribe in the Old World. Their affinities with the New World genera cannot be determined at the present because of the extremely poor knowledge of the larvae of the latter. The similarities of *Tripteroides* and *Trichoprosopon* have been pointed out repeatedly, but no detailed comparison has been made to date. However, the 2 genera appear to be amply distinct in all stages.

The dominant Old World genus *Tripteroides* is represented in the South Pacific by 15 endemic species: 5 in the nominate subgenus, 7 in *Rachionotomyia,* and 3 in *Rachisoura.*

The recent declaration of the International Commission on Zoological Nomenclature (Declaration 40) regarding the gender of generic names ending in the suffix *-oides* requires that specific names used as adjectives in *Tripteroides* be changed to the masculine termination.

BIONOMICS AND DISEASE RELATIONS.—All the species of *Tripteroides* whose immature stages are known have been found breeding in small water collections, principally in treeholes, bamboo, coconut shells and husks, fallen leaves, leaf axils and flower bracts of plants (aroids, bananas, palms, pandanus, and *Curcuma,* and so on), and frequently in the pitchers of *Nepenthes. T. sullivanae* Baisas & Ubaldo-Pagayon, 1953 from the Philippines uses small snail shells. A few species occur also in artificial containers, and *tasmaniensis* (Strickland, 1911) has been collected in rockholes. The subgenus *Rachisoura* consists exclusively of species with predaceous larvae. The aquatic cycle appears to be long in all but the few species which utilize artificial containers. The forms with specialized larval habitats in living plants, particularly in *Nepenthes,* are very difficult to rear in the laboratory.

Adults appear to be diurnal in activity. Only a few species attack man; nothing is known of the blood-feeding habits of the others.

No species of *Tripteroides* has ever been suspected of disease transmission, and only a few semidomestic species can be considered to be pests locally. Species of *Rachisoura* may play a minor role in reducing the populations of economically important species of *Aedes* breeding in small containers.

DISTRIBUTION (fig. 358).—*Tripteroides* is largely Indomalayan and Australasian. It occurs from India and Japan to Tasmania and the South Pacific. It is not known from the Ethiopian or Malagasy regions and is absent from most of the Palaearctic. In the South Pacific *Tripteroides* has been reported from the Solomons, Santa Cruz Islands, New Hebrides, Loyalties, New Caledonia, Rotuma Island, Fiji, and possibly Samoa.

KEYS TO SUBGENERA

See keys to tribe Sabethini, pp. 487–488

Subgenus TRIPTEROIDES Giles

1904. *Tripteroides* Giles, J. Trop. Med. 7:369. *TYPE SPECIES: *Runchomyia philippinensis* Giles, 1904, Philippines; original designation.

1908. *Colonemyia* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):233. *TYPE SPECIES: *C. caeruleocephala* Leicester, 1908, Malaya; first of 3 included species, selection of Brunetti (1914:58).

FEMALES.—Ornate; pleuron or abdomen or both with some silvery scaling, sometimes silvery scaling on legs as well. *Head:* at least anterior part of vertex usually with azure blue scales; erect scales in a single row; upper (central) orbital bristles not developed, lateral small; clypeus small, rounded, bare; proboscis very slender, longer than abdomen; palpus usually very short, apparently 2-segmented, segment 2 may be composite; antenna usually less than 0.7 of proboscis. *Thorax:* postnotum without hairs; *apn* and meron both small, upper edge of latter usually distinctly above base of hindcoxa; predominant mesonotal scales linear; dorsocentral bristles usually and prescutellars always present, supraalars strongly developed; pleural scaling usually confined to *apn, ppn, stp,* and *mep; pst, acx, ppl, pcx,* and lowermost part of *ppn* usually all without scales; *ppn* bristles 1,2; upper *stp* without bristles. *Legs:* often with silvery markings on femora; 2 claws on hindleg, neither greatly reduced. *Wing:* dorsal plume scales varied; cell R_2 varied. *Abdomen:* tergites with or without silvery markings.

MALES.—Essentially as in the females. *Palpus:* similar to and as short as or shorter than in females. *Antenna:* usually more strongly plumose; flagellar segments 12,13 elongate, each at least 2.0 of segment 11. *Legs:* claws of foreleg and midleg markedly enlarged; anterior claw of foreleg often toothed.

MALE GENITALIA.—Subgeneric characters not apparent; usually very small, strongly retracted; sidepiece usually very short and with few bristles.

PUPAE.—Subgeneric characters not apparent; hair 1-C very long, double; hair 3-VII long, projecting beyond posterior margin of tergite VIII; paddle rounded or slightly emarginate apically.

LARVAE.—Subgeneric characters not evident at present. *Head:* posterior tentorial pit near collar; maxillary suture complete, strongly concave laterad; labial sclerite narrow; maxilla without differentiated apical spines, palpus long; hair 15-C near caudal border. *Thorax:* hairs 6-M,7-T usually both spiniform. *Segment VIII:* comb scales free or arising from plate.

SYSTEMATICS.—The ornate species of *Tripteroides* appear to form a rather compact natural section of the genus. Probably not all known species will conform to the diagnosis given above, for at least *vicina* (Edwards, 1915) is rather aberrant in several characters. The larvae and pupae of most species are too poorly known to allow diagnosis of these stages.

There are several distinct groups within the subgenus. In the South Pacific I recognize the following, (1) the monotypic *purpuratus* group from Fiji and (2) the *bimaculipes* group, composed of *bonneti, distigma, lipovskyi,* and *binotatus,* from the Santa Cruz Islands and the Solomons.

A comparison of the South Pacific distributions of the subgenus *Tripteroides* and the *caledonicus* group of the subgenus *Rachionotomyia* suggests that the 2 groups populated the area from 2 different directions, *Tripteroides* from the northwest through the Santa Cruz–Fiji arc and the *caledonicus* group from the southwest through New Caledonia and the New Hebrides to Santa Cruz and Rotuma Island. The 2 dispersals appear to have crossed between Santa Cruz and Fiji; each has left a terminal relict, *purpuratus* of the subgenus *Tripteroides* on Fiji and *rotumanus* of the *caledonicus* group on Rotuma Island.

BIONOMICS AND DISEASE RELATIONS.—The nominate subgenus of *Tripteroides* utilizes for breeding chiefly treeholes, bamboo stubble, and various plant parts on the ground (such as coconuts). A few species have been reported from *Nepenthes* pitchers, but the immature stages of a large percentage of species are still unknown. Adults are diurnal in activity and seldom feed on man, but *T. bimaculipes* (Theobald, 1905) is reported to bite freely in the bush (Lee, 1946:232).

DISTRIBUTION (fig. **363**).—The nominate subgenus of *Tripteroides* occurs from eastern India and Japan to northern Australia and the South Pacific, where it is known only from the Solomons, the Santa Cruz Islands, Fiji, and possibly Samoa. Its absence from the New Hebrides and New Caledonia is probably of considerable zoögeographic significance, as indicated above under Systematics.

KEYS TO SPECIES

(Keys to genera and subgenera, pp. 487–488)

ADULTS

1. Sternopleuron and mesepimeron without scales (PURPURATUS GROUP) ..... 1. *purpuratus*
Sternopleuron and mesepimeron both with scales (BIMACULIPES GROUP) 2
2(1). Scutellum with broad scales only on midlobe, lateral lobes with linear scales only .... 2. *bonneti*
Scutellum with broad scales on all lobes ... 3
3(2). Abdominal tergites III-VI entirely dark-scaled .... 3. *distigma*
Abdominal tergites III-VI with conspicuous apicolateral bands of silvery scales 4
4(3). Supraalar area of mesonotum without broad scales; integument light ..... 4. *lipovskyi*
Supraalar area of mesonotum with a patch of broad dark scales; integument dark .... 5. *binotatus*

MALE GENITALIA

1. Ninth tergite lobe with 3 broad flattened foliform setae (PURPURATUS GROUP) .... 1. *purpuratus*
Ninth tergite lobe with more slender, relatively simple setae (BIMACULIPES GROUP) 2
2(1). Ninth tergite lobe very short, broad and diagonally truncate .... 2. *bonneti*
Ninth tergite lobe elongate, slender, more or less pedunculate .... 3. *distigma;* 4. *lipovskyi;* 5. *binotatus*

PUPAE

1. Paddle emarginate on apex .... 3. *distigma;* 4. *lipovskyi;* 5. *binotatus*
Paddle rounded on apex 2
2(1). Hairs 3-I, 6-VII single .... 2. *bonneti*
Hairs 3-I, 6-VII branched .... 1. *purpuratus*

LARVAE

(2. *bonneti* not included)

1. Comb scales arising from a more or less distinct sclerotized plate (PURPURATUS GROUP) .... 1. *purpuratus*
Comb scales free, not arising from a sclerotized plate (BIMACULIPES GROUP) 2
2(1). Siphon with only 7 unpaired midventral hairs .... 3. *distigma*
Siphon with at least 9 unpaired midventral hairs .... 4. *lipovskyi;* 5. *binotatus*

PURPURATUS GROUP

1. Tripteroides (Tripteroides) purpuratus (Edwards)

Figs. **363-366**

1921. *Rachionotomyia purpurata* Edwards, B. Ent. Res. 12:79. *TYPE: lectotype ♀, Suva, Fiji, May, 1911, P. H. Bahr; marked as type by Edwards; by present selection (BMNH).

Tripteroides (*Tripteroides*) *purpuratus* of Stone, Knight, and Starcke (1959).
Tripteroides (*Tripteroides*) *purpurata* of Edwards (1932:79); Taylor (1934:12); Paine (1935; 1943:9); Lee (1944*a*:23; 1946:241–242); Iyengar (1955:23, in part); Laird (1956).
Tripteroides purpurata of Knight, Bohart, and Bohart (1944:18, 67, in part).
Rachionotomyia purpurata of Edwards (1924:361); Buxton and Hopkins (1927:78).
Phonomyia (prox. *nitidiventer*) of Bahr (1912:18).

FEMALE.—*Wing:* 3.17 mm. *Proboscis:* 2.89 mm. *Forefemur:* 2.5 mm. *Abdomen:* about 2.5 mm. *Head:* decumbent scales deep azure blue dorsally, very light golden laterally and ventrally; erect scales dark, short, in a single long occipital row interrupted in the middle; orbital bristles not developed dorsally; labium dark-scaled; palpus 0.10–0.15 of proboscis, dark-scaled; antenna about 0.75 of proboscis. *Thorax:* integument generally light throughout, but may be darkened; mesonotal vestiture of linear scales, light coppery or brown, greenish in some aspects; scutellar scales similar in color but broad; 2 or more strong posterior dorsocentrals and 4,5 strong prescutellars; pleuron without silvery scales; *apn* with linear bronzy scales above and broader darker scales below; *ppn* with narrow bronzy scales above and much broader darker scales toward middle, extent and shape of scales quite variable; *ppl* apparently with a few translucent yellowish scales; remainder of pleuron apparently without scales; 1 *ppn* bristle; usually 3 *ppl*, 2 *sp*, 2 *pra*, 3,4 lower *stp*, 4,5 upper *mep* bristles. *Legs:* coxae and trochanters light; forecoxa and midcoxa with light golden scales; hindcoxa largely with silvery scales, golden apically; remainder of legs except for femora entirely dark-scaled with reddish purple reflections; femora with postmedian and subapical silvery spots on anterior surface; midfemur with narrow more or less complete silvery line basad of postmedian spot; posterior or lower surface of femora light golden. *Wing:* dorsal scales all small and broad; cell R_2 only slightly longer than vein R_{2+3}. *Haltere:* knob dark-scaled. *Abdomen:* dark scaling with reddish purple reflections; scaling of tergite I dark in center, yellow laterad; laterotergite largely covered with small broad dark scales; remaining tergites dark-scaled with silvery-scaled markings as follows, (1) tergite II with lateral patch from base to apex, (2) tergites III-VII with large apical lateral transverse unconnected patches; sternites completely golden-scaled.

MALE.—Essentially as in the female. *Antenna:* shorter, about 0.6 of proboscis; flagellar whorls dense, bristles long; flagellar segments 12,13 subequal and each about 3.0 of segment 11. *Legs:* anterior claw of foreleg with submedian slender tooth, that of midleg simple; claws of hindleg not checked.

MALE GENITALIA (fig. **365**).—As figured; diagnostic characters as in the key. *Segment VIII:* sternite simple, not produced into caudal lobe. *Segment IX:* tergite very strongly developed and heavily sclerotized, with a pair of very long lobes curving sternomesad and each bearing apically 3 broad flattened foliform setae; sternite narrow, strongly sclerotized, connected laterally with tergite by narrow long heavily sclerotized bars. *Sidepiece:* relatively short; scales moderately numerous laterally and ventrally; dorsal surface with long bristles laterally near base, none mesally; apicosternal area with long hairs and bristles; mesal surface without hairs or bristles distad of lobe; basal mesal lobe large, rather strongly differentiated, with numerous long hairs and bristles. *Clasper:* very long and slender; curved dorsad apically; spiniform short and broad in middle. *Phallosome:* simple; aedeagus rather complex but all parts joined, in tergal aspect with a narrow submedian tergal sclerotized bridge, an apical tergal shelflike process which projects sternolaterad as a sharp spiculate process on each side, and a pair of long median sternal apical spiculate processes which project sternad as long spiculate lobes. *Proctiger:* very strongly developed and heavily sclerotized; basolateral sclerotization extremely large; paraproct with 1–3 apical denticles, basal sternal part with sharp spicules; cercal sclerite indistinct, cercal setae usually 6–12.

PUPA (fig. **365**).—*Abdomen:* 3.85 mm. *Trumpet:* 0.48 mm. *Paddle:* 0.6 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, mesonotum darker; all hairs strongly pigmented. *Trumpet:* uniformly brightly darkly pigmented. *Metanotum:* darkened. *Abdomen:* uniformly strongly pigmented, lighter and yellowish distad; all hairs except small ventral strongly pigmented; hair 2-III-VII mesad of hair 1; hairs 1,3 subequal in size on II,III; 6-II at least 2.0 of hair 3-II; 6-VII usually 3b. *Paddle:* yellowish brown; midrib darker; apex rounded; spicules not developed.

LARVA (fig. **366**).—*Head:* 1.1 mm. *Siphon:* 0.89 mm. *Anal Saddle:* 0.34 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly yellowish brown; hairs moderately pigmented; labrum distinctly produced as median lobe bearing hairs 1 laterad (not shown in figure); aulaeum prominent and with long filamentous spicules centrally; mental plate rather small, produced, with 7–9 teeth on each side of enlarged median tooth; dorsal hairs all single; hair 1-C not markedly bent near base; 11-13-C in cephalic lateral group, 11 multiple; 14-C cephalic, 15-C caudal. *Thorax:* spiracular sensilla distinct; all hairs and tubercles strongly pigmented, stellate spikes and spiniform hairs black; hairs 1-3-P, 5-7-P, 6,7-M, 6-8-T on common tubercles; 6-M a single heavy spiniform; 7-T a heavy branched hooked spiniform; 2-M branched; 10-P a rather slender single spiniform. *Abdomen:* spiracular sensilla distinct; all hairs and tubercles strongly pigmented, stellate spikes black; hairs 0,1,2,5,9,11,13,14 all stellate, with slender spikelike branches; 3,4,10,12 all single; 6-I-VI all long, 6-I usually 2b, all others usually single; 7-I-VII all single, long on I,II; 3-V usually very long; hairs 3,4 with basal tubercles, latter sometimes fused. *Segment VIII:* comb of about 25 very long slender fringed spiniform scales arising from a more or less distinct plate; hair 1-VIII with very large basal tubercle; 2-VIII with distinct basal tubercle. *Siphon:* index about 3.0–3.5; moderately to very strongly uniformly pigmented; pecten of 7–11 very long teeth along entire length of siphon, teeth with heavy central shaft and broad lateral expansions;

ventral hairs in a single more or less regular line (1a-S) except for most proximal (1-S) which are paired; dorsal hairs paired. *Anal Segment:* saddle very heavily pigmented, sometimes black; marginal spicules very long; hair 1-X multiple, rather short; hair 4-X subequal to hair 1, multiple, free from saddle; gills subequal, usually shorter than saddle.

MATERIAL EXAMINED.—90 specimens; 26 ♀; 22 ♂; 4 pupae; 38 larvae; 4 individual larval rearings.

SYSTEMATICS.—*T. purpuratus* is a very clearly marked species, which is quite unlike the members of the related *bimaculipes* group in lacking sternopleural and mesepimeral scales, in the scaling of the laterotergite, and in the development of the male genitalia. The larva resembles the *bimaculipes* group but is easily separated by the diagnostic characters given above.

Individual variation in all stages of *purpuratus* is very striking, a condition similar to that found in *Uranotaenia colocasiae* and *U. painei*. The material available is inadequate to determine the presence of geographical differentiation in this species, but I have not noted any constant differences in the small samples of the populations from the various islands.

BIONOMICS AND DISEASE RELATIONS.—Paine (1943:11) reports *purpuratus* from treeholes, a tree fern stump, and a coconut husk. It has also been found in cut bamboo (Laird, 1956). Females apparently do not feed on man. This species, despite its striking ornamentation, is not commonly collected.

DISTRIBUTION (figs. 363, 364).—*Fiji:* Taveuni; Vanua Mbalavu; Viti Levu; Ngau. ? *Samoa:* Tutuila; I have seen 4 larvae which appear to be *purpuratus* and which are labeled American Samoa (Otto); there is a possibility that these were actually collected in Fiji, but it is not completely improbable that *purpuratus* or a related species occurs in Samoa. Not known elsewhere; the questionable records from New Guinea and Guam (Stone, Knight, and Starcke, 1959) are erroneous.

BIMACULIPES GROUP

FEMALES.—Essentially as in the *purpuratus* group. *Head:* decumbent scales azure blue dorsally except sometimes caudad and in a central longitudinal stripe where they are dark and without azure blue reflections; ventrally and laterally the decumbent scales are silvery; erect scales dark, usually very long and not strongly widened apically, in a single long occipital row, interrupted or not in the middle; some narrow decumbent bronzy scales caudad of erect scales; orbital bristles not developed dorsally; labium dark-scaled; palpus dark-scaled, less than 0.1 of proboscis, often 0.05, at most as long as clypeus; antenna usually less than 0.6 of proboscis. *Thorax:* integument light or dark; mesonotal vestiture predominantly of linear decumbent scales, broad scales sometimes present near wing root; dorsocentrals and prescutellars numerous and strong; *apn* with broad or linear dark scales; *ppn* with broad or linear dark scales; *ppl* without scales; *stp* almost completely covered with translucent silvery scales except in anterior lower half, scaling not extended on lower *ppn* or *ssp; mep* with extensive but sparse patch of similar scales on anterior half; remainder of pleuron without scales; 1 *ppn* bristle; usually only 1 strong *ppl* bristle, 1,2 weak hairs may be present in addition; *sp* bristles usually 2,3; *pra* bristles usually 3; several lower *stp* and upper *mep* bristles. *Legs:* coxae and trochanters light, largely with silvery or pale golden scales; remainder of legs entirely dark with purplish gloss except for femora which have golden and silvery markings; ventral surface of tibiae lighter. *Wing:* dorsal scales all small and broad; cell R_2 not much longer than vein R_{2+3}. *Haltere:* knob dark-scaled. *Abdomen:* laterotergite with or without scales; tergites with dark metallic scales, with or without conspicuous silvery markings; sternites largely with pale golden scales, some dark scales may be present on VII.

MALES.—Essentially as in the females. *Antenna:* usually shorter, barely 0.5 of proboscis; flagellar whorls dense, bristles long; flagellar segments 12,13 subequal and each about 2.0–3.0 of segment 11 (see *bonneti* for apparent exception). *Legs:* anterior claw of foreleg toothed or simple, that of midleg always simple; claws of hindleg not checked.

MALE GENITALIA.—Very small, largely retracted. *Segment IX:* tergite lobe varied but never with 3 large foliforms. *Sidepiece:* very short, dorsal surface without bristles in basal half; mesal surface without bristles distad of lobe; basal mesal lobe with variable number of bristles. *Clasper:* usually somewhat broadened; spiniform short. *Phallosome:* aedeagus not studied in detail. *Proctiger:* paraproct with 1 or more apical teeth.

PUPAE.—Group characters not apparent, but 3 of the South Pacific species have the paddle very short and slightly emarginate apically; *bonneti* has a similar short paddle but the apex is rounded; otherwise as for the subgenus.

LARVAE.—Group characters not apparent, but the 3 known South Pacific species have the following in common. *Head:* all dorsal hairs single; hair 1-C very strongly curved mesad at base; 11-13-C in lateral cephalic group; 14-C cephalic, 15-C caudal. *Thorax:* spiracular sensilla not apparent; 1-3-P, 5,6-P, 6,7-M, 6-8-T on common tubercles; 0,1,3,4,7,8,13,14-P, 1,8,13,14-M, 1,4,5,-8,13-T large stellate tufts with spikelike branches; 6-M a strong, single spiniform; 7-T a strong branched hooked spiniform; 10-P single, more or less spiniform; 2-M single. *Abdomen:* spiracular sensilla not apparent; hairs 0,1,2,5,9,11,13,14 all stellate, with slender spikelike branches, 9-I-II usually small; hairs 3,4,10,12 all single; 6-I-VI all long, single or double; 7-I-VII all single, long on I,II; hairs 3,4 without distinct basal tubercles; 14-I not developed. *Segment VIII:* no comb plate; comb scales numerous, almost ringing segment ventrally, the dorsal heavy short spines, the lateral long and slender and sometimes with spicules, the ventral slender and short; hair 1-VIII large, stellate, with large basal tubercle; 2-VIII single, with small basal tubercle; 3-5-VIII in compact group. *Siphon:* pecten of several small teeth extending over most of siphon, teeth without distinct lateral expansions; ventral hairs in a single midventral line (1a-S), mostly 2b, except for basal (1-S) which is paired and usually 3,4b; dorsal hairs (2a-S) usually 7 pairs, mostly 2b. *Anal Segment:* saddle well developed; marginal spicules long; hair 1-X usually with 3,4 uneven branches, on saddle; hair 4-X multiple, smaller than hair 1, free from saddle; gills subequal, not much longer than saddle.

SYSTEMATICS.—The *bimaculipes* group is erected for the nominate species from New Guinea and Australia and the 4 South Pacific species treated below. Probably the majority of the ornate Australasian species mentioned by Lee (1946:230–242) as belonging to the *nitidoventer* group also belong here except for *purpuratus*. The 2 groups appear to be closely related but are amply distinct in all stages.

The 4 South Pacific species are easily differentiated in the adult stage, but their pupae and larvae are very similar. The latter cannot be separated at present, as only a few specimens are known for *binotatus* and *distigma* and the range of variation of possible diagnostic characters cannot be determined for these species. Furthermore, the association of the larvae and adults of these 2 is not certain.

T. bonneti and *T. distigma* stand apart from *lipovskyi* and *binotatus,* which are more similar; the latter resembles *bimaculipes* very strongly.

BIONOMICS AND DISEASE RELATIONS.—Species of the *bimaculipes* group are primarily tree-hole-breeders and may be found in coconut shells and husks and artificial containers. *T. bimaculipes* (Theobald, 1905) is reported to bite freely in the scrub in New Guinea and northern Queensland (Lee, 1946:232), but the other species seldom attack man.

DISTRIBUTION (figs. **363**, **364**).—The group occurs in New Guinea, northeastern Australia, the Solomons, and the Santa Cruz Islands.

2. Tripteroides (Tripteroides) bonneti Belkin, n. sp.

Figs. **364**, **367**

TYPE.—*Holotype:* ♂ with associated pupal skin (Bonnet, 69-1) and genitalia slide (570516-8), Temotu (Malo), Santa Cruz Islands, from airplane wing tank used to catch rain water, Aug. 29, 1956, D. Bonnet (USNM, 64798).—This species is dedicated to David D. Bonnet in recognition of his contributions to the knowledge of the mosquitoes of the South Pacific.

FEMALE.—Unknown.

MALE.—*Wing:* 2.3 mm. *Proboscis:* 2.33 mm. *Forefemur:* 1.77 mm. *Abdomen:* about 1.67 mm. *Head:* dorsal decumbent scales apparently all azure blue, lateral and ventral pale golden; erect scales dark; antenna of typical female type, flagellar segments 12,13 not elongate, flagellar whorls with bristles short and sparse (this might possibly indicate a gynandromorph). *Thorax:* integument light yellowish, darkened on *stp* and *psp;* mesonotal scales all linear, very dark bronzy; midlobe of scutellum with very broad purplish bronzy scales, lateral lobes apparently with only linear and narrow scales; *apn* and *ppn* with linear dark bronzy scales only; *stp* scales silvery; *mep* scales very pale golden. *Legs:* forefemur with small silvery spot at about 0.67 from base and another larger one at about 0.85; midfemur with similar spots and a few silvery scales at about 0.33; hindfemur with large silvery spot at about 0.85, connected ventrally with light scaling, and a few silvery scales at about middle; anterior claw of foreleg without tooth. *Abdomen:* tergite I and laterotergite largely dark-scaled, apparently lighter laterad; tergite II with a large lateral silvery patch from base to apex; tergites III-VII with small lateral apical silvery bands which are not connected dorsally.

MALE GENITALIA (fig. **367**).—As figured; diag-

nostic characters as in the key. *Segment IX:* tergite lobe broad, short, diagonally truncate, with numerous bristles in 3 partial rows; interlobar space narrow. *Sidepiece:* basal mesal lobe with 7,8 very long bristles, 2,3 heavier than others, and numerous shorter bristles and hairs. *Clasper:* rather slender, subapical hairs short; spiniform short and broad. *Phallosome:* aedeagus apparently short, broad, and of usual structure, details cannot be seen. *Proctiger:* paraproct with 2 distinct apical curved teeth, apparently a third small denticle may be present; cercal setae apparently not developed.

PUPA (fig. **367**).—*Abdomen:* 2.7 mm. *Trumpet:* 0.34 mm. *Paddle:* 0.48 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* moderately pigmented, mesonotum darker, a dull brown; hairs strongly pigmented; hairs 2,3,5-9-C all single, all long and heavy except hair 6 which is short. *Trumpet:* strongly pigmented a dull brown. *Metanotum:* darkened, a dull brown; hairs 11,12-C long, heavy, single. *Abdomen:* uniformly pigmented a dull brown, strongly proximad, lightly on distal segments; hairs strongly pigmented, heavy, mostly single; hair 1-I with numerous branches; 7-II heavy, ventral; 6-VII single, heavy. *Paddle:* lightly pigmented, midrib evanescent in distal 0.6; apex rounded; a few small short spicules apically and on external margin.

LARVA.—Unknown.

MATERIAL EXAMINED.—1 ♂ with its pupal skin (holotype).

SYSTEMATICS.—The single adult specimen on which this species is based lacks 1 antenna and has the head in poor condition. The remaining antenna appears to belong to the specimen but is of the typical female type, as indicated above. There is a possibility that the specimen is a gynandromorph, but it may be that this species has the male antenna similar to the female, as in some other species of *Tripteroides.*

T. bonneti is easily recognized by the scutellar scaling, the male genitalia, and the characteristic development of the pupal hairs and paddle. It is very strikingly different in all these respects from all other members of the group; it may be necessary to put it in a separate group, should the larva prove to be as distinctive as the other stages.

BIONOMICS AND DISEASE RELATIONS.—The unique specimen was reared from a pupa collected in an "airplane wing tank used to catch rain water."

DISTRIBUTION (figs. **364**).—*Santa Cruz Islands:* Temotu (Malo). Not known elsewhere.

3. Tripteroides (Tripteroides) distigma (Edwards)

Figs. **364, 368, 369**

1925. *Rachionotomyia distigma* Edwards, B. Ent. Res. 15:257–258. *TYPE: holotype ♀, Tulagi, Solomon Islands, in house, A. G. Carment (BMNH).

Tripteroides (Tripteroides) distigma of Edwards (1932:78); Taylor (1934:12); Lee (1946:241); Belkin (1950:268–269); Iyengar (1955:23); Stone, Knight, and Starcke (1959).

Tripteroides distigma of Knight, Bohart, and Bohart (1944:17, 67).

Rachionotomyia distigma of Paine and Edwards (1929:304).

FEMALE.—Essentially as in the male except for usual sexual characters; antenna simple; midfemur with a few silvery scales at about middle; known from the holotype only.

MALE.—*Wing:* 2.58 mm. *Proboscis:* 3.08 mm. *Forefemur:* 2.25 mm. *Abdomen:* about 1.42 mm. *Head:* dorsal decumbent scales apparently all deep purplish azure, possibly a dark median longitudinal area; lateral and ventral decumbent scales silvery; erect scales light; antenna less than 0.5 of proboscis; flagellar whorls with bristles long and numerous; flagellar segments 12,13 subequal, elongate. *Thorax:* mesonotal and scutellar integument light, yellowish, darkened in front of wing root and along middorsal line; pleural integument light yellowish, darkened on *stp,* lower part of *mep,* and meron; mesonotum with dark bronzy linear scales with light greenish tinge, a dense patch of large very dark and very broad scales in front of wing root; scutellum with smaller very broad lighter bronzy scales on all lobes; *apn* largely with very broad small dark scales, a few narrower and linear chiefly in front; *ppn* chiefly with linear bronzy scales, a few scattered broad scales similar to those on *apn; stp* scales silvery, with slight bluish tinge; *mep* scales translucent, silvery, perhaps slightly yellowish; *ppl* bristles 2. *Legs:* forefemur and midfemur without silvery scales; hindfemur with large preapical silvery patch connected to ventral pale scaling and a long silvery anteroventral basal streak to beyond middle; anterior claw of foreleg with submedian tooth. *Abdomen:* tergite I largely dark-scaled; laterotergite with a small patch of lighter bronzy scales dorsally, largely bare; other tergites dark-scaled except for an indefinite whitish or silvery area basolaterad on II, dark scaling a light brown with violet reflections.

MALE GENITALIA (fig. **368**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe narrow, long, very prominent, apex expanded and with numerous bristles; interlobar space at its widest wider than one lobe at that point. *Sidepiece:* basal mesal lobe with about 7 long bristles, 2 of which are somewhat heavier, and with numerous short hairs. *Clasper:* rather slender, subapical hairs short; spiniform short and broad. *Phallosome:* aedeagus apparently short, broad, and of usual structure, details not studied. *Proctiger:* paraproct ending in a single heavy hooked dorsal tooth; cercal setae very short, apparently 3 pairs.

PUPA (fig. **368**).—*Abdomen:* 3.0 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.33 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* darkly dull-pigmented dorsally, lighter and distinctly yellowish ventrally; hairs strongly pigmented; all hairs branched except 9-C. *Trumpet:* strongly pigmented a bright deep yellowish brown. *Abdomen:* uniformly pigmented a dull brown proximad, lighter and slightly yellowish caudad; hairs strongly pigmented, only larger hairs heavy, smaller branched; hair 1-I with numerous branches; 7-II very close to lateral margin, apparently dorsal, rather weak; 6-VII double. *Paddle:* very lightly pigmented, midrib strong and darker; apex slightly but distinctly emarginate; spicules not evident.

LARVA (fig. **369**).—*Head:* 0.94 mm. *Siphon:* 0.73 mm. *Anal Saddle:* 0.28 mm. Chaetotaxy as figured, diagnostic characters as in the key; not definitely associated with other stages; very similar to *lipovskyi* and *binotatus,* apparently distinguished from both by only 7 accessory midventral siphonal hairs (1a-S); siphon index about 3.65.

MATERIAL EXAMINED.—9 specimens; 1 ♀; 1 ♂; 1 pupa; 6 larvae; 1 individual pupal rearing.

SYSTEMATICS.—The larval stage is not definitely associated with the pupa and adults of *distigma,* but it seems very likely that, as elsewhere in the Solomons, there is only 1 species of this group in any one locality and that therefore the larva which is figured here is actually that of *distigma.*

T. distigma is a very distinctive species in the adult stage but is very similar to *lipovskyi* and *binotatus* in the pupa and particularly the larva.

BIONOMICS AND DISEASE RELATIONS.—*T. distigma* has been collected only twice. The holotype female was caught in a house. The male was reared from a pupa collected in a treehole in association with *A.* (*Stegomyia*) *albolineatus.*

DISTRIBUTION (fig. **364**).—*Solomon Islands:* Tulagi; Florida. Not known elsewhere.

4. Tripteroides (Tripteroides) lipovskyi Belkin

Figs. **364, 370, 371**

1950. *Tripteroides* (*Tripteroides*) *lipovskyi* Belkin, U.S. Natl. Mus., Proc. 100:256–264. *TYPE: holotype ♂ with associated larval and pupal skins (JNB, 726-31), Sprague swamp, Guadalcanal, Solomon Islands, from treehole, Nov. 13, 1944, L. J. Lipovsky, M. Cohen, and A. W. Barnes (USNM, 59090).

Tripteroides (*Tripteroides*) *lipovskyi* of Iyengar (1955:23); Stone, Knight, and Starcke (1959).

Tripteroides (*Tripteroides*) *quasiornata* in part of Edwards (1932:79); Taylor (1934:12); Lee (1944*a*:25); Knight, Bohart, and Bohart (1944:18, 67).

Rachionotomyia quasiornata of Edwards (1926:109).

FEMALE.—*Wing:* 2.93 mm. *Proboscis:* 3.0 mm. *Forefemur:* 2.33 mm. *Abdomen:* about 2.33 mm. *Head:* dorsal decumbent scales all azure blue, not interrupted by median longitudinal dark stripe; lateral and ventral decumbent scales silvery or very pale golden; erect scales dark. *Thorax:* integument yellowish or light orange brown, sometimes darkened on posterior portion of postnotum, upper posterior part of *stp,* small area on anterior *mep* above, and meron; mesonotal scales all linear, majority bronzy black, some light coppery; scutellar scales broad and dark bronzy black on all lobes; *apn* predominantly with broad but rather elongate very dark scales, some narrow scales in front and above; *ppn* with linear scales dark as on mesonotum, a few broad scales sometimes present; *stp* scales silvery with bluish tinge; *mep* scales translucent, upper silvery, lower with yellowish tinge. *Legs:* all femora with distinct postmedian and preapical anterior silvery spots, larger and connected to ventral light scaling on hindfemur; midfemur with a more or less distinct and extensive basal anterior silvery streak. *Abdomen:* tergite I largely dark-scaled; laterotergite largely bare; tergite II with large lateral silvery patch from base to apex and produced mesad apically, more basal scales with yellowish tinge; tergites III-VI with apicolateral transverse silvery bands, usually not connected in the middle; tergite VII all dark or with very narrow interrupted apicolateral silvery transverse band; dark scaling iridescent with violet or purplish gloss.

MALE.—Essentially as in the female. *Antenna:* strongly plumose, segments 12,13 elongate. *Legs:* anterior claw of foreleg with submedian tooth.

MALE GENITALIA (fig. **370**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite lobe long, prominent, apex expanded and with about 16 bristles; interlobar space at its widest slightly wider than one lobe at that point. *Sidepiece:* basal mesal lobe with about 7 bristles and numerous hairs. *Clasper:* slender, subapical hairs short; spiniform short and broad, scarcely projecting beyond hood. *Phallosome:* aedeagus short, with submedian dorsal arm, apical dorsal arm, and a ventral arm, latter roughened with short spicules. *Proctiger:* paraproct ending in a large dorsal tooth and usually 3 smaller, more ventral teeth; cercal setae 5–7.

PUPA (fig. **370**).—*Abdomen:* 3.0 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.33 mm. Chaetotaxy as figured, hairs strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* darkly pigmented a dull brown, lighter in front ventrad; all hairs usually branched except 9-C, latter rarely branched. *Trumpet:* uniformly strongly pigmented a bright deep yellowish brown. *Abdomen:* uniformly strongly pigmented a dull brown proximad, lighter and slightly yellowish caudad; only larger hairs heavy, smaller branched; hair 1-I with numerous, largely single branches; 7-II very close to lateral margin, apparently dorsal, rather weak; 6-VII usually at least 2b. *Paddle:* lightly pigmented, midrib very strong and dark; apex slightly but distinctly emarginate; spicules not evident.

LARVA (fig. **371**).—*Head:* 0.9 mm. *Siphon:* 0.79 mm. *Anal Saddle:* 0.26 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly deep yellowish brown; dorsal hairs except 1-C lightly pigmented, latter and ventral hairs moderately to strongly pigmented. *Thorax:* hairs and tubercles strongly pigmented, stellate spikes and spiniform hairs blackish. *Abdomen:* all hairs and tubercles strongly pigmented, stellate spikes black. *Siphon:* index about 4.0; moderately to strongly pigmented and with a basal black ring; midventral unpaired hairs usually at least 9. *Anal Segment:* saddle very darkly pigmented, blackish.

MATERIAL EXAMINED.—246 specimens; 73 ♀; 60 ♂; 43 pupae; 70 larvae; 17 individual larval rearings.

SYSTEMATICS.—*T. lipovskyi* adults are readily separated from the other *Tripteroides* of the South Pacific, but the larvae and pupae of this species cannot be differentiated at present from those of *binotatus*. The separation of these stages from *distigma* may also prove to be difficult. *T. lipovskyi* adults cannot be separated from those of *quasiornatus* (Taylor, 1915) from Queensland, to judge by Lee's description (1946:237–238), but the larvae of the 2 species are very distinct. The only other species with which *lipovskyi* females could be confused is *nissanensis* Lee, 1946, but the male genitalia will immediately distinguish these 2 species.

Adults of *lipovskyi* show remarkably little variation, individual or geographic. New Georgia specimens are somewhat darker in integumentary coloration, but the dark linear scales of the mesonotum still contrast sharply with the integument.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *lipovskyi* are found most commonly in treeholes but have also been collected in coconut shells and a few times in bamboo stubble and frond axils of sago palms. Not infrequently they occur in artificial containers. Usually the breeding sites are in the shade. This species appears to tolerate a great deal of organic matter in the breeding sites, particularly in artificial containers but not in coconuts. The larvae usually have deep purplish red bodies, especially when found in treeholes.

Females of *lipovskyi* have been noted to feed on man occasionally during the day in forested swamp areas. Both sexes may be found resting on tree buttresses and in old coconut shells.

DISTRIBUTION (fig. **364**).—*Solomon Islands:* New Georgia; Guadalcanal. Not known elsewhere.

5. Tripteroides (Tripteroides) binotatus Belkin

Figs. **364, 372, 373**

1950. *Tripteroides* (*Tripteroides*) *binotata* Belkin, U.S. Natl. Mus., Proc. 100:264–268. *TYPE: holotype ♂, Bougainville, Solomon Islands, Jan. 18, 1944, C. R. Bruck (USNM, 59091).

Tripteroides (*Tripteroides*) *binotatus* of Stone, Knight, and Starcke (1959).
Tripteroides (*Tripteroides*) *binotata* of Iyengar (1955:23).
Tripteroides bimaculipes in part of Knight, Bohart, and Bohart (1944:18).

FEMALE.—*Wing:* 2.8 mm. *Proboscis:* 3.0 mm. *Forefemur:* 2.17 mm. *Abdomen:* about 2.08 mm. *Head:* dorsal decumbent scales all azure blue, not interrupted by median longitudinal dark stripe as stated by Belkin (1950:264), this is apparently an artifact; lateral and ventral decumbent scales silvery or very pale golden; erect scales dark. *Thorax:* integument generally dark reddish brown to blackish, darkened in front of wing root, lighter on the sides of mesonotum, particularly fossal area, and upper part of pleuron, these areas sometimes light orange brown or even yellowish; mesonotal scales largely linear, dark bronzy black, a very conspicuous patch of numerous broad dark bronzy scales in front of wing root in supraalar area over a darkened area of integument; scutellar and pleural scaling as in *lipovskyi*. *Legs:* forefemur with distinct postmedian and preapical anterior silvery spots; midfemur with similar spots and a variable but distinct basal silvery line; hindfemur with large preapical silvery spot connected to ventral light scaling and a basal silvery line to about middle, also connected to ventral light scaling. *Abdomen:* tergal scaling essentially as in *lipovskyi*.

MALE.—Essentially as in the female. *Antenna:* strongly plumose; flagellar segments 12,13 elongate. *Legs:* anterior claw of foreleg with submedian tooth.

MALE GENITALIA (fig. 372).—As figured; diagnostic characters as in the key. Apparently indistinguishable from *lipovskyi* but aedeagus not studied in detail and large series not compared.

PUPA (fig. 372).—*Abdomen:* 3.4 mm. *Trumpet:* 0.42 mm. *Paddle:* 0.39 mm. Chaetotaxy as figured; diagnostic characters as in the key; essentially as in *lipovskyi* and *distigma*, from which it cannot be differentiated at present.

LARVA (fig. 373).—*Head:* 0.84 mm. *Siphon:* 0.65 mm. *Anal Saddle:* 0.27 mm. Chaetotaxy as figured; diagnostic characters as in the key; essentially as in *lipovskyi*, from which it cannot be differentiated at present; siphon index about 3.25.

MATERIAL EXAMINED.—143 specimens; 52 ♀; 26 ♂; 1 pupa; 64 larvae; no individual rearings.

SYSTEMATICS.—*T. binotatus* adults are very distinctive and can be confused only with *bimaculipes* (Theobald, 1905) from New Guinea and northern Australia. The only reliable character that will separate the 2 species is apparently the large conspicuous patch of broad scales in the supraalar area in *binotatus;* in *bimaculipes* there are at most a few inconspicuous broad scales in this area.

The male genitalia are apparently indistinguishable from those of *lipovskyi, bimaculipes, quasiornatus*, and several other species of the group. The larvae and pupae are very similar to *lipovskyi* and cannot be separated at present from the latter and *bimaculipes*.

T. binotatus is much more variable than *lipovskyi*, both in integumentary coloration and in the extent of silvery markings of the legs and abdomen. The samples of immature stages are too small to evaluate variability or to determine diagnostic characters.

BIONOMICS AND DISEASE RELATIONS.—The immature stages have been collected primarily in treeholes, but there is one record each from an artificial container, a leaf axil of an aroid, and a ground pool. The latter is misleading, as, in all probability, the immature stages were washed out from their real habitat. Nothing is known of adult habits other than that an occasional specimen will come to man.

DISTRIBUTION (fig. 364).—*Solomon Islands:* Bougainville. Not known elsewhere.

Subgenus RACHIONOTOMYIA Theobald

1905. *Rachionotomyia* Theobald, Bombay Nat. Hist. Soc., J. 16:248, Apr. 15. *TYPE SPECIES: *R. ceylonensis* Theobald, 1905, Ceylon; monobasic.
1905. *Polylepidomyia* Theobald, Budapest Magyar Nemzeti Mus., Ann. 3:118, May. TYPE SPECIES: *P. argenteiventris* Theobald, 1905, New Guinea; monobasic.
1908. *Skeiromyia* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):248. *TYPE SPECIES: *S. fusca* Leicester, 1908, Malaya; monobasic.
1910. *Squamomyia* Theobald, Indian Mus., Rec. 4:28. *TYPE SPECIES: *S. inornata* Theobald, 1910, Burma: monobasic.
1910. *Mimeteomyia* Theobald, Monog. Culicidae 5:210–211. *TYPE SPECIES: *M. apicotriangulata* Theobald, 1910, Queensland; monobasic.
1925. *Tricholeptomyia* Dyar and Shannon, Insecutor Inscitiae Menstruus 13:72–73. TYPE SPECIES: *Wyeomyia nepenthicola* Banks, 1909, Philippines; original designation.

FEMALES.—Drab in coloration, with only white and creamy scales in addition to dark scales, no blue or silvery markings. *Head:* vertex without azure blue scales; upper (central) orbital bristles developed, usually 3,4 pairs; clypeus sometimes with scales; proboscis varied in length; palpus varied in length, up to 0.25 of proboscis, apparently 3-segmented, segment 3 sometimes with indication of composite nature; antenna apparently varied in length. *Thorax:* postnotum sometimes with hairs; *apn* and meron varied; predominant mesonotal scales often rather broad; dorsocentral and prescutellar bristles varied, supraalars usually weak; *ppl, pcx,* and lowermost part of *ppn* always with scales; remainder of pleural scaling varied but often extensive; *ppn* bristles varied, sometimes absent; upper *stp* without bristles (always?). *Legs:* not ornamented; hindleg sometimes with only 1 claw. *Wing:* dorsal vein scaling and cell R_2 varied. *Abdomen:* laterotergite usually completely scaled.

MALES.—Essentially as in the females. *Palpus:* varied; from about as long as proboscis to as short as in female. *Antenna:* usually very strongly plumose; flagellar segments 12,13 elongate. *Legs:* claws of foreleg and midleg enlarged, anterior claw of each pair sometimes toothed.

MALE GENITALIA.—Subgeneric characters not apparent; usually prominent and exerted; sidepiece usually elongate and with numerous bristles.

PUPAE.—Subgeneric characters not evident; hair 1-C double or triple; hair 3-VII not reaching posterior margin of tergite VIII; paddle apex often somewhat produced.

LARVAE.—Subgeneric characters not evident; apparently extremely varied. *Head:* maxillary suture complete, strongly concave laterad; maxilla rarely with fairly long articulated apical spines. *Thorax:* with or without spiniform hairs. *Segment VIII:* comb scales free or attached to plate.

SYSTEMATICS.—*Rachionotomyia* is raised here to subgeneric rank to include all the nonornamented species of *Tripteroides* other than those with modified larval maxillae, which are segregated in the subgenus *Rachisoura.* The Australasian subgenus *Mimeteomyia* was recognized by Edwards (1932:76) for species with a long male palpus, but Lee (1946:225) showed that several other Australasian forms with a short male palpus were closely related, including *argenteiventris,* which Edwards (1932:78) placed in group A (*Rachionotomyia*) of the subgenus *Tripteroides.* Lee redefined the subgenus to include these species but continued to use *Mimeteomyia* instead of *Polylepidomyia,* which has priority. Neither Lee nor Belkin (1950) studied the Oriental and Indomalayan nonornamented *Tripteroides* and therefore did not realize that these were more closely related to the Australasian *Polylepidomyia* (= *Mimeteomyia*) than to the ornamented group B of the subgenus *Tripteroides.* Baisas and Ubaldo-Pagayon (1953:14) also retained group A in the nominate subgenus. I have examined several species of group A and am convinced that their affinities are definitely with *argenteiventris* (*Polylepidomyia*) and *atripes* (*Mimeteomyia*) and not with *nitidoventer* (*Tripteroides*).

Rachionotomyia as here understood is a very complex subgenus and eventually may have to be subdivided. It appears to contain very generalized, poorly differentiated, and some specialized types, as well as annectent forms with both the subgenera *Rachisoura* and *Tripteroides*, and may be the general stock from which the latter 2 were derived at an early stage. Several distinct groups are evident; their characterization cannot be accomplished satisfactorily because of insufficient knowledge of the larval stage. In the South Pacific I am recognizing 4 groups, as follows: (1) the *atripes* group, represented by *solomonis*, (2) the monotypic *floridensis* group from the Solomons, (3) the *caledonicus* group, represented by 4 species from Rotuma Island, Santa Cruz Islands, New Hebrides, Loyalties, and New Caledonia, and (4) the *argenteiventris* group, represented by *coheni* from the Solomons.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *Rachionotomyia* are found in all the habitats utilized by the genus. *Nepenthes* pitchers are used by several Australasian and Philippine species.

Females of several species have been reported to bite man in the bush, and a few, including *solomonis*, are more or less domestic and occasionally reach the stature of minor pests.

DISTRIBUTION (fig. 374).—*Rachionotomyia* is widely distributed, occurring from India and the Philippines to Tasmania and the South Pacific, where it is represented from the Solomons and New Caledonia to Rotuma Island but is not known from Fiji.

KEYS TO SPECIES

(Keys to genera and subgenera, pp. 487–488)

ADULTS

(2. *floridensis* not included)

1. Light scales covering most of the mesopleuron 2
   Light scales largely restricted to a median longitudinal band on mesopleuron (CALEDONICUS GROUP) 3
2(1). Proboscis stout, markedly shorter than abdomen; abdominal tergites with conspicuous triangular lateral white markings (ATRIPES GROUP) .... 1. *solomonis*
   Proboscis slender, markedly longer than abdomen; abdominal tergites with inconspicuous continuous lateral white area (ARGENTEIVENTRIS GROUP) .... 7. *coheni*
3(1). Abdominal tergites with basal lateral light spots .... 3. *rotumanus*
   Abdominal tergites entirely dark-scaled or with apical light bands or apicolateral light spots 4
4(3). Supraalar area of mesonotum usually with several broad rounded or truncate dark scales .... 4. *caledonicus*
   Supraalar area with narrow acute scales only .... 5. *melanesiensis;* 6. *folicola*

MALE GENITALIA

(2. *floridensis* not included)

1. Ninth tergite lobe rounded, with 8–10 setae in an irregular double row (ARGENTEIVENTRIS GROUP) .... 7. *coheni*
   Ninth tergite lobe truncate, with 3–7 large setae in a single regular row 2
2(1). Clasper distinctly longer than sidepiece (ATRIPES GROUP) .... 1. *solomonis*
   Clasper shorter than sidepiece (CALEDONICUS GROUP) .... 3. *rotumanus;* 4. *caledonicus;* .... 5. *melanesiensis;* 6. *folicola*

PUPAE

(2. *floridensis* not included)

1. Integument of abdominal tergites with distinct unpigmented spots at the base of the larger hairs, especially on segments V-VII (ATRIPES GROUP) .... 1. *solomonis*
   Integument of abdominal tergites without unpigmented spots at the base of the larger hairs 2
2(1). Hair 2-III-VII at level or laterad of hair 1; hair 9-VI dorsal, near caudolateral angle and branched (ARGENTEIVENTRIS GROUP) .... 7. *coheni*
   Hair 2-III-VII distinctly mesad of hair 1; hair 9-VI lateral, as on other segments, single (CALEDONICUS GROUP) 3
3(2). Trumpet length about 4.0 median width or greater .... 3. *rotumanus*
   Trumpet length about 3.0 median width or less 4
4(3). Paddle margins with several rows of distinct spicules .... 4. *caledonicus*
   Paddle margins without or with indistinct spicules 5

5(4). Hair 5-IV-VI usually single . . . . 5. *melanesiensis*

Hair 5-IV-VI usually double . . . . 6. *folicola*

LARVAE

1. Comb scales arising from a strongly sclerotized plate 2

Comb scales free, no comb plate present . . 3

2(1). Hair 6-M spiniform (ATRIPES GROUP) . . . . 1. *solomonis*

Hair 6-M stellate (FLORIDENSIS GROUP) . . . . 2. *floridensis*

3(1). Hair 4-X on saddle; hair 7-T a long multiple tuft (ARGENTEIVENTRIS GROUP) . . 7. *coheni*

Hair 4-X free from saddle; hair 7-T more or less thickened, at most 4b (CALEDONICUS GROUP) 4

4(3). Hairs 0-II-VII, 2-I-VII minute and single; dorsum of thorax and abdomen without distinct stellate hairs . . . . 4. *caledonicus*

Hairs 0-II-VII, 2-I-VII large and stellate; dorsum of thorax and abdomen with distinct stellate hairs 5

5(4). Hair 14-VII single, minute or small . . . . 3. *rotumanus*

Hair 14-VII stellate, at least 4b 6

6(5). Unpaired ventral siphonal hairs usually at least double and 8 or more in number; stellate hairs of abdomen at most 25b . . . . 5. *melanesiensis*

Unpaired ventral siphonal hairs usually single and less than 6 in number; stellate hairs of abdomen usually at least 30b . . . 6. *folicola*

ATRIPES GROUP

FEMALES.—Pleuron very extensively scaled. *Head:* dorsal decumbent scales largely dark (light brown to black) except for a narrow orbital border of white scales; lateral and ventral decumbent scales white; erect scales short, dark; clypeus small, rounded, bare; proboscis shorter than abdomen, dark-scaled or with few white scales at base of labium; palpus about 0.15 of proboscis, dark-scaled or with some whitish scales on basal 0.5, apparently 3-segmented, segment 3 short but distinct, segments 1 and 2 apparently composite; antenna about 0.85 of proboscis; torus with small hairs but no scales; flagellar segment 1 with a few scales near base. *Thorax:* postnotum bare; *apn* lobes small, widely separated; meron small, its upper edge distinctly above base of hindcoxa; mesonotal vestiture very dense; all lobes of scutellum with broad scales; anterior dorsocentral bristles absent, posterior present or absent, prescutellars present, varied; upper part of *ppl,* lower anterior half of *stp* and its extreme caudoventral angle, meron, and metapleuron bare, all the rest of pleuron largely covered with broad scales which are largely white except on upper part of *ppn;* upper *stp* bristles absent. *Legs:* coxae and trochanters white-scaled; forefemur and midfemur largely white-scaled posteroventrally, hindfemur in addition with extensive white scaling on anterior surface to near apex; tibiae with white-scaled line ventrally, larger on hindleg; tarsi all dark. *Wing:* veins Rs, R_{2+3}, R_2, R_3, M, and base of M_{1+2} and M_{3+4} with slender narrow long plume scales; cell R_2 about 4.0 as long as vein R_{2+3}. *Abdomen:* tergite I dark-scaled in center, white-scaled laterally; laterotergite completely white-scaled; tergites II-VII dark-scaled except for apicolateral triangular white-scaled patches, that on II extending to base, remainder progressively more apical but varied in extent; sternites entirely white-scaled.

MALES.—Essentially as in the females. *Palpus:* 0.75–0.8 of proboscis length; 5-segmented, segments 2 and 3 ankylosed, segment 5 with several longish bristles. *Antenna:* very strongly plumose; flagellar segments 12,13 elongate, 12 longer than 13 and almost equal to 8–11 combined. *Legs:* anterior claws of both foreleg and midleg with subbasal tooth.

MALE GENITALIA.—*Segment IX:* tergal lobe more or less prominent, with 3–6 bristles in a single row. *Sidepiece:* relatively short; dorsal surface with bristles in basal half; basal mesal lobe short, with 4–6 bristles, 1 enlarged. *Clasper:* very long, slender; hairs small; spiniform short, broad. *Phallosome:* aedeagus of usual form, details not studied. *Proctiger:* paraproct usually with 3–5 apical teeth; cercal setae small, inconspicuous.

PUPAE.—Group characters not apparent; trumpet short and broad; clear rounded areas at base of larger dorsal hairs of abdomen.

LARVAE.—*Head:* labrum prominent; posterior tentorial pit near collar; maxillary suture complete, divergent then strongly recurved mesad; aulaeum rounded in front, with moderately long filamentous spicules; mental plate with 8 or more teeth on each side of enlarged central tooth; hair 1-C sometimes frayed apically or with apical spicules; 4-7-C usually all branched; 14-C heavy, stellate, with spikelike branches; 15-C caudal. *Antenna:* longer than normal; distinctly narrowed distad of hair 1-A, latter thickened, split beyond middle. *Thorax:* spiracular sensilla not apparent; hairs 1-3-P, 5-7-P, 6-8-M, 6-7-T on common tubercles; 6-M,7-T both branched, spiniform; 0-P large; 0,1,3,4,7,8,13,14-P, 1,8,13,14-M, 1,4,5,8,13-T large stellate hairs with spikelike branches. *Abdomen:* spiracular sensilla not apparent; hair 14-I present; 0,1,2,5,9,11,13,14 all stellate, with spikelike branches; 3,4,10,12 all single; 6,7-I,II long, single; 6-III-VI long, usually double; 3,4 with basal tubercles. *Segment VIII:* the more dorsal, larger scales arising from plate, the ventral smaller, free; pentad hairs (1-5-VIII) with basal tubercles. *Siphon:* short; both ventral and dorsal hairs paired (1a,2a-S). *Anal Segment:* saddle with strong marginal spinelike spicules; hair 1-X long, on saddle; hair 4-X short, free from saddle.

SYSTEMATICS.—The *atripes* group includes *atripes* (Skuse, 1889) from New South Wales and Victoria, *punctolateralis* (Theobald, 1903) from southern Queensland, *apicotriangulatus* (Theobald, 1910) from northern Queensland, *occidentalis* Brug, 1934 from Timor, *solomonis* from the Solomons, and possibly *digoelensis* Brug, 1934 from New Guinea. The latter is undoubtedly distinct and may belong to a separate group, but the taxonomic status of all the remaining nominal species is very uncertain. Lee (1946:261–264) recognized 3 distinct species, synonymizing *apicotriangulatus* with *atripes* and *occidentalis* with *punctolateralis.* However, this complex may consist of a single polytypic species or even 1 extremely variable species with a large number of ecological or local geographical forms. This problem cannot be resolved without a special study of a large number of individually reared specimens. For the present it seems advisable to follow Lee and to treat *solomonis* as a distinct species. As indicated below under *solomonis,* it is possible that this form is a recent human introduction from Australia.

BIONOMICS AND DISEASE RELATIONS.—Members of this group are semidomestic species and are often found breeding in artificial containers, in addition to the natural habitat in treeholes and bamboo stubble. Females bite man readily and are sometimes numerous enough to become pests locally.

Of all Australasian *Tripteroides,* the *atripes* group is the only one that may be considered to be of economic importance because of the semidomestic habits of all the known forms.

DISTRIBUTION (fig. 374).—The group has been reported from Timor, eastern Australia, New Guinea, the Solomons, and once from New Caledonia.

1. Tripteroides (Rachionotomyia) solomonis (Edwards)

Figs. 375-377

1924. *Rachionotomyia solomonis* Edwards, B. Ent. Res. 14:363. *TYPE: holotype ♀, Tulagi (Florida group not Guadalcanal), Solomon Islands, caught in house, July, 1923, A. G. Carment (BMNH).

Tripteroides (Polylepidomyia) solomonis of Stone, Knight, and Starcke (1959).

Tripteroides (Mimetomyia) solomonis of Edwards (1932:77); Taylor (1934:12); Lee (1944*a*:20; 1946:264); Knight, Bohart, and Bohart (1944:20, 68); Belkin (1950:240–250); Iyengar (1955:24); Rageau (1958*a*:878; 1958*b*:8; both questionable).

Rachionotomyia solomonis of Edwards (1926:109); Paine and Edwards (1929:305, 308–310).

FEMALE.—*Wing:* 3.08 mm. *Proboscis:* 2.27 mm. *Forefemur:* 1.92 mm. *Abdomen:* about 2.75 mm. As described for group; coloration darker than in any other form; integument very dark deep brown or black including clypeus and antenna; dark scaling of head, legs, and abdomen purplish black. *Head:* proboscis and palpus entirely dark-scaled. *Thorax:* mesonotum with thick vestiture of rather narrow, long curved decumbent dark iridescent bronzy scales; a conspicuous patch of broader pure white scales in supraalar area; a small number of narrow white scales on central portion of anterior promontory; at least a few dingy white scales along margin of prescutellar space; scutellar scales irridescent dark bronzy; dorsocentral bristles absent, usually 3 pairs of prescutellars; upper part of *ppn* with some dark scales; *ppn* bristles usually absent. *Abdomen:* tergite I extensively dark-scaled; light scaling of tergites III-VI distinctly triangular and not very extensive.

MALE.—Essentially as in the female except for sexual characters mentioned under group.

MALE GENITALIA (fig. 376).—As figured; diagnostic characters as in the key; apparently indistinguishable from other members of the group.

PUPA (fig. 376).—*Abdomen:* 3.2 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.45 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* mesonotum a dark yellowish brown, remainder much lighter, yellowish; hairs darkly pigmented, all branched except 6,7,9-C. *Trumpet:* uniformly bright dark yellowish brown. *Metanotum:* dark yellowish brown. *Abdomen:* with distinct tergal color pattern; ground color light yellowish brown, with much darker brown completely covering tergites I,II, all but small lateral areas on III, progressively less on succeeding segments, absent on VIII; hairs moderately to strongly pigmented, those on darkened tergal areas arising from rounded basal spots of light ground color; hair 3-VII thin, shorter than tergite VIII. *Paddle:* light yellowish brown, midrib darker, brown; apex broadly produced; spicules not apparent.

LARVA (fig. 377).—*Head:* 0.95 mm. *Siphon:* 0.6 mm. *Anal Saddle:* 0.31 mm. Chaetotaxy extremely variable, in general as figured; diagnostic characters as in the key. *Head:* uniformly light to moderate yellowish brown; dorsal hairs moderately pigmented, stellate ventral hairs dark; hair 11-C with branches of 2 uneven lengths arising separately from base (not separate hairs as stated by Belkin, 1950:243). *Thorax* and *Abdomen:* hairs and tubercles strongly pigmented, stellate hairs blackish. *Segment VIII:* attached comb scales rather sharply pointed, not rounded apically. *Siphon:* index usually about 2.5–3.0; usually very strongly pigmented, sometimes blackish; pecten of 4,5 simple teeth, usually restricted to basal 0.67. *Anal Segment:* saddle darkly pigmented, usually blackish; marginal spicules usually about 20 sharp teeth; hair 1-X usually 3b; 4-X usually 4,5b; gills variable.

MATERIAL EXAMINED.—869 specimens; 176 ♀; 170 ♂; 98 pupae; 425 larvae; 17 individual larval rearings.

SYSTEMATICS.—*T. solomonis* is the most variable *Tripteroides* in the Solomons. In the adults the white scaling on the presutellar area is extremely variable; many specimens show no light scales at all, others have a conspicuous white area around the "bare space." The light scaling in the supraalar area is quite variable in extent but is always conspicuous. The white scales on the anterior promontory are sometimes reduced. The pleural chaetotaxy is also subject to some variation; in particular, the posterior *ppn* bristle, which is usually absent, may be weakly developed. The lobe of tergite IX of the male is extremely variable and shows no constant difference from *punctolateralis* and *atripes,* as illustrated by Lee. The larvae show remarkable variation in almost all hairs, particularly the head hairs. The "clypeal spines," hair 1-C, show interesting variation in the presence of a tuft of very fine spicules or fringes on the apex when this hair is relatively short; other specimens have a longer hair 1-C with a simple acute tip. This character is not associated with any other larval or adult character or larval habitat, nor is it sexual. Hair 11-C is peculiar in being composed of 2 parts, one with shorter branches than the other. The development of stellate hairs on the thorax and abdomen is quite variable; some specimens show very slender, lightly pigmented spikes, while others have them stout and black. The comb scales vary considerably in size and number but are usually pointed on the apex; some of the larvae have the apex of the scales slightly rounded, but none of them approach the condition found in *atripes* or *punctolateralis.* The dorsal siphonal hairs vary greatly in position and in the number of branches. The ventral siphonal hairs are even more variable in number and may have 3,4 branches. The pecten is usually restricted to the basal two-thirds of the siphon, but occasionally a small tooth is found near the apex.

No correlation between any of the above variations has been found either in the larvae or adults. Larvae from bamboo stubble tend to be darker and have better developed stellate hairs with a larger number of branches, while those collected in artificial containers usually have more slender stellate spikes. Larvae from treeholes are usually intermediate.

T. solomonis exhibits considerable geographical variation. Guadalcanal specimens tend to have less prescutellar white scaling; those from New Georgia, Sterling, and Bougainville have very conspicuous white scaling in this area. The majority of specimens from Sterling and Bougainville have the scutellar scales quite pale, almost white in certain aspects, usually on the midlobe only. There are all intergradations from almost white to entirely dark scales in these populations, although the latter condition is rare. No other differences are apparent in these adults; the larvae exhibit all the variations seen in Guadalcanal populations and show no constant differences from them.

The taxonomic status of *solomonis* is uncertain. Although it shows rather constant differences from *atripes* and *punctolateralis,* these may be due more to environmental than to genetic factors. The occurrence of *solomonis* chiefly around human settlements suggests that it is an introduced form. The record of *solomonis* from New Caledonia probably represents a human introduction of the *atripes* group. Although these specimens may actually be *solomonis,* they could also be dark specimens of *atripes* or *punctolateralis* brought in from Australia.

A somewhat parallel situation exists in the *Aedes* (*Finlaya*) *notoscriptus* complex. Neither problem can be resolved without detailed study in all the areas involved. For the present *solomonis* is considered to be probably endemic to the Solomons.

BIONOMICS AND DISEASE RELATIONS.—*T. solomonis* is a general breeder in small natural and artificial containers. It has been collected in treeholes, papaya stumps, bamboo stubble, most commonly in various artificial containers, both large and small, and in water collections in canvas. There are no records of breeding in leaf axils of plants. The water in the breeding sites is frequently extremely foul and may contain large amounts of decaying organic matter. In treeholes the larvae acquire a purplish red body coloration.

Females are frequently collected attempting to bite during the day in the vicinity of the breeding sites. They may become serious pests around human dwellings where artificial containers are allowed to accumulate water. They are readily attracted to artificial lights and were frequently collected in routine night hand catches on Guadalcanal. On this island *solomonis* appears to be semidomestic, as it was collected only along the coast in association with man and never far back in the jungle.

DISTRIBUTION (fig. 375).—*Solomon Islands:* Bougainville; Sterling; New Georgia; Russell; Tulagi; Florida; Guadalcanal; Malaita; Rennell. *New Caledonia:* only males, undoubtedly collected in New Caledonia, are available; without larvae it is impossible to determine if this is actually *solomonis* and not some other member of the *atripes* group. Not known elsewhere.

FLORIDENSIS GROUP

2. Tripteroides (Rachionotomyia) floridensis Belkin

Figs. 374, 375, 378

1950. *Tripteroides floridensis* Belkin, U.S. Natl. Mus., Proc. 100:269–271. *TYPE: holotype larva (KLK, 839), Halavo, Florida, Solomon Islands, from axil of wild banana, Dec. 17, 1943, R. L. Ingram (USNM, 59092).

Tripteroides floridensis of Iyengar (1955:24); Stone, Knight, and Starcke (1959).

FEMALE, MALE, and PUPA.—Unknown.

LARVA (fig. 378).—*Head:* 1.12 mm. *Siphon:* 0.99 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key; integument uniformly light yellowish throughout except for darker basal ring of siphon; hairs very lightly pigmented except for 7-T and those of anal segment, spikes of stellate hairs very slender. *Head:* maxillary suture complete; mental plate with 9–13 teeth on each side of enlarged median tooth; hairs all single except 14,15-C and occasionally 12-C; 14-C cephalic and far laterad; 15-C caudal. *Antenna:* simple; hair 1-A submedian, single. *Thorax:* spiracular sensilla not apparent; hairs 1-3-P, 5,6-P, 6,7-M on common tubercles; 0,1,3,4,7,8,13,14-P, 1,6,8,13,14-M, 1,4,-5,8,13-T all stellate; only 7-T spiniform, branched and hooked; 6-M stellate; 4-M usually double; 3-T branched; 10-P double, not spiniform. *Abdomen:* spiracular sensilla not apparent; hairs 0,1,2,5,9,11,13,14 all stellate; 3,4 double on some segments; 10 double on some segments; hair 6 long on I-VI, usually 2b on I-IV, single on V,VI; hair 7 long on I,II, short on other segments; hair 14-I not developed. *Segment VIII:* comb scales 5–8 simple acute spines arising from a distinct comb plate. *Siphon:* index about 5.0 or a little less; pecten of 6 or more simple spines; ventral hairs consisting of 1 pair of single hairs near base (1-S) and a midventral line of about 12 hairs, mostly double (1a-S); dorsal hairs (2a-S) 6,7 pairs, usually 3b. *Anal Segment:* marginal spicules 4–6, long; hair 1-X double, on saddle; 4-X usually 5,6b, short, free from saddle; gills rounded, a little less than 2.0 of saddle length.

MATERIAL EXAMINED.—11 larvae.

SYSTEMATICS.—This species is placed in *Rachionotomyia* only provisionally. The larva is quite unlike that of any described species but suggests this subgenus rather than *Tripteroides*. Particularly distinctive is the combination of the following characters: comb plate, long siphon, hair 7-T a strong spiniform, and hair 6-M a stellate tuft.

BIONOMICS AND DISEASE RELATIONS.—*T. floridensis* is known from a single collection of 11 larvae made in a single axil of a wild banana leaf.

DISTRIBUTION (fig. 374, 375).—*Solomon Islands:* Florida. Not known elsewhere.

CALEDONICUS GROUP

FEMALES.—Pleural scales restricted, a conspicuous diagonal light-scaled band from *apn* to lower *mep*, bounded by darkened integument dorsally and laterally. *Head:* dorsal decumbent scales dark except for a narrow orbital line of whitish scales; lateral and ventral decumbent scales whitish; erect scales short, dark; some narrow whitish occipital scales; clypeus small, rounded, bare; proboscis distinctly longer than abdomen, very slender, entirely dark-scaled; palpus about 0.1 of proboscis, dark-scaled, apparently 3-segmented, segments 1 and 2 with some indication of composite nature, segment 3 extremely short and indistinct; antenna about 0.6 of proboscis; torus with a few short hairs and scales; flagellar segment 1 with numerous scalelike hairs on mesal face. *Thorax:* postnotum bare; *apn* lobes small, widely separated; meron small, its upper edge more or less distinctly above base of hindcoxa; mesonotal integument brown and with faint indication of darker longitudinal lines; dense mesonotal vestiture of small bronzy very narrow curved scales, lighter in color above pleuron, and more slender, longer, less curved, and with white scales on anterior promontory; scales above paratergite light, whitish, longer, broader, and more outstanding; scutellum brown, midlobe densely covered with broad flat dark bronzy scales, lateral lobes with a few smaller similar and some narrow scales; postnotum brown, darker centrally; dorsocentral bristles usually 6 pairs, prescutellars 7 or more; pleuron dark brown above and below diagonal scale band, lighter on band and membranes; a conspicuous diagonal whitish-scaled band from *apn*, across lowermost part of *ppn*, lower part of *ssp*, upper middle *stp*, to middle *mep;* upper part of *ppn* with a variable number of broad whitish scales; *ppl* and upper *pcx* with translucent whitish scales; lower caudal part of *stp* with a line of broad whitish scales; a few broad whitish scales at base of *pra* and upper *mep* bristles; 1 *ppn* bristle; usually 3 *sp* bristles; *ppl* bristles usually 3 or more strong and several weak; usually 1 distinct upper *stp* and usual lower *stp* bristles; *pra* with 2 heavy bristles and occasionally some light hairs; upper *mep* bristles well developed. *Legs:* coxae and trochanters with whitish scales similar to those on pleuron; femora dark-scaled above, light-scaled below; tibiae and tarsi dark-scaled, lighter below; hindleg with 2 subequal claws. *Wing:* veins Rs, R_{2+3}, R_2, R_3, and M with slender narrow long plume scales, rather sparse; cell R_2 distinctly less than 3.0 of length of vein R_{2+3}. *Haltere:* light brown at base and stem, dark-scaled on knob. *Abdomen:* tergite I dark-scaled; laterotergite bare; tergites II-VI with basal or apical light markings, sometimes absent; sternites light-scaled.

MALES.—Essentially as in the females. *Palpus:* about 0.7–0.8 of proboscis length; 5-segmented, segments 2 and 3 ankylosed, segment 5 with about 3 moderately long apical bristles. *Antenna:* about 0.67 of proboscis length; very strongly plumose; flagellar segments 12,13 elongate, 12 longer than 13 and about equal to 8–11 combined. *Legs:* anterior claw of only foreleg with submedian tooth.

MALE GENITALIA.—*Segment IX:* tergal lobe slightly wider than long, with 4,5 bristles in a single row, 3 of the bristles broadened and flattened before apex; interlobar space usually less than width of lobe. *Sidepiece:* elongate, subcylindrical; dorsal surface with bristles in basal half; basal mesal lobe short but distinct, with 6,7 strong heavy bristles and a patch of hairs. *Clasper:* long, slender; hairs small; spiniform long, subapical. *Phallosome:* aedeagus short, of usual form, details not studied. *Proctiger:* paraproct usually with 3,4 apical teeth; cercal setae more or less distinct.

PUPAE.—Group characters not apparent; hair 1-C double, long; trumpet varied in shape; paddle sometimes with more or less distinct spicules, apex rounded or more or less angularly produced.

LARVAE.—*Head:* labrum not prominent; posterior tentorial pit near collar; maxillary suture complete, markedly divergent caudad; mental plate broad; hair 1-C not strongly curved mesad at base; dorsal hairs varied, single or branched; 11-13-C in a cephalic lateral group; 14-C cephalic; 15-C caudal. *Antenna:* more or less uniform in width; hair 1-A postmedian, usually long. *Thorax:* spiracular sensilla not apparent; common tubercles poorly developed other than those of hairs 9-12; chaetotaxy varied, stellate hairs conspicuous or not developed; hair 6-M never spiniform; 7-T more or less spiniform or thickened, sometimes branched and hooked; 10-P not spiniform. *Abdomen:* spiracular sensilla not apparent; chaetotaxy varied, stellate hairs conspicuous or not developed; hair 14-I absent. *Segment VIII:* comb without plate. *Siphon:* varied in length; pecten reduced or well developed; ventral hairs in a more or less uniform midventral line (1a-S) except for basal pair (1-S); dorsal hairs (2a-S) paired. *Anal Segment:* saddle with strong marginal spinelike spicules; hair 1-X varied, always on saddle; hair 4-X free from saddle, varied.

SYSTEMATICS.—The *caledonicus* group is here restricted to the South Pacific species: *rotumanus, caledonicus, melanesiensis,* and *folicola.* Lee (1946) included not only *tasmaniensis* (Strickland, 1911) but also the *argenteiventris* group in his *caledonicus* group. *T. tasmaniensis* resembles the members of the restricted *caledonicus* group in having the pleural scaling reduced but is so different in other details, as far as I can judge from descriptions, that I believe it should be placed in a separate monotypic group, with distinct affinities with the *caledonicus* group and perhaps more with *rotumanus* than any other species.

In the *caledonicus* group, *rotumanus* is the only species which is readily recognizable in the adult stage; the other 3 species are at present practically indistinguishable even in the male genitalia. The larvae of all 4 species are rather clearly marked, while the pupae are much more similar and difficult to separate. As indicated below, *melanesiensis* appears to be a complex of currently evolving populations. Eventually it may be possible to segregate additional forms from this complex.

As indicated above in the discussion of the systematics of the subgenus *Tripteroides,* the distributions of the latter and of the *caledonicus* group are of great zoögeographic interest.

BIONOMICS AND DISEASE RELATIONS.—The bionomics of the included species of the *caledonicus* group are given below. Both general container-breeders and restricted plant-breeders are present in the group. Females apparently rarely bite man.

DISTRIBUTION (figs. 374, 375).—The *caledonicus* group is restricted to the South Pacific and occurs from Rotuma Island through the Santa Cruz group and the New Hebrides to New Caledonia.

3. Tripteroides (Rachionotomyia) rotumanus (Edwards)

Figs. 375, 379, 380

1929. *Rachionotomyia rotumana* Edwards, B. Ent. Res. 20:337–338. *TYPE: holotype ♂ with attached genitalia mount, Rotuma Island, Apr., 1928, W. D. Carew; marked as type by Edwards (BMNH).

Tripteroides (*Polylepidomyia*) *rotumanus* of Stone, Knight, and Starcke (1959).
Tripteroides (*Mimeteomyia*) *rotumana* of Edwards (1932:77); Taylor (1934:12); Paine (1935, 1943:9); Lee (1944*a*:23; 1946:267); Belkin (1955:243–246); Iyengar (1955:24); Laird (1956:82).
Tripteroides rotumana of Knight, Bohart, and Bohart (1944:19, 67).

FEMALE.—*Wing:* 2.67 mm. *Proboscis:* 2.42 mm. *Forefemur:* 1.92 mm. *Abdomen:* about 2.0 mm. As described for group except for following distinguishing features; pleural scales flat white; upper *ppn* scales conspicuous; *pcx* scales conspicuous; upper *stp* bristle strongly developed, lower *stp* bristles present, not absent as stated by Edwards (1929*b*:337); abdominal tergites II-VII with basal lateral light patches.

MALE.—Essentially as in the female except for sexual characters which are as described for group; palpus about 0.7 of proboscis length.

MALE GENITALIA (fig. 379).—As figured, apparently indistinguishable from other members of the group.

PUPA (fig. 379).—*Abdomen:* 2.6 mm. *Trumpet:* 0.32 mm. *Paddle:* 0.43 mm. Chaetotaxy as figured; diagnostic characters as in the key, separation from other members of group tenuous and uncertain. *Cephalothorax:* dark brown; hairs strongly pigmented, all branched except 6,9-C. *Trumpet:* index about 4.2; uniformly dark. *Abdomen:* basal segments and intersegmental areas dark brown, remainder light; hairs moderately to strongly pigmented; hair 1-II-VI with 3 or more branches; 2-II-VII well developed, usually single; 5-IV-VI single, long; 5-VII short, multiple; 8-VII small, usually double. *Paddle:* lightly pigmented, midrib darker; apex not distinctly produced; spicules distinct.

LARVA (fig. 380).—*Head:* 0.85 mm. *Siphon:* 0.6 mm. *Anal Saddle:* 0.26 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly moderate yellowish brown; mental plate with 7,8 teeth on each side of enlarged median tooth; hairs poorly pigmented except 11-C; hairs 4-6-C single; 14-C very small, single. *Antenna:* hair 1-A single. *Thorax:* hairs well pigmented; no common tubercles other than those of hairs 9-12; hairs 0,1,3,4,7,8,13,14-P, 1,8,13,14-M, 1,4,5,8,13-T all more or less stellate, with few spikelike branches; 6-M weak; 7-T double, more or less thickened, spiniform. *Abdomen:* hairs strongly pigmented; hairs 0,1,2,5,11,13,14 all more or less stellate, with few spikelike branches; 9-IV-VI also stellate; 6-I-VI long, 6-I,II usually 4,3b, 6-III-VI usually double or single; 7-I,II long, double or triple; hair 14-VII usually single. *Segment VIII:* comb of about 20 long scales. *Siphon:* index about 2.2–2.6; pecten teeth usually 6–8; basal ventral hair (1-S) usually 8b, other ventral hairs (1a-S) usually triple; dorsal hairs (2a-S) usually triple. *Anal Segment:* hair 1-X usually single; 4-X long, usually 4b.

MATERIAL EXAMINED.—73 specimens; 9 ♀; 3 ♂; 5 pupae; 56 larvae; no individual rearings.

SYSTEMATICS.—*T. rotumanus* is the most isolated member of the *caledonicus* group and the only one with striking differential adult characters. The immature stages of this species, on the other hand, do not depart markedly from the general pattern of the group, certainly not as much as *caledonicus.* In several respects, particularly the presence of a strongly developed upper sternopleural bristle, *rotumanus* appears to be more primitive than the other members of the group.

The occurrence of this species on the isolated group of Rotuma is of considerable interest. I suggested earlier that *rotumanus* may have originated as a result of a human introduction of a *melanesiensis* stock from the New Hebrides (Belkin, 1955:225). It appears more likely now that it is a relict species and that it reached its present location through islands no longer in existence in the area between the Santa Cruz group or the New Hebrides and Rotuma.

BIONOMICS AND DISEASE RELATIONS.—Only 2 collections of *rotumanus* have been made. The breeding site of the original collection is not recorded, but the only known adults of this species were reared from this collection in Suva (R. W. Paine). The second collection was made in a tin can in deep shade in the bush area on the edge of the village of Oinafa in association with larvae of *Aedes* (*Stegomyia*) *rotumae* (Bonnet, 18). It is of interest to note that *rotumanus* was not found in several treehole collections in which *rotumae* was abundant. Perhaps its normal breeding sites are to be found in treeholes deep in the bush.

DISTRIBUTION (fig. **375**).—*Rotuma Island.* Not known elsewhere.

4. Tripteroides (Rachionotomyia) caledonicus (Edwards)

Figs. **375, 381, 382**

1922. *Rachionotomyia caledonica* Edwards, B. Ent. Res. 13:100–101. *TYPE: lectotype ♂, genitalia missing, Houailou, New Caledonia, bred from pitcher of *Nepenthes,* July 31, 1914, P. D. Montague; present selection (BMNH).

Tripteroides (*Polylepidomyia*) *caledonicus* in part of Stone, Knight, and Starcke (1959).

Tripteroides (*Mimeteomyia*) *caledonica* of Edwards (1932:77, in part); Taylor (1934:12); Lee (1944*a*:22; 1946:265; both in part); Belkin (1955:227–230; restricted); Iyengar (1955:24); Rageau (1958*a*:878, in part; 1958*b*:7).

Tripteroides caledonica in part of Knight, Bohart, and Bohart (1944:19, 67).

Rachionotomyia caledonica of Edwards (1924:361–362); Buxton and Hopkins (1927:74, 75; in part).

FEMALE.—*Wing:* 3.25 mm. *Proboscis:* 2.67 mm. *Forefemur:* 2.17 mm. *Abdomen:* about 2.47 mm. Very similar to *melanesiensis;* a few broad, apically rounded or truncate dark scales along the supraalar bristles; abdominal tergites II-VI with complete apical transverse light bands.

MALE.—Essentially as in the female except for sexual characters; palpus about 0.7 of proboscis length; abdominal apical light bands more extensive and involving tergite VII.

MALE GENITALIA (fig. **381**).—As figured, apparently indistinguishable from other members of the group.

PUPA (fig. 381).—*Abdomen:* 3.6 mm. *Trumpet:* 0.45 mm. *Paddle:* 0.5 mm. Chaetotaxy as figured, hairs moderately to strongly pigmented; diagnostic characters as in the key, separation from other members of group tenuous. *Cephalothorax:* very lightly pigmented except middorsally; hairs rather short and lightly branched except 6,7,9-C which are usually single. *Trumpet:* index about 2.3; very darkly pigmented, apex lighter. *Metanotum:* darkened. *Abdomen:* very lightly pigmented, except proximad middorsally and on intersegmental areas; hair 1-II-VI usually 1-3b; 2-II-VII very small, single; 5-IV-VI single, long; 5-VIII short, usually 1,2b; 8-VII small, usually 2,3b. *Paddle:* very lightly pigmented; midrib broad and strongly sclerotized at base, evanescent apically; apex rounded; margins with several dorsal rows of distinct long spicules from base externally around apex to basal 0.33 internally.

LARVA (fig. 382).—*Head:* 0.84 mm. *Siphon:* 0.6 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key; markedly different from other members of group. *Head:* mottled dark blackish brown; mental plate with 9–12 teeth on each side of median tooth; all hairs strongly pigmented and all single except 7-9,12,14-C which are usually 2,3b. *Thorax:* hairs strongly pigmented; hairs 5,6-P, 6,7-M on common tubercles; no strong stellate hairs; 6-M long; 7-T single, thickened but not distinctly spiniform; 13-T very long; 9-P,M,T with few branches. *Abdomen:* hairs strongly pigmented; hairs 0,14 minute, single on all segments; no well-developed dorsal stellate hairs; hair 11-I-VI more or less stellate, usually with 2–4 spikelike branches; 6-I-VI, 7-I-II all long, single. *Segment VIII:* comb of about 15–20 short blunt scales, fringed apically and less conspicuously laterally. *Siphon:* index about 2.5–3.2; pecten consisting of 1 tooth on left side only; basal ventral hair (1-S) usually triple, accessory hairs (1a-S) distinctly paired and usually all single; dorsal hairs (2a-S) single. *Anal Segment:* marginal spicules rather short; hairs 1,2,4-X all long and usually double; gills rounded, markedly unequal.

MATERIAL EXAMINED.—46 specimens; 7 ♀; 9 ♂; 18 pupae; 12 larvae; 7 individual pupal rearings.

SYSTEMATICS.—Adults of *caledonicus* are practically indistinguishable from *melanesiensis* and *folicola* at the present, but the immature stages are quite distinct, particularly the larva. The latter is so different superficially that it does not appear to belong to the same group as the others. However, on closer examination the larval chaetotaxy suggests the younger instars of the more generalized species of the group. This neotenic larval condition is found in many other nepenthicolous *Tripteroides.*

BIONOMICS AND DISEASE RELATIONS.—*T. caledonicus* breeds exclusively in *Nepenthes* pitchers. Nothing is known of the adult habits of this species.

DISTRIBUTION (fig. 375).—*New Caledonia:* Houailou; La Coulee; Hienghene (Williams, 1943). Not known elsewhere; records of *caledonicus* from the New Hebrides and Loyalty Islands pertain to *melanesiensis* or *folicola.*

5. Tripteroides (Rachionotomyia) melanesiensis Belkin

Figs. 375, 383, 384

1955. *Tripteroides* (*Mimeteomyia*) *melanesiensis* Belkin, Pacific Sci. 9:233–243. *TYPE: holotype larva (KLK, 759*a*), Segond Channel area, Espiritu Santo, New Hebrides, from treehole, Sept. 21, 1943, K. L. Knight, J. G. Franclemont, and J. N. Belkin (USNM, 62390).

Tripteroides (*Polylepidomyia*) *melanesiensis* of Stone, Knight, and Starcke (1959).

Tripteroides (*Mimeteomyia*) *melanesiensis* of Iyengar (1955:24); Laird (1956); Rageau (1958*a*:878; 1958*b*:7); Rageau and Vervent (1958:26–27).

Tripteroides (*Mimeteomyia*) *caledonica* in part of Edwards (1932:77); Taylor (1934:12); Lee (1944*a*:22; 1946:265); Perry (1946:13–14).

Tripteroides caledonica in part of Knight, Bohart, and Bohart (1944:19, 67).

Rachionotomyia caledonica in part of Buxton and Hopkins (1927:74–78).

Tripteroides coheni of Mills (1954:106); Rageau (1958*a*:878), Rageau and Vervent (1958:27).

FEMALE.—*Wing:* 3.35 mm. *Proboscis:* 3.0 mm. *Forefemur:* 2.3 mm. *Abdomen:* about 2.12 mm. As described for group except for following; no broad scales among supraalar bristles; pleural scales dingy translucent white; upper *ppn* scales inconspicuous; *pcx* scales few, inconspicuous; upper *stp* bristles sometimes poorly developed; abdominal tergites II-VI completely dark or with complete or incomplete apical light transverse bands.

MALE.—Essentially as in the female except for sexual characters as described for group; palpus about 0.8 of proboscis; abdominal apical light bands more extensive and involving tergite VII.

MALE GENITALIA (fig. 383).—As figured, apparently indistinguishable from those of other members of group.

PUPA (fig. 383).—*Abdomen:* 3.4 mm. *Trumpet:* 0.5 mm. *Paddle:* 0.6 mm. Chaetotaxy as figured; diagnostic characters as in the key, separation from other members of group tenuous and uncertain. *Cephalothorax:* moderately dark reddish brown middorsally, lighter laterally and ventrally; ventral hairs moderately pigmented, dorsal darker; all hairs usually branched except 9-C, most hairs strongly developed. *Trumpet:* index about 2.8–3.0; bright deep reddish brown. *Abdomen:* moderately dark reddish brown, darker middorsally and in intersegmental areas, very lightly pigmented distad; small hairs weakly or moderately pigmented, larger hairs darker; hair 1-II-VI multiple; 2-II-VII large, multiple; 5-IV-VI long, single; 5-VII branched, often as long as tergite VIII, as is hair 1-VII; 8-VII large, usually double; ventral hairs often strongly developed. *Paddle:* very lightly pigmented; midrib darker, narrow; apex sometimes slightly produced; spicules usually few and scattered, sometimes in a distinct marginal dorsal row.

LARVA (fig. 384).—*Head:* 1.0 mm. *Siphon:* 1.25 mm. *Anal Saddle:* 0.33 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* usually uniform light reddish brown; mental plate with 7,8 teeth on each side of enlarged median tooth; all hairs moderately pigmented; hairs 4-6-C usually single; 14-C thickened, usually double; 15-C long, usually 8,9b. *Thorax:* hairs usually strongly pigmented; 7,8-T on common tubercle; hairs 0,1,3,4,7,8,13,14-P, 1,8,13,14-M, 1,4,5,8,13-T all stellate hairs with spikelike branches; 6-M moderate, not thickened, single; 7-T usually double, more or less spiniform. *Abdomen:* hairs strongly pigmented; hairs 0,1,2,5,9,11,13,14 all usually strong stellate tufts with spikelike branches; 14-VII stellate; 6-I-VI long, usually single, 6-I,II sometimes branched; 7-I-II long, usually double. *Segment VIII:* comb scales varied. *Siphon:* index extremely variable, from 2.0 to 6.0 or even more; pecten teeth and hairs extremely variable but not as in other species. *Anal Segment:* hairs and gills extremely variable but not as in other species.

MATERIAL EXAMINED.—2,448 specimens; 446 ♀; 329 ♂; 216 pupae; 1,457 larvae; 24 individual rearings (10 larval, 4 pupal).

SYSTEMATICS.—Adults of *melanesiensis* are practically indistinguishable from *caledonicus* and *folicola;* the immature stages are in general similar to *rotumanus* and *folicola.* The larvae and pupae of the latter are easily separated from *melanesiensis,* as indicated in the respective diagnoses.

T. melanesiensis exhibits more striking variation in the larval stage than any other species of mosquito I have seen. Each type of breeding place appears to have a peculiar form and every island has morphologically distinguishable populations. It would appear, therefore, that we are dealing with numerous ecophenotypes, or possibly ecotypes or ecospecies, as well as geographical races. No attempt has been made to analyze thoroughly all the samples of populations now available, but I have indicated elsewhere (Belkin, 1955:238–242) some of the trends which are evident in this complex.

Attempts to segregate the various forms into ecological or geographical races are complicated by the fact that *melanesiensis* is a very plastic species showing a great deal of individual variation within single collections, as well as in different collections from the same habitat in some geographical areas. Differences in the development of stellate hairs, metathoracic spine, anal gills, comb scales, pecten teeth, length and shape of siphon, and number and branching of accessory siphonal hairs are sometimes so striking that larvae from a single collection may appear to represent a very distinct species. Furthermore, it is very likely that there is contamination and mixing of local populations through human agency.

Distinct larval morphological features are usually associated with the type of larval habitat, at least over part of the range. Thus treehole-breeders generally have a longer siphon, shorter anal gills, darker pigmentation, a greater development of stellate tufts, accessory hairs, and pecten teeth, and longer and more pointed comb scales. Breeders in coconut shells, bamboo, and cacao pods represent the other extreme; the larval forms from artificial containers are intermediate but generally closer to the treehole-breeders. On the other hand, parallel ecological types in different portions of the range are usually distinct in other features, indicating in all probability distinct isolated genetic stocks on practically every island.

There appears to be a sharp demarcation between the populations in the Santa Cruz Islands and the New Hebrides area and those in the Loyalties and New Caledonia not only on larval characters but, to a lesser extent, in adult coloration, the northern forms being generally much darker. It may be possible with further study to segregate additional species from the *melanesiensis* complex. The palm bract population from New Caledonia (Belkin, 1955:234) is fairly well marked but is known from a single collection; the constancy of its characters cannot be determined at present.

BIONOMICS AND DISEASE RELATIONS.—*T. melanesiensis* utilizes a wide variety of habitats. The typical form is a treehole-breeder. Other reported breeding sites are bamboo, coconut shells and husks, artificial containers of various types, and even palm bracts and a rock pool. As indicated above, it is possible that more than 1 species is involved. *T. melanesiensis* tolerates brackish water as well as highly polluted water, such as in septic tanks.

Females of *melanesiensis* are seldom attracted to man. Miss Cheesman (*in lit.*) reports being bitten on 2 occasions by the Araucaria treehole-breeding form, but in the New Hebrides, where *melanesiensis* is abundant, none of the forms are known to attack man. Adults have been found resting near their breeding places.

DISTRIBUTION (fig. **375**).—*Santa Cruz Islands:* Nupani; Fenualoa; Naelo; Vanikoro; Tikopia. *Banks Islands:* Vanua Lava. *New Hebrides:* Espiritu Santo; Aessi; Aore; Tutuba; Aoba; Pentecost; Vao; Malekula; Efate; Eromanga; Futuna; Aneityum. *Loyalty Islands:* Ouvea; Lifu; Mare. *New Caledonia:* Bouloupari; Bourail; La Foa; Tinchialit; unspecified localities; Ile des Pins; Belep Group (Art). Not known elsewhere.

6. Tripteroides (Rachionotomyia) folicola Belkin

Figs. **375, 385, 386**

1955. *Tripteroides* (*Mimeteomyia*) *folicola* Belkin, Pacific Sci. 9:230–233. *TYPE: holotype larva (KLK, 784), Renee River area, Espiritu Santo, New Hebrides, from axil of wild banana, Oct. 17, 1943, R. L. Ingram and J. Laffoon (USNM, 62389).

Tripteroides (*Polylepidomyia*) *folicola* of Stone, Knight, and Starcke (1959).
Tripteroides (*Mimeteomyia*) *folicola* of Iyengar (1955:24); Laird (1956); Rageau (1958*a*:878); Rageau and Vervent (1958:27).
Tripteroides (*Mimeteomyia*) *caledonica* in part of Perry (1946:13–14).
Tripteroides caledonica in part of Knight, Bohart, and Bohart (1944:19, 67).

FEMALE.—*Wing:* 3.17 mm. *Proboscis:* 2.83 mm. *Forefemur:* 2.17 mm. *Abdomen:* about 2.25 mm. Indistinguishable from *melanesiensis.*

MALE.—Essentially as in the female except for sexual characters as described for group; indistinguishable from *melanesiensis.*

MALE GENITALIA (fig. 385).—As figured, apparently indistinguishable from those of other members of the group.

PUPA (fig. 385).—*Abdomen:* 3.36 mm. *Trumpet:* 0.53 mm. *Paddle:* 0.67 mm. Chaetotaxy as figured; diagnostic characters as in the key, separation from other members of group tenuous. *Cephalothorax:* uniformly very light yellow; hairs moderately pigmented, rather short and strongly branched except 6-C which is usually single. *Trumpet:* index about 2.5; uniformly bright yellow. *Abdomen:* uniformly light bright yellow, intersegmental sclerites darkened; hairs lightly to moderately pigmented; hair 1-II-VI multiple; 2-II-VII well developed, single; 5-IV-VI long, usually 2,3b; 5-VII moderate, multiple, shorter than tergite VIII; 8-VII short, multiple; ventral hairs normal. *Paddle:* very lightly pigmented; midrib darker, narrow; apex angularly produced; spicules not apparent.

LARVA (fig. 386).—*Head:* 0.9 mm. *Siphon:* 0.78 mm. *Anal Saddle:* 0.24 mm. Chaetotaxy as figured; diagnostic characters as in the key; in general very similar to *melanesiensis;* pigmentation of head, thorax, and abdomen very light brownish yellow; thoracic and abdominal hairs yellowish brown; stellate tufts with 30 or more slender spikes. *Head:* hairs 5-9,12,14,15-C strongly branched, particularly ventral hairs. *Antenna:* hair 1-A branched. *Abdomen:* hairs 6-I-IV usually all branched; 7-I,II single or double. *Segment VIII:* comb scales about 30, sharply pointed and unfringed apically. *Siphon:* index about 2.75–3.5; pecten teeth 8–10, broad at base; basal ventral hair (1-S) usually 5b, others (1a-S) unpaired and usually single, 5 in number; dorsal hairs (2a-S) usually 9 pairs, all rather short, double or single. *Anal Segment:* hair 1-X usually 4b; 2-X usually 6b; 4-X usually 4b, about 2.5–3.0 of saddle length; gills subequal, about 2.0 of saddle length.

MATERIAL EXAMINED.—101 specimens; 25 ♀; 24 ♂; 15 pupae; 37 larvae; 7 individual larval rearings.

SYSTEMATICS.—The adults of *folicola* are indistinguishable from *caledonicus* and *melanesiensis.* The immature stages are in general similar to *melanesiensis* but are readily separated by the diagnostic characters given above.

The larvae from the different habitats are remarkably similar and, although there is some individual variation in chaetotaxy, there is no overlap whatever in diagnostic characters with *melanesiensis.*

BIONOMICS AND DISEASE RELATIONS.—*T. folicola* breeding sites are restricted to the leaf axils of living plants. I have seen specimens from banana, taro, *Zingiber* (?), and sago palm (?), but it is very likely that the specimens reported by Perry (1946:13) from pandanus were also *folicola*. All known adults have been reared and nothing is known of their bionomics.

DISTRIBUTION (fig. 375).—*New Hebrides:* Espiritu Santo. Not known elsewhere.

ARGENTEIVENTRIS GROUP

7. Tripteroides (Rachionotomyia) coheni Belkin

Figs. 374, 375, 387, 388

1950. *Tripteroides* (*Mimeteomyia*) *coheni* Belkin, U.S. Natl. Mus., Proc. 100:250–256. *TYPE: holotype ♂ with associated larval and pupal skins (JNB, 939-32), White River valley, Guadalcanal, Solomon Islands, from treehole, Apr. 7, 1945, M. Cohen (USNM, 59089).

Tripteroides (*Polylepidomyia*) *coheni* of Stone, Knight, and Starcke (1959).
Tripteroides (*Mimeteomyia*) *coheni* of Iyengar (1955:24).

FEMALE.—*Wing:* 3.33 mm. *Proboscis:* 2.83 mm. *Forefemur:* 1.93 mm. *Abdomen:* about 2.25 mm. Pleuron very extensively scaled; proboscis longer than abdomen. *Head:* dorsal decumbent scales dark, except for a very narrow orbital line of white scales; lateral and ventral decumbent scales white; erect occipital scales short, white in center, dark laterally; clypeus small, rounded, bare; proboscis slightly but distinctly longer than abdomen, entirely dark; palpus about 0.15 of proboscis, dark-scaled, apparently 3-segmented; antenna about 0.70–0.75 of proboscis. *Thorax:* postnotum bare; *apn* lobes fairly large, widely separated; meron small, its upper edge about in line with base of hindcoxa; mesonotal integument dark brown, with a thick shaggy vestiture of mixed broad and narrow curved dark bronzy scales, a few narrow white scales on anterior promontory; scutellum dark, completely covered with broad flat dark bronzy scales; postnotum brown, darker centrally; 1 pair of dorsocentral bristles, 3,4 large prescutellars; pleural integument brown, scaling essentially as in the *atripes* group but *pcx* with scaling more extensive and *psp* less so and scales rather translucent, not dead white; upper part of *apn* and upper 0.5–0.67 of *ppn* with broad dark scales; 1 strong *ppn* bristle, 4–6 *ppl*, 2–4 *sp*, 1,2 upper *stp*. *Legs:* essentially as in *atripes* group; 2 claws on hindleg. *Wing:* essentially as in *atripes* group but scaling not as dense or long. *Haltere:* dark-scaled on upper part of stem and knob. *Abdomen:* upper portion of tergites I-VII dark bronzy; laterotergite and a lateral band on tergites II-VII white-scaled, line of demarcation straight but not even; sternites entirely light-scaled, slightly yellowish.

MALE.—Essentially as in female. *Palpus:* about 0.85 of proboscis length; 5-segmented, segments 2 and 3 ankylosed, segments 4 and 5 with a few short dark bristles; bristles in flagellar whorls very long and dense; segments 12,13 elongate, 12 about 2.0 of 13. *Legs:* anterior claw of foreleg with submedian tooth. *Abdomen:* sternal light scaling more dingy.

MALE GENITALIA (fig. 387).—As figured; diagnostic characters as in the key. *Segment IX:* tergal lobe small, rounded, with 8,9 strong bristles in irregular double apical rows; interlobar space somewhat less than width of one lobe. *Sidepiece:* conical, elongate; with very long bristles distally on dorsal surface and shorter ones in basal half; basal mesal lobe rather distinct, small, with about 6–8 long bristles, about 4 of which are heavier, and numerous hairs. *Clasper:* long, slender; dorsal hairs short; spiniform short, pointed, deeply inserted. *Phallosome:* aedeagus short, of usual structure, details not studied. *Proctiger:* paraproct with about 4 short teeth in a dorsoventral row.

PUPA (fig. 387).—*Abdomen:* 3.9 mm. *Trumpet:* 0.42 mm. *Paddle:* 0.51 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly light yellowish brown; hairs moderately to strongly pigmented; hair 1-C long, double or triple, 8-C single or double, others usually single or with few branches. *Trumpet:* uniformly bright moderate orange brown. *Abdomen:* uniformly light yellowish brown, lighter distad, intersegmental sclerites darker; hairs very strongly pigmented, larger hairs thickened; hair 1-I with numerous branches, a few dendritic; 1-II-VII short, with thickened basal stem on II-VI and short slender branches; 2-III-VII laterad of or in line with hair 1; 5-VII very short, thickened; 9-VI dorsal, near caudolateral angle, thickened and usually branched. *Paddle:* very lightly pigmented, midrib not much darker; apex more or less angularly produced; spicules not apparent.

LARVA (fig. 388).—*Head:* 0.8 mm. *Siphon:* 0.69

mm. *Anal Saddle:* 0.27 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly pigmented a moderate to light yellowish brown; maxillary suture complete, divergent caudad; mental plate rather wide, with about 8–10 teeth on each side of prominent median tooth; maxilla with inner apical angle produced into a spur, 2 strong articulated spines on oral apical surface, larger about half as long as body of maxilla, occasionally a smaller articulated spine also present; body of maxilla short and broad; dorsal hairs lightly pigmented, ventral moderately to strongly pigmented; dorsal hairs branched; 11-C weak, branched; 12,13-C removed mesad, single; 14-C strongly developed, usually double, removed caudad; 15-C small, submedian. *Antenna:* slightly irregular in shape, somewhat narrower in basal 0.5; a little darker than head capsule; hair 1-A postmedian. *Thorax:* spiracular sensilla poorly differentiated; hairs moderately to strongly pigmented, no common tubercles other than those of hairs 9-12; hairs 1,3,7,8,13,14-P, 1,14-M, 1,5,13-T stellate, with few spikelike branches; 4-P, 3-T also with spikelike branches, somewhat stellate; 9,10,12-P all single, long, subequal; 6-M long, single, not spiniform; 7-T long, multiple; 8-M very short, 1,2b; 9-M single or double, 9-T usually triple. *Abdomen:* spiracular sensilla poorly differentiated; hairs moderately to strongly pigmented, tubercles poorly developed; hair 0 mesad and cephalad of hair 2, minute on II-V, stellate on VI,VII; hair 14-I absent; 1,2,5,11,13-I-VI, 9-III-VI stellate, with few slender spikelike branches; 6-I-V, 7-I-II long, single or double; 7-III-VI short, branched. *Segment VIII:* comb scales 7,8, sharply pointed, free, lightly fringed at base. *Siphon:* index about 2.5; very heavily pigmented; pecten of 3,4 fringed teeth in basal 0.5; basal ventral hair (1-S) paired, usually 2,3b, remaining 9-11 ventral hairs (1a-S) in a more or less regular midventral row, each usually single; dorsal hairs (2a-S) 6-8 on each side, usually single or double, apical small, weak, others thickened. *Anal Segment:* saddle very large, darkly pigmented, with very short marginal spicules; hairs 1,4-X both attached to saddle and long and single; gills usually much longer than saddle, rounded apically.

MATERIAL EXAMINED.—16 specimens; 5 ♀; 4 ♂; 4 pupae; 3 larvae; 3 individual rearings (2 larval, 1 pupal).

SYSTEMATICS (fig. 374).—This very interesting species is placed provisionally in the *argenteiventris* group (fig. 374), which I am separating from the *caledonicus* group of Lee (1946:246–272) to include species of *Rachionotomyia* with a proboscis longer than the abdomen, pleural scaling extensive as in the *atripes* group, and a long palpus in the male. The included species are *argenteiventris* (Theobald, 1905) (= *ater* Taylor, 1914, and *brugi* Edwards, 1927), the *argenteiventris* of Lee (1946:268–270), *microlepis* (Edwards, 1927), all from New Guinea, and *collessi* Lee, 1946 from north Queensland. Stone (1957*a*:173–174) has examined the female type specimen of *argenteiventris* and determined that it has a palpus about one-sixth as long as the proboscis. A paratype of *argenteiventris* in the British Museum is not conspecific, since it has the palpus less than 0.1 of the proboscis and differs in other respects. This specimen probably is a representative of the same form which Lee considered to be "*argenteiventris*" but which is now without a name. The species in this group are very similar and have caused much confusion in the past. Therefore, all the material should be reëxamined before new names are proposed.

The larva of *coheni* is markedly different from those described by Lee, particularly in the development of the apical maxillary spines and hairs 1 and 4 of the anal segment. I have seen quite similar larvae from the Admiralties. They are suggestive of *Rachisoura* to some extent, and it is possible that *coheni* represents a derivative of the line from which this subgenus arose. It may be necessary to separate such species as a distinct group after the larva of the true *argenteiventris* is described, but it is also possible that *coheni* and *argenteiventris* are conspecific.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *coheni* have been collected in treeholes only. All the adults have been reared. This species appears to be very scarce. The larvae do not appear to be predaceous or cannibalistic in the laboratory, but all collections consisted of only a few nearly mature larvae in a given breeding site without any associated mosquitoes of other species.

DISTRIBUTION (fig. 375).—*Solomon Islands:* Bougainville; Sterling; New Georgia; Guadalcanal. Not known elsewhere; the records by Mills (1954:106), Rageau (1958*a*:878), and Rageau and Vervent (1958:27) of this species from the New Hebrides are undoubtedly in error and probably refer to *melanesiensis.*

Subgenus RACHISOURA Theobald

1910. *Rachisoura* Theobald, Monog. Culicidae 5:207. *TYPE SPECIES: *R. sylvestris* Theobald, 1910, Queensland; monobasic.

FEMALES.—Essentially as in *Rachionotomyia;* drab in coloration, with only white and creamy scales in addition to dark scales, no blue or silvery markings. *Head:* proboscis varied in length; palpus varied in length, up to 0.25 of proboscis; antenna apparently varied in length; clypeus sometimes with scales. *Legs:* not ornamented. *Wing:* plume scales of veins R_2, R_3, and R_{2+3} broad and dense.

MALES.—Essentially as in the females; palpus varied in length, sometimes as long as proboscis.

PUPAE.—Subgeneric characters not evident if *mabinii* Baisas & Ulbaldo-Pagayon, 1953 from the Philippines is included; for characteristics of Solomons species, see below.

LARVAE.—*Head:* posterior tentorial pit at collar; maxillary suture nearly straight, not reaching posterior tentorial pit, very distant from midventral line so that labial sclerite of head capsule is very wide; maxilla with long apical articulated spines or "horns"; maxillary palpus long. *Segment VIII:* comb scales free or arising from plate.

SYSTEMATICS.—*Rachisoura* is characterized at present chiefly by the very distinctive larval head, which is suggestive of some species of *Trichoprosopon* in the development of articulated apical maxillary spines. I have not been able to find good diagnostic characters for the adults, as the descriptions of the various species are inadequate and no specimens were available for detailed study.

The subgenus is a complex one and in a confused state nomenclaturally and taxonomically. The type species, *sylvestris* (Theobald, 1910) from Queensland, is not conspecific with *filipes* (Walker, 1861) from New Guinea, as believed by Lee (1946:243). It seems very likely that the male and female described by Theobald represent the sexes of the same species and not 2 different species. Unfortunately, *sylvestris* is as yet unknown in the larva and pupa. However, there is no question that *sylvestris* is congeneric with the *filipes* of Lee. The latter may indeed be *filipes* of Walker, but the type specimen of *filipes* is in such poor condition that it is impossible to determine this with any degree of certainty. *T. sylvestris* of Theobald has a long male palpus and in the female a much more slender proboscis and longer palpus than the *filipes* of Lee.

For the present I am retaining the South Pacific *Rachisoura* in the *filipes* group of Lee but am defining it exclusively on the basis of the 3 species I have before me. It is evident that there are additional groups in the subgenus.

The affinities of *Rachisoura* are not apparent, but it is clear that the subgenus has many primitive characters, some of which it shares with less specialized groups of *Tripteroides s. str.* and *Rachionotomyia.* The similarities with some *Trichoprosopon* species are rather striking and, I believe, indicative of genetic affinities. As indicated above under the discussion of the genus, I believe that *mabinii* Baisas & Ubaldo-Pagayon, 1953 should be segregated into a separate subgenus.

BIONOMICS AND DISEASE RELATIONS.—At least 3 species of *Rachisoura* have been observed to feed on other mosquito larvae as well as smaller individuals of their own species, and it is presumed that all of them use the enlarged apical spines of the maxillae to capture prey. They may also feed on drowned ants and other moribund or dead insects in their habitat. The reported breeding places of *Rachisoura* species are bamboo, treeholes, coconut husks and shells, leaf axils of taro and other aroids, pandanus axils, and *Nepenthes* pitchers. At least 2 species are occasionally found in artificial containers.

Adults are not known to feed on man. They may be found resting in the vicinity of their breeding sites and on tree buttresses. Since species of *Rachisoura* do not feed on man, they are not directly involved in disease transmission. It is very unlikely that they play a very important part as larval predators of economically important species utilizing the same type of breeding sites, since their populations are seldom sufficiently large to affect materially the densities of their prey.

DISTRIBUTION (fig. 389).—*Rachisoura* is known only from New Guinea, northeast Australia, and the Solomons. *T. mabinii* Baisas & Ubaldo-Pagayon, 1953, described from the Philippines as a *Rachisoura,* should be placed, I believe, in a separate subgenus.

KEYS TO SPECIES

(Keys to genera and subgenera, pp. 487–488)

ADULTS

1. *Females:* flagellar segments 12 and 13 subequal to segment 11; genitalia not evident 2
   Males: flagellar segments 12 and 13 elongate; genitalia prominent 4

2(1). Palpus with at least 3 stout apical hairs not arising side by side; prescutellar bristles absent or 1 weak pair .... 3. *torokinae*
   Palpus with at most 2 long slender hairs arising side by side on apex; prescutellar bristles at least 2 strong pairs 3

3(2). At least lower half of *ppn* white; palpus with or without apical hairs (never in leaf axils) ... . 2. *stonei*
   Only lower third of *ppn* white; palpus without apical hairs (in leaf axils only) .... 1. *mathesoni*

4(1). Palpus without differentiated apical bristles .. .. 1. *mathesoni*
   Palpus with conspicuous long differentiated apical bristles 5

5(4). Palpus with 4–8 apical bristles .... 2. *stonei*
   Palpus with 20 or more apical bristles .... 3. *torokinae*

MALE GENITALIA

1. Interlobar space of tergite IX about as wide as one of the lobes .... 1. *mathesoni*
   Interlobar space of tergite IX much narrower than width of one lobe 2

2(1). Bristles of lobe of tergite IX relatively slender .... 2. *stonei*
   Bristles of lobe of tergite IX flattened and broad .... 3. *torokinae*

PUPAE

1. Hair 2-IV-VI distinctly mesad of hair 1; paddle with distinct apical process and without spicules .... 1. *mathesoni*
   Hair 2-IV-VI at level or laterad of hair 1; paddle without distinct apical process and with spicules .... 2. *stonei;* 3. *torokinae*

LARVAE

1. Hair 2-III-V minute and weak, far removed from hair 1 and without basal tubercle .... 1. *mathesoni*
   Hair 2-III-V a strong spike, either on a separate tubercle or on a common tubercle with adjacent hair 1 2

2(1). Hair 6-VI short, multiple .... 2. *stonei*
   Hair 6-VI long, single .... 3. *torokinae*

FILIPES GROUP

FEMALES (South Pacific species only).—*Head:* dorsal decumbent scales dark, overlying in front a narrow orbital border of small whitish scales; lateral and ventral decumbent scales whitish; erect scales short, very broad on apices, whitish in center, dark laterad, those in middle semierect and not well differentiated from decumbent scales; 4,5 conspicuous long orbital bristles above; clypeus rounded, bare; proboscis length subequal to abdomen and usually to forefemur; palpus slender, about 0.17–0.25 of proboscis, dark-scaled, apparently 3- or 4-segmented, segment 1 probably composite, segments 2 and 3 ankylosed, segment 4 very short or absent; antenna about 0.8 of proboscis. *Thorax:* postnotum usually with 2–4 minute hairs on lower central part; *apn* large; meron small, its upper edge about in line with base of hindcoxa; mesonotum with dark integument, completely covered with dense shaggy vestiture of narrow curved decumbent dark bronzy scales of varied size, some broader, a few narrow whitish scales on anterior promontory; scutellum with very broad flat dark bronzy scales; acrostichal and dorsocentral bristles completely absent, prescutellars reduced, sometimes absent; pleuron dark, very densely and extensively scaled, scales largely whitish, broad but elongate, decumbent or semierect; upper caudal part of *apn* with erect bronzy scales, anterior and lower with whitish scales; *ppn* completely covered with scales, dark above, light below; *ppl, pst, acx, pcx* with numerous whitish scales; all of mesopleuron almost completely covered with whitish scales, including *psp* and *pra,* only lower anterior *stp* with bare spot and meron bare; metapleuron without scales; *apn* bristles 4–6 dark above and 6–10 lighter weaker hairs below; only 1 weak *ppn* bristle; 4–6 light *ppl* bristles; 2–5 *sp* bristles; *stp* with 6–8 light hairs below and occasionally 1–3 very weak hairs above; *pra* with 3–6 dark bristles; upper *mep* with 10–12 light hairs. *Legs:* all dark bronzy except for white-scaled coxae and trochanters and conspicuously light-scaled lower surface of all femora; lower surface of most segments lighter; hindtibia with rather strong bristles; hindleg with 2 minute claws. *Wing:* all dorsal scales broad; ventral plume scales broad on distal 0.25 of wing. *Haltere:* upper part of stem and knob dark-scaled. *Abdomen:* tergites dark-scaled above, with lateral whitish-scaled areas not visible from above; tergite I completely scaled; laterotergite light-scaled in mesal 0.5 or more; sternites with dingy white scales.

MALES (South Pacific species only).—Essentially as in the females. *Proboscis:* essentially similar. *Palpus:* of similar length and segmentation, segment 4 always present, better developed. *Antenna:* similar in length; flagellar whorls only slightly more dense and bristles not markedly longer; flagellar segments 12 and 13 elongate. *Legs:* claws of foreleg enlarged, anterior larger and toothed, posterior simple; claws of midleg not markedly enlarged or unequal, simple; claws of hindleg 2, minute as in the female.

MALE GENITALIA (South Pacific species only).—*Segment IX:* tergite very strongly developed, long; tergite lobe short, bristles short and heavy. *Sidepiece:* rather slender and conical; scales numerous; basal mesal lobe rather distinct, separated by short distal mesal membrane, with numerous thickened bristles and hairs. *Clasper:* very slender, curved; hairs very short, inconspicuous, sparse; spiniform short, inserted under terminal hood. *Phallosome:* aedeagus slender, more or less conical or even cylindrical, with a short broad dorsal postmedian arm, which forms a bridge, a long slender tergal apical arm, and a short broad sternal apical arm with 2,3 dorsal teeth; ventral paramere rather small, with a distinct process or arm; basal piece strongly developed. *Proctiger:* basal lateral sclerotization very strong and with long dorsal arm; paraproct strongly developed, apex with a single long dorsal tooth; 2–4 short cercal setae.

PUPAE (South Pacific species only).—*Cephalothorax:* hair 1-C long, single, and heavy; 2-9-C moderately developed. *Trumpet:* inserted much closer to wing base than middorsal line. *Abdomen:* dorsal sensillum present only on III,IV; hair 1-I moderately dendritic, with few primary branches; 2-III-VII removed from caudal margin but not far cephalad; 3-I,II longest and heaviest hair of respective segments; 3-VII short, not thickened; 6,7-I,II relatively poorly developed; 6-VII cephalad of hair 9; hair 9-IV-VI removed only short distance from caudolateral angle; 8-III-VII ventral; 7-II ventral. *Paddle:* midrib distinct; apex more or less produced.

LARVAE (South Pacific species only).—*Head:* hair 1-C rather slender, not markedly curved mesad; 14-C single, more or less thickened; 15-C cephalic. *Thorax:* spiracular sensilla poorly developed; hair 0-P short; 1-3-P removed from middorsal line; 5-7-P not on common tubercle; 13-14-P both mesal; 1-M single. *Abdomen:* spiracular sensilla poorly developed; hairs 6-I-II markedly differentiated, shorter than 6-III-V; hair 0-II-VII minute, far cephalad and usually not displaced laterad; 2-I-VII not displaced far cephalad from hair 1; 1,11-I-VII stellate, with spikelike branches; 5-I-VII short, not stellate; 9-I-VII short, single; 7-III-V short, multiple. *Segment VIII:* comb scales about 5–10, free portion of scale short, with median spine and basal denticles; hair 1-VIII dorsal; 2-VIII dorsad of comb; 3-5-VIII in median lateral group. *Siphon:* pecten teeth usually absent from basal 0.20; ventral hairs largely in a single line (1a-S) except for paired basal one (1-S); dorsal hairs (2a-S) paired; hair 8-S long, branched. *Anal Segment:* saddle small, with marginal spicules; hair 1-X on saddle; 4-X long, multiple, not on saddle; gills long, slender, tapered.

EGGS.—Unknown.

SYSTEMATICS.—The 3 South Pacific species are closely related and appear to be sufficiently similar to the *"filipes"* of Lee to be included in the same group. The group as conceived by Lee (1946:242) is rather heterogeneous, as it includes 2 species with a long male palpus. The larvae as described appear to be quite similar; unfortunately, none have been available for comparison with the South Pacific species, and therefore the above diagnosis may not apply outside this area.

The affinities of *mathesoni, stonei,* and *torokinae* are difficult to determine. They appear to be most similar to *"filipes"* of Lee but are amply distinct from it. *T. stonei* and *torokinae* are allopatric species which possess a unique character in the group, as far as is known, in the development of long bristles on the small apical segment of the male palpus.

BIONOMICS AND DISEASE RELATIONS.—The South Pacific species of the group breed in bamboo, treeholes, coconut shells and husks, artificial containers, and leaf axils of aroids and possibly pandanus. Elsewhere presumed members of the group also occur in *Nepenthes* pitchers.

The bionomics of the adults are unknown. Both sexes may be found resting in the breeding places or nearby on tree buttresses. An occasional female will attempt to bite during daylight hours. Members of this group are not attracted to light traps. It is very unlikely that the group is involved in disease transmission.

DISTRIBUTION (fig. 389).—As far as is known, the *filipes* group is found only in New Guinea, northern Australia, and the Solomons.

1. Tripteroides (Rachisoura) mathesoni Belkin

Figs. 389-391

1950. *Tripteroides* (*Rachisoura*) *mathesoni* Belkin, U.S. Natl. Mus., Proc. 100:219–228. *TYPE: holotype ♂ with associated larval and pupal skins (JNB, 260–12), Matanikau River valley, Guadalcanal, Solomon Islands, from leaf axil of taro, Mar. 13, 1944, L. J. Lipovsky and A. W. Barnes (USNM, 59086).

Tripteroides (*Rachisoura*) *mathesoni* of Iyengar (1955:24); Laird (1956); Stone, Knight, and Starcke (1959).

Tripteroides (*Rachisoura*) *filipes* in part of Edwards (1932:76); Taylor (1934:11); Lee (1944*a*:18; 1946:246).

Tripteroides filipes in part of Knight, Bohart, and Bohart (1944:22, 67).

Rachionotomyia (*Rachisoura*) *filipes* in part of Paine and Edwards (1929:305, 310–312).

FEMALE.—*Wing:* 3.33 mm. *Proboscis:* 2.67 mm. *Forefemur:* 2.42 mm. *Abdomen:* about 2.75 mm. Orbital light line very narrow; palpus about 0.20–0.25 of proboscis length, segment 4 extremely minute or absent, usually poorly or not at all articulated, without bristles; *apn* and *ppn* light-scaled usually only on lower third; 2 or more pairs of prescutellars usually present.

MALE.—Essentially as in the female; palpal segment 4 more distinct but without bristles on apex; anterior claw of foreleg with submedian tooth.

MALE GENITALIA (fig. 390).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with wide shallow median emargination approximately equal in width to one of the lateral tergal lobes; tergite lobe diagonally truncate mesad, with 12–14 or more strong bristles along apical margin, arranged in 2 irregular rows.

PUPA (fig. 390).—*Abdomen:* 4.07 mm. *Trumpet:* 0.4 mm. *Paddle:* 0.59 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly deep yellowish, mesonotum darkened; only hairs 1,8,9-C strongly pigmented. *Trumpet:* index about 3.5; uniformly darkly pigmented. *Abdomen:* segment I largely yellowish, remainder darker yellow with brownish infuscations on more proximal segments; large hairs very strongly pigmented, others concolorous with integument; hair 2-IV-VI distinctly mesad of hair 1. *Paddle:* uniformly clear yellowish; apex distinctly produced; without distinct apical or marginal spicules.

LARVA (fig. 391).—*Head:* 1.0 mm. *Siphon:* 0.65 mm. *Anal Saddle:* 0.28 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly light yellowish brown; hairs poorly pigmented except for 1,5,14-C; mental plate usually with 7,8 strong teeth on each side of median tooth; maxilla as figured; hair 14-C small. *Thorax:* tubercles and hairs moderately or lightly pigmented except for 1,5-P which are very dark; hair 1-T small, slender, not spikelike. *Abdomen:* tubercles, spikes, and larger hairs strongly pigmented; hair 2-II-VI small, not on common plate with hair 1; hairs 1,11 relatively poorly developed but with spikelike branches; 13-I-V small, weak, multiple. *Segment VIII:* comb of 6–11 scales. *Siphon:* index about 3.0–3.5; very heavily pigmented, usually black; pecten of 6–9 teeth usually absent from basal third. *Anal Segment:* saddle very heavily pigmented, usually black, with 4,5 spinelike large marginal spicules.

MATERIAL EXAMINED.—469 specimens; 134 ♀; 96 ♂; 88 pupae; 151 larvae; 8 individual larval rearings.

SYSTEMATICS.—*T. mathesoni* is readily distinguished from *stonei* and *torokinae* in the male, pupa, and larva, but the female is very difficult to separate from *stonei.* There is considerable individual variation in all stages of *mathesoni* but not in the diagnostic characters given above. The postnotal bristles are frequently absent and the prescutellar bristles quite variable. One female examined had well-developed scales on the anterior margin of the clypeus. The white scaling of the posterior pronotum is extremely variable and not infrequently is similar to that in *stonei* and *torokinae.* In the larvae, the most obvious variation is noticeable in the development of the maxillary spines and the size and pigmentation of the stellate tufts. Some specimens show stellate tufts almost twice as long as in others. The populations from New Georgia, Roviana, and Bougainville conform well with the typical populations from Guadalcanal.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *mathesoni* have been collected chiefly in the leaf axils of wild and cultivated aroids (probably *Colocasia* and *Alocasia*), often in association with *Uranotaenia quadrimaculata,* upon which the larvae prey. The larvae collected on Guadalcanal by L. J. Dumbleton (*in* Lee, 1946:246) in pandanus probably belong to this species. Large specimens of *mathesoni* are usually found singly or at most 3 or 4 per leaf axil. They appear to be strongly cannibalistic.

Adults are seldom seen in the field except around aroids, where they apparently rest. On several occasions females of *mathesoni* have been noticed flitting around collectors in the bush but have not been recorded biting humans. They have not been collected in light traps or in lighted quarters at night. In the laboratory females could not be induced to feed on humans.

DISTRIBUTION (fig. 389).—*Solomon Islands:* Bougainville; New Georgia; Roviana; Guadalcanal. Not known elsewhere.

2. Tripteroides (Rachisoura) stonei Belkin

Figs. 389, 392, 393

1950. *Tripteroides* (*Rachisoura*) *stonei* Belkin, U.S. Natl. Mus., Proc. 100:228–236. *TYPE: holotype ♂ with associated larval and pupal skins (JNB, 856-22), Poha River valley, Guadalcanal, Solomon Islands, from coconut shell, Feb. 7, 1944, J. J. Cuccio (USNM, 59087).

Tripteroides (*Rachisoura*) *stonei* of Iyengar (1955:24); Stone, Knight, and Starcke (1959).

Tripteroides (*Rachisoura*) *filipes* in part of Edwards (1932:76); Taylor (1934:11); Lee (1944*a*:18; 1946:246).

Tripteroides filipes in part of Knight, Bohart, and Bohart (1944:22, 67).

Rachionotomyia (*Rachisoura*) *filipes* in part of Paine and Edwards (1929:305, 310–312).

FEMALE.—*Wing:* 3.92 mm. *Proboscis:* 2.92 mm. *Forefemur:* 2.58 mm. *Abdomen:* about 2.9 mm. Palpus 0.20–0.25 of proboscis, segment 4 distinct and often with 1,2 pairs of slender apical bristles; *apn* and *ppn* light-scaled usually on at least lower half, often *ppn* almost completely whitish; 2 or more pairs of prescutellar bristles.

MALE.—Essentially as in the female; palpus longer, usually 0.25–0.27 (without bristles) of proboscis, segment 4 larger, directed mesad and with 4–8 long apical bristles; anterior claw of foreleg with tooth in apical third.

MALE GENITALIA (fig. 392).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with deep narrow median emargination, usually less than 0.5 of width of 1 of the lateral tergal lobes; tergite lobe apically truncate or slightly rounded, with 8–16 strong bristles, arranged in 2 irregular rows.

PUPA (fig. 392).—*Abdomen:* 4.05 mm. *Trumpet:* 0.42 mm. *Paddle:* 0.48 mm. Chaetotaxy as figured, all hairs strongly pigmented; diagnostic characters as in the key. *Cephalothorax:* dorsal surface and base of wing cases darkly pigmented, remainder light brown. *Trumpet:* index about 3.5; uniformly brightly darkly pigmented. *Metanotum:* darkened. *Abdomen:* pigmentation usually a very deep slightly yellowish chocolate brown, posterior segments lighter; hair 2-III-VII laterad of or in line with hair 1. *Paddle:* uniformly light brown, midrib dark; apex slightly produced, with distinct sharp spicules; inner margin with short spicules.

LARVA (fig. 393).—*Head:* 0.99 mm. *Siphon:* 0.61 mm. *Anal Saddle:* 0.25 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly light brown; hairs moderately pigmented, except for 14-C which is black; mental plate usually with 8 or more strong teeth on each side of median tooth; maxilla as figured; hair 14-C a large spike. *Thorax:* tubercles and hairs moderately or strongly pigmented, hairs 1,5-P and 1-T black; hair 1-T large, with heavy spikelike branches. *Abdomen:* tubercles and the heavier and larger hairs all very strongly pigmented, spike hairs blackish, all other hairs moderately to lightly pigmented; hairs 2-II-VI large single spikes arising from common basal plate with hair 1 or on separate one nearby; hairs 1,11 strongly developed; 13-I-V more or less stellate, with spikelike branches; 6-VI short, multiple. *Segment VIII:*

comb of 4–8 scales. *Siphon:* index usually 2.5 or less; moderately to strongly pigmented; pecten of 3–5 teeth, usually absent from basal half. *Anal Segment:* saddle very heavily pigmented, with 4,5 spinelike large marginal spicules.

MATERIAL EXAMINED.—673 specimens; 163 ♀; 116 ♂; 126 pupae; 268 larvae; 20 individual larval rearings.

SYSTEMATICS.—*T. stonei* is readily distinguished from *mathesoni* except in the female by the diagnostic characters given above. *T. stonei* and *T. torokinae* are an allopatric pair of species, well marked in the male and the female, but largely indistinguishable at present in the larval and pupal stages. It is possible that additional species exist in the *stonei-torokinae* complex, since considerable geographical variation has been noted, as indicated below.

As in *mathesoni,* there is a great deal of individual variation in *stonei.* In the adults the postnotal bristles are frequently absent, the spiraculars may be increased to 6, the upper sternopleurals are often absent, and the prescutellars may be increased to 4 pairs in the more vigorous individuals. Large specimens show a completely white-scaled posterior pronotum, but in smaller, weaker specimens the light scaling may cover slightly less than the lower half of the sclerite. The maxillary spines of the larva vary a great deal in size; frequently the small spines are considerably enlarged so that there is little difference between adjacent spines and little differentiation of the largest spine from the others.

T. stonei shows considerable geographical variation, at least in the female. All females from Arundel Island have 2 slender bristles on the apex of the palpus, but the males agree well with the Guadalcanal populations, where apical palpal bristles are very rarely found in the females. The New Georgia populations, on the other hand, are similar to the Guadalcanal populations in all stages. It is possible, therefore, that more than 1 species is confused under *stonei.* It would be necessary to study a large series of individual rearings to clarify this point.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *stonei* are commonly found in treeholes, bamboo stubble, and particularly coconut shells and husks and fallen spathes on the ground. They are also numerous in various artificial containers such as tin cans but have never been found in leaf axils of aroids. The prey of *stonei* larvae probably consists of any of the numerous species of mosquitoes that utilize similar breeding sites. A dozen or more larvae of *stonei* are usually found in one breeding site; they are never numerous enough to completely eliminate all their prey.

Adults are commonly seen in the field resting in coconut shells and on buttresses of large trees in swampy areas. An occasional specimen has been collected attempting to bite during the day. This species has never been collected in light traps, in lighted quarters, or in human dwellings.

DISTRIBUTION (fig. 389).—*Solomon Islands:* Arundel; New Georgia; Roviana; Rendova; Guadalcanal. Not known elsewhere.

3. Tripteroides (Rachisoura) torokinae Belkin

Figs. **389, 394, 395**

1950. *Tripteroides* (*Rachisoura*) *torokinae* Belkin, U.S. Natl. Mus., Proc. 100:236–240. *TYPE: holotype ♂ (ABG, 172), Torokina, Bougainville, Solomon Islands, from treehole, Feb. 3, 1944, A. B. Gurney (USNM, 59088).

Tripteroides (*Rachisoura*) *torokinae* of Iyengar (1955:24); Stone, Knight, and Starcke (1959).

FEMALE.—*Wing:* 3.5 mm. *Proboscis:* 2.5 mm. *Forefemur:* 2.5 mm. *Abdomen:* about 2.53 mm. Palpus about 0.17 of proboscis, segment 4 distinct, articulated, and with 2–4 strong apical bristles; *apn* and *ppn* light-scaled in at least lower half, often *ppn* almost completely whitish; prescutellar bristles usually absent, at most 1 weak pair.

MALE.—Essentially as in the female; palpus longer, about 0.23–0.25 (without bristles) of proboscis, segment 4 similar to but longer than in *stonei* and with a dense clump of 20–30 bristles which are more than 0.5 of palpus shaft; anterior claw of foreleg with tooth subapical.

MALE GENITALIA (fig. **394**).—As figured; diagnostic characters as in the key. *Segment IX:* tergite with a triangular median emargination, at its widest point less than 0.5 of width of one of the lobes; tergite lobe wide and short, diagonally truncate, with about 14 flattened expanded bristles with very fine curved ends and arranged in partial double row.

PUPA (fig. **394**).—*Abdomen:* 4.18 mm. *Trumpet:* 0.39 mm. *Paddle:* 0.58 mm. Chaetotaxy as figured; diagnostic characters as in the key; essentially similar to *stonei* except that pigmentation is usually lighter; hair 2-III-VII more mesal; paddle apex slightly more produced.

LARVA (fig. **395**).—*Head:* 0.89 mm. *Siphon:* 0.72 mm. *Anal Saddle:* 0.29 mm. Chaetotaxy as figured; diagnostic characters as in the key; very similar to *stonei,* apparently distinct in having hair 6-VI long and single, instead of short and at least double.

MATERIAL EXAMINED.—36 specimens; 20♀; 5♂; 6 pupae; 5 larvae; no individual rearings.

SYSTEMATICS.—*T. torokinae* resembles *stonei* quite closely and is its counterpart in the northern Solomons. It can be readily distinguished in the male and the female by the diagnostic characters given above. The larva and pupa, which are only provisionally associated with the adults, are extremely similar to those of *stonei* and cannot be separated with certainty from the latter since only a very small series of *torokinae* is available.

BIONOMICS AND DISEASE RELATIONS.—The immature stages of *torokinae* have been collected in treeholes in association with *T. binotatus* and *T. solomonis.* No information is available on the habits of the adults.

DISTRIBUTION (fig. **389**).—*Solomon Islands:* Bougainville; Sterling. Not known elsewhere.

TRIBE TOXORHYNCHITINI

Genus TOXORHYNCHITES Theobald

1827. *Megarhinus* Robineau-Desvoidy, Soc. d'Hist. Nat. de Paris, Mem. 3:403, 412. TYPE SPECIES: *Culex haemorrhoidalis* Fabricius, 1794, South America; monobasic.—Preoccupied by *Megarhinus* Rafinesque, 1820, manuscript name proposed in synonymy and available under Opinion 4, International Commision on Zoological Nomenclature. The status of *Megarrhinus, Megarhina,* and *Megarrhina* of authors has not been determined; it is possible that *Megarrhinus* and *Megarrhina* are available names, since they may be considered to be invalid emendations. Therefore these names must be suppressed by the International Commission if the current usage of *Toxorhynchites* for this taxon is to be maintained.

1901. *Toxorhynchites* Theobald, J. Trop. Med. 4:234, July 15, no included species; Monog. Culicidae 1:244–245, Nov. 23, *T. brevipalpis* Theobald, 1901, only species unquestionably referred to genus. *TYPE SPECIES: *T. brevipalpis* Theobald, 1901, Natal, Africa.—Validated, type species fixed, and *Toxorhynchites* Howard, June 1901 suppressed by the International Commission on Zoological Nomenclature, Opinion 548 (1959).

1906. *Worcesteria* Banks, Philippine J. Sci. 1:779. *TYPE SPECIES: *W. grata* Banks, 1906, Philippines; original designation.

1908. *Teromyia* Leicester, Kuala Lumpur Inst. Med. Res. Fed. Malay States, Studies 3(3):48, 49. *TYPE SPECIES: *T. acaudata* Leicester, 1908, Singapore; the first of 5 new species, selection of Brunetti (1914:72).

For complete synonymy, see Stone, Knight, and Starcke (1959).

FEMALES.—Very large, brilliantly colored mosquitoes with the distal portion of labium attenuate and usually sharply recurved caudad. *Head:* eye contiguous in front and below; vertex covered entirely with decumbent broad scales; a small number of erect scales on occiput; orbital bristles restricted to a few pairs dorsally; ventral surface of head capsule with numerous weak bristles; clypeus short and very broad, laterally overlying base of palpus; proboscis inserted into a small deep cavity of head capsule; labium long, thick and rigid at base, attenuate and flexible on distal portion which is usually sharply recurved caudad, with numerous weak subbasal bristles; labella long and very slender; palpus apparently 4-segmented (possibly 5-segmented), varied in length, apical segment sometimes reduced; antenna short, usually about 0.6 of proboscis; torus not greatly developed; flagellum with whorls sparse, long on basal segments and not developed on mesal surface; flagellar segment 1 markedly longer than segment 2 and with a patch of scales. *Thorax:* mesonotum moderately arched; scutellum not lobed and with a more or less continuous even row of marginal bristles; postnotum bare; paratergite very broad, always bare; *apn* lobes rather large and not very widely separated; *pra* not separated by suture from *stp;* meron small, its upper edge in line with base of hindcoxa; mesonotum with decumbent scales only, majority broad; scutellum with broad decumbent scales only; pleuron densely covered with broad decumbent scales on *apn, ppn, ppl, pst,* most of *stp* and continued to *pra,* and most of *mep;* bristles few and small in size; acrostichals, dorsocentrals, and prescutellars completely absent, mesonotum with bristles developed only on anterior promontory and antealar and supraalar lines; *apn* with anterior row of bristles; *ppn* bristles absent; a few *ppl* bristles; a row of short *sp* bristles; *psp* bristles absent; *stp* without usual upper and caudal line of bristles but with a few bristles near middle and in lower caudal angle; *pra* bristles well developed; *mep* with a caudal row of bristles from a distinct group of upper bristles, lower *mep* bristles present or absent. *Legs:* with distinct short heavy bristles; femora subequal, not swollen apically; tibiae subequal; foretarsal segment 4 about as long as or longer than 5; all claws short and simple; pulvilli not developed. *Wing:* very long and slender; wing membrane with distinct microtrichia; vein scales all short, broad and appressed, largely absent from posterior veins; cell R_2 extremely short, usually about 0.33 of vein R_{2+3}; vein Rs right-angled at base and with a short basal spur; vein R_{4+5} right-angled at base and with a long scaled basal spur which carries crossvein *r-m;* cross vein *m-cu* sharply angled; a sclerotized furrow in cell Cu_1 in front of vein Cu_2 leading distad to a submarginal angled thickening; plical vein strongly marked, without scales at base ventrally; vein 1A ending on margin distad of branching of Cu; vein R without dorsal remigial bristles; vein Sc without bristles ventrally at base; alula and upper calypter bare. *Abdomen:* tergites, sternites, and laterotergite completely scaled; bristles short, numerous but largely restricted to sides except on tergite I and genital segments; tip of abdomen truncate conical. *Buccopharyngeal Armature:* not developed.

FEMALE GENITALIA.—Not studied in detail; tergite VIII larger than sternite; cercus broad, flat; postgenital plate somewhat tapering; 3 equal spermathecae (Edwards, 1941:25).

MALES.—Essentially similar to the females. *Palpus:* always long; segments 4 and 5 turned up and laterad and without long hairs; segment 5 very long and slender. *Antenna:* about the same length as in the females; torus not greatly enlarged; flagellar whorls dense; flagellar segments 12 and 13 elongate, segment 12 with large basal whorl of bristles, segment 13 with a few bristles. *Legs:* claws of foreleg and midleg enlarged, unequal, the larger with a tooth.

MALE GENITALIA.—Rather small and inconspicuous. *Segment VIII:* long and narrow, partially retracted into segment VII and containing retracted genitalia. *Segment IX:* well developed; tergite produced in the middle and truncate or emarginate apically, its lobes not strongly developed but with bristles; sternite long and without bristles. *Sidepiece:* short and slender; with numerous bristles and scales; a distinct basal mesal lobe with thickened bristles; an unsclerotized mesal strip from basal mesal lobe to point of insertion of clasper. *Claspette:* represented by basal mesal lobe. *Clasper:* usually long and narrow and with 1 simple spiniform. *Phallosome:* relatively simple; aedeagus long, swollen at base, and produced as a narrow process with a few short recurved teeth distally, usually with a narrow submedian dorsal bridge; ventral paramere complex. *Proctiger:* very prominent, long, conical; with strongly sclerotized long slender paraproct; cercal setae few in number, subapical.

PUPAE.—*Cephalothorax:* middorsal ridge moderate; all hairs present; hair 1-C very strongly developed, single; 2,3-C close together toward midventral line; 6,7-C far forward close to 4,5-C; 8,9-C close together, well caudad of trumpet. *Trumpet:* not placed on distinct tubercle; widely spaced, nearer wing base than middorsal line; tracheoid and slit not developed. *Abdomen:* dorsal sensillum on III,IV only (Old World species); hair 1-I dendritic; all normal hairs present; hair 9-II-VII small, ventral in position, removed from caudolateral angle; 9-VIII at caudolateral angle, small; hair 6 strongly developed at least on VI, single or with few branches, inserted in a depressed area, in Old World species hair 6 also very long on II-V and in a depression; 8-VI,VII dorsal, cephalad of hair 6; 5-III-VI long, usually single. *Terminal Segments:* hair 1-IX distinct, bristlelike but short; 1-X strongly developed; female cercal lobe short, slightly projecting. *Paddle:* relatively broad; external buttress more or less distinct; midrib dividing paddle unevenly, outer part wider than inner; a distinct apical emargination or truncation; margins with more or less distinct spicules; hairs 1,2-P both absent.

LARVAE.—Very large, purplish or reddish in color in life. *Head:* rectangular, usually a little wider than long; dorsal portion cephalad of antennae very short; ventral surface of head capsule very long; posterior tentorial pit far cephalad of caudal border; maxillary suture poorly developed, not reaching posterior tentorial pit; cephalic border of labial plate produced in center and with short fine spicules; aulaeum apparently with short spines; mental plate short and very broad, teeth irregular and strongly developed; only about 10 mouthbrush filaments on each side, arising from strongly protruding lobe, each filament strongly flattened and without serrations or spicules; hair 1-C relatively long, not on tubercle; 0-C well developed; 2-C absent; 3-C relatively strongly developed; 4-C near 1-C; hairs 5-8-C in a row removed from others; 11-13-C in lateral cephalic groups; 14,15-C far cephalad but not on anterior border; hairs 16,17-C apparently not developed. *Antenna:* simple, cylindrical; without spicules; less than 0.5 of head length; hair 1-A inserted beyond 0.5, branched; 2,3-A inserted basad of hair 1. *Thorax:* spiracular sensilla distinct; notched organ not developed; hairs 8-12-P,M,T on large common tubercles, 9 single spikelike and barbed, 8 short multiple; 1-3-P on common tubercle; 5-7-P on large common tubercle, spikelike and strongly barbed; 13-P not developed; 13-M,T on large turbercle, spikelike and barbed; 1,2-M on small common tubercle; 3-7-M on large common tubercle or 3,4-M on separate tubercle, 6-M spikelike and barbed; 1-T single, on small tubercle; 3,4-T on small common tubercle; 6,7-T spikelike, barbed, on large separate tubercles. *Abdomen:* spiracular and dorsal sensilla distinct, latter on III,IV only (Old World species); tergites without sclerotizations other than those at base of hairs and around spiracular sensilla; none of the hairs palmate or plumose; hairs 1,3-5 (and sometimes 2) on common tubercle on segments I-VII; 6,7,9 on common tubercle on segments I-IV and 6–9 on V-VII; 10–13 on common tubercle on segments I-VII, sometimes tubercle divided, particularly on segment I; smaller branched hairs with long basal stem and distal brush; hairs 1,3,4,11,13 usually single or double, spikelike or thickened and barbed; hairs 6,7-I-VI,7-VII usually double or single, more or less thickened and barbed. *Segment VIII:* comb completely absent; hairs 2-5-VIII and sometimes 1-VIII arising from a large sclerotized lateral plate; 4,5-VIII usually thickened and barbed. *Siphon:* short, without acus; pecten completely absent; hair 1-S in basal 0.5; no accessory 1a-S hairs; 2-S small, single, no accessory hairs (2a-S); valves short; trachea well developed. *Anal Segment:* saddle always complete, without acus; strongly irregularly emarginate ventrally at base but not markedly for ventral brush; caudal margin with long spicules; median dorsal caudal process not developed; hair 1-X on saddle margin; dorsal brush with both hairs branched from base, simple; ventral brush with 9,10 pairs of single, strongly fringed hairs on a grid which is joined to saddle on midventral line; accessory saddle hairs not developed; gills very short, globose.

EGGS.—Laid singly, usually on water surface.

SYSTEMATICS.—The tribe Toxorhynchitini consists of the single genus *Toxorhynchites.* The distinctness of this genus has long been recognized and it has been customary to separate it as a primary division of the culicines equivalent to all the others combined. I believe that this overemphasizes the peculiarities of the genus and therefore regard it instead as constituting 1 of the 12 tribes of the Culicinae.

The most distinctive features of *Toxorhynchites* are secondary adaptive characters related in the adult and the larva to the large size and the feeding habits. The genus is unique in the development of the proboscis and its insertion in the head capsule. It shares with most of the Anophelini the unlobed condition of the scutellum. In several respects the adults resemble the Sabethini, particularly in scaling, in the reduction of thoracic bristles and the lack of scales on the alula and upper calypter, and in the male genitalia. The peculiar secondary sclerotizations of the wing membrane may be associated with the large size. The larva is not as different from other culicines as is generally regarded; its chaetotaxy, although peculiar on the head, is everywhere easily homologized with that of the other tribes. Even the absence of the comb and the development of large common tubercles at the base of many hairs, including 1 on segment VIII, is paralleled in *Trichoprosopon,* as well as in some other sabethines. The pupa appears to be unique in the development of hair 1-X on the cercal lobe, but it shows a number of similarities with the sabethines in the complete absence of a tracheoid in the trumpet, position of hairs 2,3-C, and the absence of both paddle hairs. It is of interest to note that hair 1-X is usually represented by an alveolus or minute hair in *Culiseta* and has been reported as an anomaly in *Aedes* (*O.*) *monticola* Belkin & McDonald, 1959.

Although superficially the genus appears to be very compact in all stages, 3 well marked sections are evident and should be recognized as subgenera: *Ankylorhynchus* Lutz, 1904 and *Lynchiella* Lahille, 1904, confined to the New World, and *Toxorhynchites,* restricted to the Old World.

While the numerous similarities between *Toxorhynchites* and the sabethines may all be owing to convergence, I believe that this is not true and suggest that they are indicative of a rather close relationship. The largest number of species are found in the Indomalayan area, but all of these conform to 1 type. Of the more than 50 described species, only some 22 are found in the New World; these are more diversified and at the same time appear to have retained more primitive characters.

BIONOMICS AND ECONOMIC IMPORTANCE.—The immature stages of *Toxorhynchites* are normally found only in water accumulations in living or dead plants. Several species breed in treeholes and are frequently found in artificial containers. Other species have been reported from bamboo, from leaf axils of bromeliads, bananas, *Strelitzia,* and *Dracaena,* and from pitchers of *Nepenthes.* The larvae are predaceous, feed chiefly on mosquito larvae of other species, and are often strongly cannibalistic when confined in a small breeding site. Both the larvae and the pupae are enormous in size in comparison with other mosquitoes. In most species the larvae are reddish, pinkish, or purplish in color. The aquatic cycle may be completed in less than 2 weeks with ample food supply or may be prolonged for several months.

The adults are diurnal in feeding and mating activities. Females and males both feed on flower nectar, probably on other plant exudations, and possibly on decaying fruits. Females never take blood. Mating is said to take place in flight with the pair joined end to end (Muspratt, 1951:358); swarming apparently does not occur. Most species are strictly sylvan and seldom venture far from their breeding sites.

Since *Toxorhynchites* females are entirely vegetarian, they cannot be involved in the transmission of disease. Three species (*brevipalpis, inornatus,* and *splendens*) have been used to a limited degree in the control of economically important mosquitoes breeding in treeholes, artificial containers, and small water accumulations in plant material. Only a limited success has been obtained to date because of the tendency of the introduced populations of *Toxorhynchites* to die out after a short time. It appears also that, even when established, these mosquitoes may not play a very important part in reducing the populations of an adaptable native host species, as seems to have been true with *splendens* in Fiji.

DISTRIBUTION (fig. 396).—*Toxorhynchites* is largely confined to the tropical regions. It is absent from New Zealand, New Caledonia, the smaller continental islands, and all oceanic islands. It is not indigenous in the South Pacific area but may be represented there by 3 introduced species in Fiji and Samoa. All of these are members of the subgenus *Toxorhynchites,* which occurs only in the Old World. The subgenera *Ankylorhynchus* and *Lynchiella* are confined to the New World.

KEYS TO SPECIES

(Keys to tribes, pp. 118–122)

FEMALES

1. First foretarsal segment entirely or largely dark-scaled . . . . 1. *brevipalpis*
First foretarsal segment largely or completely light-scaled 2
2(1). Lateral scale tuft of abdominal segment VI largely yellow . . . . 2. *splendens*
Lateral scale tuft of abdominal segment VI largely white . . . . 3. *inornatus*

MALES

1. First flagellar segment with dark scales only . . . . 1. *brevipalpis*
First flagellar segment with dense patch of light scales on mesal surface 2
2(1). Lateral scale tuft of abdominal segment VI large, predominantly dark; abdominal tergite V with a pair of conspicuous dorsal sublateral yellowish spots . . . . . . 2. *splendens*
Lateral scale tuft of abdominal segment VI small, about half white and half black; abdominal tergite V without dorsolateral yellowish spots . . . . 3. *inornatus*

MALE GENITALIA

1. Aedeagus with a distinct strongly sclerotized narrow dorsal bridge . . . . . . 1. *brevipalpis*
Aedeagus without a distinct strongly sclerotized narrow dorsal bridge 2
2(1). Apex of aedeagus very narrow and strongly sclerotized laterally . . . . 2. *splendens*
Apex of aedeagus broader and poorly sclerotized laterally . . . . 3. *inornatus*

PUPAE

1. Hair 6-VII single . . . . 1. *brevipalpis*
Hair 6-VII usually branched 2
2(1). Hair 1-III single . . . . 2. *splendens*
Hair 1-III usually branched . . . . 3. *inornatus*

LARVAE

1. Hair 10-P,M,T thickened and strongly barbed; 4-I usually single; 2-II-VI usually attached to large dorsal plate . . . . 3. *inornatus*
Hair 10-P,M,T, not markedly thickened; 4-I usually double; 2-II-VI free from large dorsal plate 2
2(1). Hair 11-IV,V usually 3,4b . . . . . 2. *splendens*
Hair 11-IV,V usually single or double . . . . 1. *brevipalpis*

1. Toxorhynchites (Toxorhynchites) brevipalpis Theobald

Figs. 396-398

1901. *Toxorhynchites brevipalpis* Theobald, Monog. Culicidae 1:245–246. *TYPES: syntypes, 2 ♀, Natal, Africa (BMNH).
For synonymy, see Stone, Knight, and Starcke (1959).

Toxorhynchites brevipalpis of Laird (1956); Peterson (1956).

FEMALE.—*Wing:* 6.25 mm. *Proboscis:* 6.75 mm. *Forefemur:* 4.75 mm. *Abdomen:* about 5.0 mm. *Head:* integument uniformly black; scaling of vertex predominantly bluish or greenish and with indistinct narrow light orbital line; labium bluish purple; palpus about 0.25 of proboscis, apparently 4-segmented and with only 2 long segments, bluish purple; antennal torus with a few translucent scales above; scales of flagellar segment 1 all dark. *Thorax:* integument uniformly black; mesonotum except the lateral areas with small rather narrow greenish scales; sides of mesonotum, *apn*, and *ppn* with much larger broader predominantly bluish and purplish scales, a few whitish scales at lower end of patch of bluish scales on *ppn;* scutellum with greenish and bluish scales, bronzy laterad; remaining pleural, coxal and prosternal scales silvery white; lower part of *ppn* against *stp* sometimes with streak of scales; upper part of postcoxal membrane sometimes with scales; 1 small anterior upper *mep* bristle; 1,2 strong lower *mep* bristles; *stp* with several rather long white hairs in central part. *Legs:* purplish blue; femora whitish below; foretarsal segment 1 at most with narrow white basal ring, segment 2 white except for narrow apical dark ring; midtarsal segment 1 with broad basal white ring, segment 2 white on about basal 0.5; hindtarsal segment 1 sometimes with a few white scales, segment 2 white usually on at least basal 0.5; remainder of legs dark-scaled. *Abdomen:* integument black; tergite I with greenish blue scales in center, white laterad; laterotergite white-scaled; tergites II-VIII dorsally with blue scales usually purplish, sometimes greenish or reddish, a lateral patch of appressed white scales on II,III,V,VI, sometimes a very narrow white-scaled line on IV; tergite VI with caudolateral tuft of long narrow outstanding scales nearly all white; tergite VII with black caudolateral tuft; tergite VIII with orange caudolateral tuft; sternites largely with purplish blue scales, sternites V,VI each with 1 pair of lateral triangular white-scaled patches.

MALE.—Generally similar to the female. *Palpus:* slightly longer than proboscis; segment 2 with submedian and apical patches of light scales; segment 3 with subbasal and preapical patches of light scales. *Antenna:* torus without scales; flagellar segment 1 with larger patch of dark scales. *Legs:* foretarsus with segment 1 usually entirely dark, segment 2 usually with white scaling restricted to basal 0.5 and incomplete; midtarsus and hindtarsus with white scaling more restricted. *Abdomen:* tergite IV with larger lateral white patch; tergite VII with distinct lateral white patch; caudolateral scale tufts of tergites VI-VIII more conspicuous.

MALE GENITALIA (fig. 397).—As figured; diagnostic characters as in the key. *Segment IX:* tergite truncate apically, at most slightly emarginate and without distinctly separated lateral tergal lobes but with bristles arranged in 2 lateral groups. *Sidepiece:* bristles long; scales very numerous laterally and ventrally; basal mesal lobe with numerous bristles and 2,3 larger differentiated apical bristles. *Clasper:* about 0.9 of sidepiece length; very slender; uniform in width except for slight basal swelling; with numerous short bristles beyond basal 0.2; spiniform long. *Phallosome:* aedeagus very narrow and strongly sclerotized apically, without denticles, a conspicuous strongly sclerotized narrow dorsal submedian bridge.

PUPA (fig. 397).—*Abdomen:* 6.5 mm. *Trumpet:* 1.03 mm. *Paddle:* 1.58 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly strongly pigmented, darker caudad middorsally; hairs largely concolorous with integument, 1-C distinctly darker. *Trumpet:* bright orange brown, very dark at base. *Abdomen:* strongly pigmented, darker on anterior segments; larger hairs blackish and contrasting sharply with integument; hair 1-III-V long and single; 5-III-VII long and single; 6-I-VII long and single, those on V-VII usually longer. *Paddle:* rather uniformly strongly pigmented, midrib bright light orange brown; distal 0.5 of outer and inner margins with numerous long fine spicules.

LARVA (fig. 398).—*Head:* 1.5 mm. *Siphon:* 0.95 mm. *Anal Saddle:* 0.95 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly darkly pigmented. *Antenna:* uniformly light orange brown. *Thorax:* hair 7-P,T double; 10-P not markedly thickened; 3-7-M on common plate; 13-M double; 10-M not markedly thickened; 10-T not markedly thickened. *Abdomen:* hair 2-I-VI not on common plate with hairs 1,3-5; 4-I usually double; 7-I-IV usually double; plate of 10-13-I tending to be split into 2 separate plates. *Segment VIII:* hair 1-VIII distinctly separate from large plate and without large basal tubercle. *Siphon:* index about 1.5–1.75; uniformly very darkly pigmented; hair 1-S very variable in branching, 2-5b. *Anal Segment:* rather uniformly strongly pigmented, somewhat lighter than siphon; caudal marginal spicules alternately long and short; ventral brush with 9 pairs of hairs.

MATERIAL EXAMINED.—40 specimens; 10 ♀; 10 ♂; 10 pupae; 10 larvae; no individual rearings.

SYSTEMATICS.—This is a variable species which appears to be represented by 2 or more geographical races in Africa. The form introduced into Hawaii and Samoa is the typical race.

BIONOMICS.—*T. brevipalpis* is a treehole-breeder and is frequently found in larger artificial containers and less frequently in small ones, such as tin cans and pots. In suitable breeding sites, the immature stages may be found in considerable numbers. The larvae do not appear to be as cannibalistic as those of other species.

DISTRIBUTION (fig. 396).—Widespread in Ethiopian region and reported from Madagascar. Introduced into *Hawaii* (Bonnet and Hu, 1951) and from there to *Samoa:* Tutuila (Peterson, 1956).

2. Toxorhynchites (Toxorhynchites) splendens (Wiedemann)

Figs. 396, 399, 400

1819. *Culex splendens* Wiedemann, Zool. Mag. 1(3):2. TYPES: syntypes, ♀ (?), Java (VIENNA, *fide* Barraud, 1934:24; VIENNA, COPEN, *fide* Stone, Knight, and Starcke, 1959).

For synonymy, see Stone, Knight, and Starcke (1959).

Toxorhynchites (*T.*) *splendens* of Stone, Knight, and Starcke (1959).
Toxorhynchites splendens of Iyengar (1955:23); Laird (1956); Peterson (1956).
Mergarhinus splendens of Paine (1934, 1935, 1943:30), Lee (1944*a*:15).
Megarhinus splendens splendens of Knight, Bohart, and Bohart (1944:12, 66).

FEMALE.—*Wing:* 7.2 mm. *Proboscis:* 7.5 mm. *Forefemur:* 5.25 mm. *Abdomen:* about 5.5 mm. *Head:* integument dark brown or blackish; scaling of vertex predominantly bluish or greenish and with an indistinct narrow light orbital line; labium bluish purple; palpus about 0.25 of proboscis, apparently 4-segmented and with only 2 long segments, bluish purple; antennal torus with a large conspicuous dense patch of silvery scales; scales of flagellar segment 1 light and translucent. *Thorax:* integument very dark brown or blackish; mesonotum densely covered with rather dull bronzy scales with bluish green tinge, scales only slightly narrower and smaller on disc than on sides, larger and more distinctly blue or bright bronzy in front, above wing root, on scutellum, and on area immediately cephalad of latter; *apn* with distinctly bluish scales; *ppn* with scales largely silvery but with a bluish or bronzy tinge above; other pleural scales and coxal scales silvery but with a slight yellowish tinge; postcoxal scale patch distinct; lower part of *ppn* against *stp* without scales; *stp* with numerous scattered long white hairs; usually 2 strong anterior upper *mep* bristles and 1 strong lower *mep* bristle. *Legs:* general coloration purplish with bronzy or bluish tinge; forefemur and midfemur pale golden ventrally and posteriorly; hindfemur largely pale golden, except dorsocaudad; foretibia and hindtibia largely dark, foretibia pale golden posteriorly; midtibia largely golden except at base and apex; tarsi variable; foretarsal segments 3–5 dark, segment 1 dark at base and remainder white or with apical dark ring, segment 2 white in basal 0.5; midtarsus usually extensively white but extremely variable, segment 1 white in basal 0.5 but with a dark dorsal patch at base, segments 2 and 3 usually largely white but often with apical dark ring, segment 4 white at base, remainder dark; hindtarsus with segment 2 white in basal 0.5 or more, remainder usually dark. *Abdomen:* tergites largely bluish or greenish; tergite I dark in center, yellowish laterally; laterotergite silvery; tergites II,III,V with lateral yellowish patches visible dorsally, larger on III and V; tergite IV with smaller lateral yellow line; tergite VI with sublateral incomplete diagonal yellow line; lateral scale tuft of segment VI largely orange yellow followed by dark brown, that of VII dark brown or black, of VIII orange yellow; sternites II,III,V,VI mainly yellowish with median purplish line; sternites IV,VII,VIII with median purplish area more extensive and predominating.

MALE.—Generally similar to the female. *Palpus:* slightly longer than proboscis; segments 2 and 3 with variable patches of light scales dorsally and laterally. *Antenna:* torus without scales; flagellar segment 1 with a larger patch of scales, light on mesal surface, darker dorsally. *Legs:* tibiae all dark; tarsi usually all dark or with very indistinct light scaling at or near base of segments 1 and 2. *Abdomen:* lateral scale tufts larger and more conspicuous, that of VI largely dark.

MALE GENITALIA (fig. 399).—As figured; extremely similar to *brevipalpis*, apparently differing only in the absence of a distinct narrow dorsal sclerotized bridge on the aedeagus; clasper hairs shorter and apparently restricted to distal half.

PUPA (fig. 399).—*Abdomen:* 6.62 mm. *Trumpet:* 1.2 mm. *Paddle:* 1.85 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly strongly pigmented, darker caudad middorsally; hairs largely concolorous with integument, 1-C darker. *Trumpet:* dark orange brown, lighter distad. *Abdomen:* uniformly very strongly pigmented a bright brown; larger hairs darker than integument; hair 1-III-V long and single; 5-II-VII long and single; 6-I-VI long, subequal, usually single, rarely branched or very strongly barbed; 6-VII usually with several branches, rarely single. *Paddle:* uniformly strongly pigmented, midrib brighter and darker; distal 0.5 of outer and inner margins with numerous long fine spicules.

LARVA (fig. 400).—*Head:* 1.7 mm. *Siphon:* 1.15 mm. *Anal Saddle:* 1.0 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly darkly pigmented. *Antenna:* concolorous with head capsule or slightly darker. *Thorax:* hairs, tubercles, and plates strongly pigmented; hair 7-P,T double; 10-P,M,T not markedly thickened; 13-M double; 3-7-M on common plate. *Abdomen:* hairs, tubercles, and plates strongly pigmented; hair 2-I-VI usually not on common tubercle of 1,3-5; hair 4-I double; 3-II-V often double; 7-I-IV usually double; 11-I on separate plate from that of 10-13-I; 11-IV,V often 3,4b. *Segment VIII:* hair 1-VIII distinctly separate from large plate and without large basal tubercle. *Siphon:* index about 2.0; uniformly very darkly pigmented, blackish; hair 1-S usually 3-5b. *Anal Segment:* uniformly darkly pigmented; caudal marginal spicules irregularly alternating short and long except near hair 1-X where the 2 lengths are usually in separate groups; ventral brush with 9 pairs of hairs, rarely 1 or more of these branched near base.

MATERIAL EXAMINED.—54 specimens; 8 ♀; 14 ♂; 21 pupae; 11 larvae; 3 individual larval rearings.

SYSTEMATICS.—*T. splendens* has never been thoroughly studied. The typical form from Java appears to differ in numerous details from other populations identified as "*splendens*" from as far away as the Himalayan foothills, Ceylon, Philippines, and New Guinea. It is very likely that several distinct species or subspecies are confused under this name at the present.

Typical *splendens* is quite distinct from *inornatus* in all stages, particularly in the larva. On the other hand, *splendens* larvae are remarkably similar to the African *brevipalpis* in the general body chaetotaxy.

BIONOMICS.—Paine (1934) gives extensive notes on the bionomics of *splendens* in Java and on the colonization of this species in Fiji. Typical *splendens* from Java is predominantly a breeder in treeholes and bamboo stumps and invades artificial containers quite readily.

DISTRIBUTION (fig. **396**).—*Indonesia:* Java (typical form). Also reported from *India, Ceylon, Assam, Burma, Andamans, Malaya, Thailand, Indochina, Yunnan, Hongkong, Philippines, Indonesia,* and *New Guinea* (Barraud, 1934:27–28; Knight, Bohart, and Bohart, 1944:66; Horsfall, 1955:314). *South Pacific:* typical form introduced in 1931 and 1933 (Paine, 1934), possibly established in a few localities; last recovery reported by Lever (*in* Paine 1943:31) from Mango; apparently recovered by Symes (1959). *Fiji:* Vanua Levu; Ovalau; Viti Levu; Rambi; Taveuni; Makongai; Lauthala; Vanua Mbalavu; Mango; Naingani; Ono; Kandavu (all Paine, 1934). *Rotuma Island* (Paine, 1934). *Samoa:* Tutuila (Peterson, 1956).

3. Toxorhynchites (Toxorhynchites) inornatus (Walker)

Figs. **396, 401, 402**

1865. *Megarhina inornata* Walker, Linn. Soc. London, J. Proc. Zool. 8:102–103.
*TYPE: holotype ♂, New Guinea (BMNH).

Toxorhynchites (*T.*) *inornatus* of Stone, Knight, and Starcke (1959).
Toxorhynchites inornatus of Iyengar (1955:22); Laird (1956).
Megarhinus inornatus of Edwards (1923*a*:5–6; 1924:356; 1932:61); Paine (1934, 1935, 1943:9); Lee (1944*a*:15), Knight, Bohart, and Bohart (1944:12, 66).

FEMALE.—*Wing:* 6.6 mm. *Proboscis:* 7.2 mm. *Forefemur:* 5.3 mm. *Abdomen:* about 6.0 mm. In general very similar to *splendens* and differing as follows. *Thorax:* mesonotal scaling more strongly metallic and more greenish, particularly on the sides; *ppn* largely bluish green, only a few white scales below. *Legs:* hindtibia pale below and in front; hindtarsal segment 1 with a broad basal white ring. *Abdomen:* basal abdominal tergites greenish, distal bluish; light areas smaller and less distinctly yellow, usually only tergite V with large lateral spots visible from above; lateral scale tuft of segment VI largely white followed by a few black scales; light scaling of sternites with only a faint yellowish tinge, sternite IV almost completely dark.

MALE.—Generally similar to the female. *Palpus:* distinctly longer than proboscis; segment 2 with subapical ventrolateral light patch, segment 3 with similar but more extensive submedian light patch. *Antenna:* torus without scales; flagellar segment 1 with larger scale patch, light on mesal surface, dark dorsally. *Legs:* tibiae all dark; foretarsus all dark except sometimes for indistinct subbasal long dorsal light patch on segment 1; midtarsus all dark except for broad basal white rings on segments 1 and 2; hindtarsus dark except for variable basal white ring on segment 2 and sometimes on segment 1. *Abdomen:* tergites all more strongly bluish, purplish caudad, lateral light spots not apparent from above; lateral scale tufts larger and more conspicuous, that of VI about half white and half black.

MALE GENITALIA (fig. **401**).—As figured; extremely similar to *splendens;* apparently differing in the broader and poorly sclerotized apex of aedeagus; clasper hairs more numerous, essentially as in *brevipalpis* but shorter.

PUPA (fig. **401**).—*Abdomen:* 7.9 mm. *Trumpet:* 1.3 mm. *Paddle:* 1.7 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Cephalothorax:* uniformly strongly pigmented, darker caudad middorsally; hairs largely concolorous with integument, 1-C darker. *Trumpet:* dark orange brown, lighter distad; very strongly oblique apically. *Abdomen:* uniformly darkly pigmented; larger hairs darker than integument; hair 1-III usually 3-5b; 1-IV,V single; 5-III-VII long, single; 6-I-VI long, subequal, usually single; 6-VII usually 3-branched. *Paddle:* uniformly strongly pigmented, midrib brighter and darker; distal 0.3 of outer and inner margins with numerous long fine spicules.

LARVA (fig. **402**).—*Head:* 1.7 mm. *Siphon:* 1.15 mm. *Anal Saddle:* 1.07 mm. Chaetotaxy as figured; diagnostic characters as in the key. *Head:* uniformly darkly pigmented. *Thorax:* hairs, tubercles, and plates strongly pigmented; hair 7-P usually single, 7-T double; 10-P,M,T strongly thickened and barbed; 13-M double; 3-7-M on common plate. *Abdomen:* hairs, tubercles, and plates strongly pigmented; hair 2-I-VI usually attached to common plate of 1,3-5 or very close to it; 4-I usually single; 3-I-V single or double; 7-I-IV usually double; 11-I on common plate with 10-13-I; 11-IV,V usually single. *Segment VIII:* hair 1-VIII with a large separate basal tubercle near the large plate. *Siphon:* index about 2.0–2.25; uniformly darkly pigmented; hair 1-S variable, 3-5b. *Anal Segment:* saddle uniformly darkly pigmented; caudal marginal spicules irregularly alternating short and long except near hair 1-X where the 2 lengths are in separate groups; ventral brush with 9 pairs of hairs.

MATERIAL EXAMINED.—18 specimens; 2 ♀; 3 ♂; 11 pupae; 3 larvae; no individual rearings.

SYSTEMATICS.—The material from Rabaul and Fiji which I am referring to this species appears to agree quite well with Edwards' concept of *inornatus*, which was described from New Guinea (Edwards, 1923*a*:5–6). This species is quite distinct from *splendens* in all stages, particularly in the larva. There is no indication that it hybridized with *splendens* on Fiji (Paine, 1934:3).

BIONOMICS.—Laird (1947:455–458) has made some observations on the bionomics of *inornatus* on New Britain. The immature stages have been found in treeholes, coconut husks, and artificial containers, often in association with *Armigeres lacuum* Edwards, 1922.

DISTRIBUTION(fig. **396**).—*New Guinea* (typical form). Also reported from *New Britain, Queensland, Buru* (Edwards, 1932:61). Introduced unsuccessfully into *Hawaii* (Swezey, 1931). *South Pacific:* introduced from New Britain to Fiji by Paine (1934:3), possibly established in a few localities; apparently recovered by Symes (1959). *Fiji:* Vanua Mbalava; Taveuni. The records from Ellice Islands (Rainbow, 1897; Stone, Knight, and Starcke, 1959) are erroneous.

SUBFAMILY CHAOBORINAE
The Carnivorous or Phantom Midges

ADULTS.—Mouthparts not developed into a proboscis; head and legs never with broad flat scales; thorax, legs, wing, and sometimes abdomen with some narrow hairlike scales, wing fringe with broader, striated scales; integument weakly spiculate. *Head:* eyes above antennae from widely separated to closely approximated, inner anterior margin always at least slightly emarginate, usually distinctly so; vertex and occiput usually with numerous hairs or bristles of varying sizes; clypeus variable, usually with numerous hairs; mouthparts short, not developed into proboscis; maxillary palpus as in Dixinae; antenna with scape poorly to moderately well developed; torus moderately to strongly swollen, in males with basal flagellar segment deeply inserted into it; flagellum normally 13-segmented (reduced in some *Chaoborus*), with differentiated whorls of bristles in both sexes, usually strongly plumose in males. *Thorax:* anterior pronotal lobes (*apn*) from very broadly to narrowly connected; prealar sclerite more or less distinctly separated from sternopleuron; meron usually distinctly separated; scutellum evenly rounded, without lateral lobes; mesonotal bristles numerous and strongly developed; pleural bristles variable; upper anterior part of mesospiracular depression without sense organ. *Legs:* femora, tibiae, and tarsi with very numerous bristles of varying size, with or without narrow hairlike scales; tibiae with or without small "spurs"; hindtibia not distinctly swollen, tibial combs sometimes developed; claws with or without spicules or hairs at base, teeth present or absent in both sexes; pulvilli present and well developed or reduced or even absent. *Wing:* membrane with uniform microtrichia, either distinct or very small; veins with long hairlike scales; posterior border of wing with fringe scales of 3 or 4 lengths; alula with similar fringe; upper calypter always fringed, lower variable; costal margin as strong basad of crossvein *h* as distad of it; Sc connected to R by prearculus and by a more or less distinct and incomplete sclerotization before separation of Rs from R_1; Sc ending on C distinctly beyond separation of Rs from R_1; Rs curved at base then longitudinal, with or without a longitudinal basal spur; R_{2+3} in line with Rs, not distinctly arched, always branched; R_{4+5} more or less transverse at base, apparently always without basal spur. *Haltere:* generally as in Dixinae but usually shorter and with bristles reduced. *Abdomen:* tergites and sternites with numerous bristles, some very long; tergites sometimes with some hairlike scales; spiracles apparently variable in number. *Sexual Dimorphism:* usually very marked; palpus similar in the 2 sexes; males usually with strongly plumose flagellum and very large torus.

FEMALE GENITALIA.—*Segment VIII:* well developed; usually without special features. *Segment IX:* tergite well developed, without lateral lobes but with numerous bristles; sternite developed as the posterior cowl, usually with distinct lateral enlargement at articulation with tergite. *Genital Atrium:* simple; no ventral sclerotizations between sternite VIII and cowl. *Proctiger:* weakly developed, tergal and sternal sclerotizations weak; sternite truncate or emarginate apically; cercus well developed, projecting strongly beyond tergite, with numerous bristles. *Spermatheca:* with a sclerotized basal part of duct; usually 3 in number; 1 in Corethrellini. *Bursa Copulatrix:* not developed.

MALE GENITALIA.—Usually (always?) inverted beyond segment VII, apparently not in *Eucorethra. Segment VIII:* usually strongly modified, narrowed, shortened or constricted at base. *Segment IX:* tergite well developed, bearing bristles caudolaterad; sternite poorly developed, much smaller than tergite, without bristles. *Sidepiece:* long, not widened at base; usually without processes of any kind but sometimes with a slight apical lobe and with 1 or more bristles or groups of bristles differentiated. *Clasper:* about as long as sidepiece, always simple, with numerous hairs and with or without terminal spiniform. *Phallosome:* very simple; with one pair of projecting sclerotizations (penis valve of Cook, 1956) articulating with sternal margin of sidepiece, with or without basal articular sclerites, the basal piece and the paramere may be both involved in these sclerites; in Corethrellini the "penis valves" appear to be united distally into a single median structure. *Proctiger:* very weakly developed, without any sclerotizations or bristles.

PUPAE.—Extremely varied in structure in the different genera. *Cephalothorax:* chaetotaxy generally as in Culicinae but some hairs absent and others developed. *Trumpet:* varied in position; located on distinct tubercle or not; spiracular closing mechanism within body of cephalothorax (apparently absent in *Chaoborus*) but a trachealike tube extending into trumpet for a variable distance where it is constricted, greatly expanded into a bulb or attached to a perforated plate, or even branched; apex of trumpet wide and as in Culicinae (*Eucorethra*), almost or apparently completely closed (*Chaoborus s. lat., Mochlonyx*), broad but covered by a perforated plate (Corethrellini). *Abdomen:* usually long except in Corethrellini; curved under cephalothorax, pendant (vertical) or horizontal; with more or less distinct lateral margins between tergites and sternites; tergites without submedian transverse ridges; chaetotaxy generally as in Culicinae, not homologized for the majority of the genera. *Terminal Segments:* segment VIII short or long; tergite IX distinct or represented by lobe; sternite IX not distinct. *Paddle:* fused at base, immovable and without buttresses (Corethrellini) or separate, movable, and with buttresses; hairs varied. *Females* and *Males:* anal lobes varied.

LARVAE.—Extremely varied in structure in the different genera but all with prehensile antenna and without distinct mouthbrushes. *Head:* extremely varied in shape; posterior tentorial pits located high on side or even on dorsal surface of extreme caudal portion of head capsule; maxillary sutures always present (in *Chaoborus* forming caudolateral border of head capsule); cephalic border of labium with or without (*Chaoborus, Mochlonyx*) teeth, these teeth apparently not homologs of mental plate; maxillary palpus very small, inconspicuous; chaetotaxy essentially as in Culicinae but with some extra hairs; position of hairs greatly varied in different genera; cervical membrane without hairs but hair 16-C apparently present in *Corethrella. Antenna:* inserted close together on front, or lateral and widely separated; integument smooth; hair 1-A very small, on shaft or apex; 3-5-A long, curved, apical, more or less spiniform. *Thorax:* segments compacted into a single mass wider than abdominal segments; mesothoracic and metathoracic spiracular sensilla usually both present; chaetotaxy essentially as in Culicinae; hairs 9-12-P,M,T present, hair 11 weak or absent (?). *Abdomen:* prolegs and spines absent; integument smooth; spiracular sensilla varied; dorsal sensilla present on III-V; chaetotaxy essentially as in Culicinae, some long lateral hairs present, inconspicuous in *Chaoborus. Segment VIII:* chaetotaxy as in the Culicinae; comb always absent. *Spiracular Apparatus:* completely absent in *Chaoborus* and *Cryophila,* short in *Eucorethra,* a distinct siphon in *Mochlonyx* and the Corethrellini; pecten teeth never developed; valves when present essentially as in Culicinae and Dixinae, without long marginal bristlelike spicules, but sometimes short marginal spinules present (*Eucorethra*); spiracular trachea very small. *Segment IX:* sometimes more or less distinct but not complete. *Anal Segment:* more or less cylindrical; caudal process of Dixinae probably represented by base of hairs 2,3-X; saddle incomplete or absent; supraanal spicules not developed; accessory hairs (*x,y,z*) present or absent, chaetotaxy otherwise as in Culicinae; a retractile anal apparatus ventrad of anus, consisting of hooked spines and spinules; ventral brush usually strongly developed; gills usually developed, retractile.

EGGS.—Described only for *Mochlonyx,* in which they are deposited singly on water, and *Chaoborus,* in which a batch of hard-shelled, spindle-shaped eggs is enclosed in a mass of jelly. In both instances, the eggs sink down into the water shortly after deposition.

SYSTEMATICS.—The subfamily Chaoborinae is a miscellaneous assemblage of several very strikingly different genera having in common relatively few characters, as indicated above. All the forms are predaceous in the larval stage, and all apparently use their antennae in feeding and have the mouthbrushes undeveloped or poorly developed. On the whole, the differences between some of the genera are greater than between the tribes of the Culicinae; therefore, it would be advisable to recognize at least the tribes erected but not used by Edwards (1932:16). It appears to me that the group is of polyphyletic origin and that eventually it will be split into 2 or more subfamilies. At least, the Corethrellini are so strikingly different in many characters from the Chaoborini and Eucorethrini that they probably deserve the rank of a subfamily. However, I prefer to retain the *status quo* until more information is available for this much neglected group. A foundation for a thorough world revision of the group was recently made by Cook (1956) in a treatment of Nearctic species.

Some authorities recognize the Chaoborinae as a family distinct from but closely related to the Culicidae. In my opinion, there is very little to support such a view, since the differences between the less specialized chaoborines and culicines are largely a matter of degree. It is true that there is a sharp distinction in the development of the mouthparts. However, the similarities in wing venation of the adults and the general morphology and the chaetotaxy of the larvae and pupae indicate extremely close relationship and, as far as I know, complete separation from related nematocerous groups.

The Chaoborinae are very poorly known, having attracted the interest of very few workers in the past. Most species have been described on superficial characters of coloration of the adults. Outside the Holarctic region, the larvae and pupae are practically unknown, only striking pupal differences having been described for some species of Neotropical *Corethrella.*

I have made no attempt to characterize the tribes here, since I have not studied enough material from outside the South Pacific area and since very little morphological information is available for most of the genera. Therefore the treatment below is on a generic level. However, the general tribal characters are included in the keys to the genera.

BIONOMICS AND DISEASE RELATIONS.—All the chaoborines are predaceous in the larval stage and use their antennae in feeding. The Eucorethrini and Chaoborini are restricted to ground water, while the Corethrellini are found in addition in treeholes, bamboo, and water collections in living plants. The food consists apparently chiefly of crustaceans and insect larvae, often various culicines. The foregut of the larvae is said to be eversible since preserved specimens occasionally exhibit this condition; however, it is not known whether or not this occurs in the living larva. Larval habits differ considerably in the different genera; in general, however, chaoborine larvae only rarely and sometimes never come to the water surface. For specific habits of South Pacific forms, see below.

Little is known of the bionomics of adults except for some species of *Chaoborus* which at times are extremely abundant and become a nuisance. Both sexes of the majority of species are attracted to artificial lights. Males of some forms swarm. Since chaoborines are incapable of blood-feeding, they cannot be involved in disease transmission.

DISTRIBUTION.—The subfamily is worldwide in occurrence but several genera have a restricted distribution: *Mochlonyx* is Holarctic, *Cryophila* Palaearctic, and *Eucorethra* Nearctic; *Promochlonyx* is known only from southeast Australia. *Chaoborus* and *Corethrella* are probably both worldwide in distribution and probably have been overlooked in many areas.

In the South Pacific area only 1 species, *Corethrella novaezealandiae,* was recorded prior to this study. An additional *Corethrella* is described below from the Solomon Islands. A species of *Chaoborus* was found on Guadalcanal but is not described at this time, since only a single larva is now available. Additional chaoborines undoubtedly occur in the area. It is surprising that a primitive member of the Chaoborini has not been found in New Zealand, since *Promochlonyx* occurs in southeast Australia.

KEY TO TRIBES AND GENERA

(Keys to subfamilies, pp. 90–91)

ADULTS

1\. Distance between eyes above antennae distinctly more than maximum width of one eye; vein R_1 ending on C far distad of level of apex of vein Cu_1 (CHAOBORINI, sp. 1) .... CHAOBORUS, p. 543

Distance between eyes above antennae much less than maximum width of one eye; vein R_1 ending on C at or basad of level of apex of vein Cu_1 (CORETHRELLINI) .... CORETHRELLA, p. 538

FEMALE GENITALIA

1\. One spermatheca (CORETHRELLINI) .... CORETHRELLA, p. 538

Three spermathecae (CHAOBORINI, sp. 1) .... CHAOBORUS, p. 543

MALE GENITALIA

1\. Penis valves separate apically (CHAOBORINI, sp. 1) .... CHAOBORUS, p. 543

Penis valves fused apically (CORETHRELLINI) .... CORETHRELLA, p. 538

PUPAE

1\. Body depressed, ovoid; cephalothorax large, in same plane as short abdomen; trumpet apex with a large broad perforated plate; paddles immovable, fused at base (CORETHRELLINI) .... CORETHRELLA, p. 538

Body cylindrical; cephalothorax small, abdomen elongate; trumpet apex rounded, with a small papilla; paddle free, movable (CHAOBORINI, sp. 1) .... CHAOBORUS, p. 543

LARVAE

1\. Head with a curved lateral row of short heavy spines behind eye on each side; labium with a distinct plate bearing toothlike spines (CORETHRELLINI) .. CORETHRELLA, p. 538

Head compressed, without a curved lateral row of short heavy spines behind eye on each side; labium without a distinct plate bearing toothlike spines (CHAOBORINI, sp. 1) .... CHAOBORUS, p. 543

TRIBE CORETHRELLINI

Genus CORETHRELLA Coquillett

1902. *Corethrella* Coquillett, N. Y. Ent. Soc., J. 10:191. *TYPE SPECIES: *Corethra brakeleyi* Coquillett, 1902, U.S.A.; original designation.

1911. *Ramcia* Annandale, Spolia Zeylanica 7:187. *TYPE SPECIES: *R. inepta* Annandale, 1911, Ceylon; monobasic.

1942. *Lutzomiops* Lane, Rev. de Ent. 13:127. TYPE SPECIES: *Corethrella nigra* Lane, 1939, Brazil; original designation.—As subgenus of *Corethrella*.

FEMALES.—Very small Chaoborinae with the following special features. *Head:* distance between eyes above antennae less than one-fourth maximum width of one eye; eye deeply emarginate around antenna; 1,2 pairs of long frontal bristles, a row of long orbital bristles, and small proclinate hairs or hairlike scales on disc of vertex and laterally; clypeus less than half height of head; antennal scape strongly developed, with hairs numerous and extending beyond apex of torus; torus (pedicel) moderate in size and with numerous hairs. *Thorax:* mesonotum strongly bulging anteriorly, somewhat flattened behind; a sparse vestiture of long slender erect and short appressed hairlike scales; acrostichal, dorsocentral, humeral, and supraalar bristles well developed; scutellum very prominent, a marginal row of large bristles and a vestiture of hairlike scales between bristles and on disc; parascutellum (postalar callus) with one bristle; metanotum with short hairs laterally; anterior pronotal lobes (*apn*) narrowly connected; upper part of *stp* below prealar area more or less distinctly separated from lower; pleuron without scales and with bristles only on *apn, ppn,* and upper caudal part of *mep*. *Legs:* femora, tibiae, and tarsi densely covered with bristles of varied sizes; some very long bristles and slender hairlike scales on all femora and tibiae and base of hindtarsus; foretibia and hindtibia with an apical comb and small "spur"; claws all simple and subequal; pulvilli absent. *Wing:* membrane with extremely minute microtrichia; veins with very long slender hairlike scales; caudal margin both dorsally and ventrally with short, curved slender hairs at base of fringe; fringe very long, composed of scales of 4 different lengths, broadened apically on main part of wing, hairlike on alula; upper and lower calypters both with a fringe of long hairs; vein R_1 ending on C at about level of end of Cu_2 or distinctly basad; vein Rs very short, without longitudinal basal spur. *Haltere:* rather long and slender, with microsetae or minute scales restricted to distal half. *Abdomen:* very short, tergites densely covered with hairlike scales. *Genitalia:* only 1 spermatheca.

MALES.—Essentially as in the females. *Antenna:* scape smaller than in females and with less numerous hairs; torus about twice as large as in the females and with less numerous hairs; bristles of flagellar whorls longer but not more numerous than in females. *Legs:* claws of foreleg uneven, 1 greatly enlarged.

MALE GENITALIA.—Rotated 180° beyond segment VII. *Segment VIII:* sharply constricted anteriorly, appearing pedunculate, about equal in length to segment VII. *Sidepiece:* shorter than in other genera, usually with 1 or more strongly differentiated setae. *Clasper:* slender; with or without terminal spiniform. *Phallosome:* with "penis valves" fused apically; several basal articular sclerites present.

PUPAE.—Entire body rigid and in one plane, markedly depressed, wide on cephalothorax and with abdomen strongly tapered. *Cephalothorax:* elongate; median part of metanotum not separated from mesonotum; chaetotaxy greatly reduced, hairs 1–3 apparently absent as well as several others, all single; hairs 6,7-C on a tubercle near trumpet. *Trumpet:* on a conspicuous tubercle; spiracular apparatus within body of cephalothorax, a very slender trachealike tube continuing into trumpet, sometimes branched before reaching the broad perforated plate which covers the broad "opening" of trumpet. *Metanotum:* median part not separated from mesonotum of cephalothorax. *Abdomen:* strong lateral margins between tergites and sternites; segment VIII about half width of II; chaetotaxy as in Culicinae except on I and VIII where some hairs are missing; hairs all single. *Paddle:* fused at base; thick, triangular, without midrib; with 2 apical hairs, 1 of which is spiniform; a third lateral hair, closer to base, probably represents hair 1-IX.

LARVAE.—*Head:* broader than long, with a curving row of short heavy spines on each side behind eye; an anterolateral groove into which antenna folds at rest;

maxillary suture complete; cephalic border of labial plate toothed; chaetotaxy in general as in Culicinae, hair 16-C present near crown. *Antenna:* inserted far forward near midline on protuberance at end of ventrolateral antennal groove; integument smooth, hair 1-A at apex; 2,3,6-A long, heavy, spinelike. *Thorax:* chaetotaxy as in Culicinae, with only 13-P and possibly 11-P,M,T not developed; metathorax with 4 prominent conical sclerotized tubercles bearing respectively hairs 6,7,9–12, and 13. *Abdomen:* spiracular sensilla sometimes present on I-VII, dorsal sensilla on III-V; chaetotaxy essentially as in Culicinae except that an extra hair (*x*) is present laterally on segments I-VIII; segments I,II with lateral process bearing hairs 6,7,*x;* median anterior tergal plate present or absent on I-VIII, larger posteriorly; sternal plates present or absent on VII,VIII. *Spiracular Apparatus:* a short, broad, ventrally flattened siphon present; valves as in Culicinae, two hairs (6,9-S) spiniform; siphonal trachea extremely narrow. *Anal Segment:* shorter than siphon, with small saddle; ventral brush of 2 pairs of hairs only (4a,b-X); 2,3 pairs of accessory lateral hairs (*x-z*).

EGGS.—Undescribed.

SYSTEMATICS.—The genus *Corethrella* is considered here in the broad sense to include all the Corethrellini. Undoubtedly it will be split into several genera in the future, a course which has already been initiated by Lane (1951:336), who recognizes the separate genus *Lutzomiops* for some Neotropical species. To date *Ramcia,* with *inepta* Annandale, 1911 from Ceylon as the type species, is the only other supraspecific category that has been proposed. It is impossible to tell at present whether or not any of the Old World *Corethrella* are truly congeneric with *brakeleyi* Coquillett, 1902, the type species of the genus.

BIONOMICS.—The immature stages of different species of *Corethrella* have been collected in swamps, in marginal vegetation of springs, in crabholes, treeholes, bamboo, and pitcher plants, and in leaf bases of bromeliads, calatheas, and other waterholding plants. Except for a few species utilizing ground pools for breeding, the larvae and pupae are uncommon or even rare. The larvae are very sluggish and, being in addition small and poorly pigmented, are very inconspicuous. Several species are cream colored or pinkish. In habitats with restricted amount of water (treeholes, waterholding plants), the larvae remain motionless for long periods in the debris on the bottom of the container and very rarely come to the surface. In ground pools they spend more time at the surface, moving only rarely and going down when strongly disturbed to the bottom muck, where they remain for long periods. The attitude of the larvae at the surface is very similar to that of anophelines, and *Corethrella* can be mistaken easily for them. The strongly sclerotized and pigmented pupae of the 3 species I have seen all float motionless in a horizontal position on the water surface, to all appearances like a seed or a bit of chaff. The larval and pupal development is very slow and erratic in the laboratory, most of the specimens dying before transformation. The habits of the adults are completely unknown and the eggs have not been described. Most species are seldom seen as adults but some are attracted to artificial lights, at least in small numbers.

DISTRIBUTION (fig. **403**).—Some 50 species of *Corethrella* are known from the world, with only 5 species previously recorded from the Old World. In the South Pacific area, the only species previously known was *novaezealandiae,* the only representative of the genus recorded east of Borneo. The discovery of a species in the Solomons indicates that the genus is probably represented in the intermediate areas.

KEYS TO SPECIES

(Keys to tribes and genera, p. 537)

ADULTS

1. Vein R_1 ending on C about halfway between Sc and R_2 .... 1. *novaezealandiae*
Vein R_1 ending on C much closer to Sc than to R_2 .... 2. *solomonis*

MALE GENITALIA, PUPAE, LARVAE

Known only for *solomonis*

1. Corethrella novaezealandiae Tonnoir

Figs. 403, 404

1927. *Corethrella novae-zealandiae* Tonnoir, Canterbury Mus., Rec. 3:107–108. TYPE: holotype ♀, Otira, Westland, South Island, New Zealand, Feb. 7, 1922, A. L. Tonnoir (NELSON).

Corethrella novae-zealandiae of Miller (1950:43).
Corethrella novaezelandiae of Edwards (1932:19); Taylor (1934:8).

FEMALE (fig. 404).—*Wing:* 2.5 mm. *Entire body:* 2.0 mm. Coloration ochreous, darker below (Tonnoir); the single specimen I examined at the BMNH has a general yellowish appearance but is somewhat darker than *solomonis*. *Head:* brown with yellow bristles or hairlike scales; antenna nearly as long as entire body; scape and torus brownish; flagellum yellowish but somewhat darker distally; flagellar segment 1 about 6 times as long as wide, segment 2 about 0.6 of segment 1, segments 3–9 all subequal to segment 2, segments 10–12 gradually slightly shortened, segment 13 slightly enlarged and conical. *Thorax:* mesonotum ochreous; scutellum and disc of postnotum brownish; pleuron mostly dark and shining. *Legs:* ochreous, thickly covered with long and short golden hairs. *Wing:* slightly yellowish and slightly infuscated on the crossveins and at the forks; veins with golden scales; fringe silvery golden; vein Sc apparently shorter than in any other species so that vein R_1 ends on C about halfway between ends of Sc and R_2. *Haltere:* yellow.

MALE, PUPA, and LARVA.—Unknown.

MATERIAL EXAMINED.—1 ♀.

SYSTEMATICS.—Apparently this species differs from all other described *Corethrella* in the very short vein Sc. This character may prove to be of sufficient importance to recognize at least a distinct subgenus for *novaezealandiae*.

BIONOMICS.—This species is apparently known by the single original collection of 2 females made by Tonnoir under unspecified circumstances.

DISTRIBUTION (fig. 403).—*New Zealand:* South Island (Otira, Westland). Not known elsewhere.

2. Corethrella solomonis Belkin, n. sp.

Figs. 403-405

TYPE.—*Holotype:* ♀ with associated larval and pupal skins (JNB, 920–301), Tenaru area, Guadalcanal, Solomon Islands, from leaf axil of a pandanaceous plant, probably *Sararanga* sp., Mar. 15, 1945, J. N. Belkin and M. Cohen (USNM, 64799).

Corethrella sp. of Laird (1956).

FEMALE (fig. 404).—*Wing* (without fringe): 1.56 mm. *Forefemur:* 0.65 mm. *Abdomen:* about 1.15 mm. A yellowish species; wing with a transverse dark band strongest on anterior margin and fringe, a darkening of the base of fringe on apex of wing, a basal darkening on stem of R and surrounding area, and a dark streak on posterior margin near alula; femora slightly darkened apically; tibiae darkened subbasally and subapically, tarsal segments darkened at base dorsally; integument light yellowish brown and bristles and hairlike scales golden throughout except as noted. *Head:* clypeus slightly infuscated, with a submedian transverse group of bristles longer than sclerite mesally, shorter and more numerous laterally; mouthparts infuscated; palpus strongly infuscated, with very numerous long bristles and hairlike scales, details of segmentation not discernible in specimen; antennal scape with 4 long hairlike scales on mesal projection; torus (pedicel) darkened apically on outer side, with numerous hairlike scales; flagellar segment 1 short, strongly swollen, length less than 2.5 of maximum width, bristles in an irregular triple whorl on swollen portion, mesal surface with numerous hairlike scales, some long; flagellar segment 2 about 0.75 of segment 1, succeeding segments gradually longer until the 8th, then shorter; apical segments infuscated. *Thorax:* usual pollinosity; prescutellar area, scutellum, postnotum, and paratergite darkened, parascutellum whitish; mesonotal hairlike scales apparently sparse (partially denuded); pleuron extensively infuscated on *apn*, posterior part of *ppn, ppl*, portions of *stp* and *pra*, and most of *mep* and metapleuron, whitish on membranes and below wing; *apn* with 1,2 short bristles on lower part; *ppn* with 3,4 very long bristles in middle upper part and a tuft of several shorter ones anteriorly; no other bristles developed, none present on upper *mep*. *Legs:* bristles and scales dark on infuscated areas as described above; scale tuft of hindfemur large, more proximal scales lighter, appearing silvery. *Wing* (fig. **404**): whitish at extreme base; wing scales light yellowish, rather broad; wing membrane rather strongly infuscated between C, Sc, R_1, and R_{2+3} in area of dark bands; dark areas as indicated above; only distal portion of upper calypter fringed, lower calypter without fringe. *Haltere:* whitish in basal part, apex yellowish and with minute yellowish hairs. *Abdomen:* tergites II-VII largely dark basally, extensively light laterally and apically, bristles and scales sparse dorsally, more numerous laterally; sternites largely light, darkened basolaterally.

MALE.—Unknown.

PUPA (fig. **404**).—*Abdomen:* about 1.75 mm. *Trumpet:* 0.42 mm. *Paddle* (from base of segment IX): 0.27 mm. Pigmentation uniformly light yellowish brown, trumpet and abdomen brighter and deeper than cephalothorax; chaetotaxy as figured, all hairs single. *Trumpet:* on a very prominent and large tubercle; index about 12.0; basal part very slender but with a slight bulbous enlargement near base; apical half widened and bearing large perforated plate; inner tube without taenidia but appearing segmented, branched before middle, 1 branch supplying each side of the plate, from each branch very fine tubules in a single series lead each to a cuplike depression along the edge of the plate (in side view); external surface with spiculate reticulations. *Abdomen:* integument indistinctly spiculate except laterally where margins appear serrate; hairs 2-II-VII on strong tubercles, which are heavily sclerotized only on lateral surfaces, these hairs heavy, distinctly curved, and almost twice as long as their tergites on segments II-VI. *Terminal Segments:* integument strongly spiculate; segment VIII narrowed basally and very strongly emarginate apically, with wide lobes around the base of the fused paddles. *Paddle:* short, widely divergent.

LARVA (fig. **405**).—*Head:* 0.5–0.6 mm. *Siphon:* 0.2–0.3 mm. *Anal Saddle:* 0.2–0.3 mm. Pigmentation of integument extremely light, sclerotizations extremely difficult to see; morphology and chaetotaxy as figured and in general as described for *C. laneana* Vargas (Belkin and McDonald, 1955:87–89) except as noted; hair development and branching extremely variable, the large hairs very darkly pigmented, the shorter hairs lighter in color, the minute hairs extremely difficult to see, hairs usually branched a considerable distance from base. *Head:* width about 1.5 length; no collar developed, median dorsal and ventral borders not apparent, no dorsal sclerites caudad of frontoclypeus, sclerotization of head capsule gradually disappearing into cervical membrane; pigmentation uniformly very light yellowish, imbrications distinct only laterally and particularly along oral margin below antennal groove; 14–16 spines in each lateral row, pigmentation of spines similar to head capsule; labial plate with teeth darkly pigmented, number and size variable, usually quite similar to *laneana* (the mandibular teeth fit in an interlocking fashion with those of the labial plate on each side); all hairs except 1,2,13-C strongly pigmented. *Antenna:* about 0.45 of head. *Thorax:* hairs 11-P,M,T apparently not developed; hair O-P present (also present but missed in *laneana*), this hair strongly displaced caudad; spines of tubercles of metathoracic hairs longer; large hairs black. *Abdomen:* no distinct tergal plates on I-VII or sternal on VII; sternal spicules very small; tubercles of 6,7,*x*-I,II each with a distinct spine; large hairs black; hairs 6,7-III,IV branched; spiracular sensilla indistinct. *Segment VIII:* tergal plate well developed, but without distinct ventrolateral borders; sternal plate slightly developed; hair 14-VIII apparently present on sternal plate; tubercles of hairs 3,5-VIII with long spines, these hairs considerably longer than siphon. *Siphon:* very poorly pigmented and without distinct reticulations; hair 1-S longer, inserted farther from base. *Anal Segment:* saddle large, about as long as siphon, but with very indefinite ventrolateral margins; spicules distinct; hair 1-X about as long as saddle; 2,3-X more than twice as long as saddle and as long as hairs 4a,b; hair *y* apparently absent; gills subequal, sharply pointed, slightly less than half as long as saddle; anal apparatus with 2 pairs of spines curved ventrally and sharply serrated.

MATERIAL EXAMINED.—1 ♀; 1 pupa; 33 larvae; 1 individual larval rearing.

SYSTEMATICS.—*C. solomonis* is different from all other *Corethrella* I have seen in lacking upper mesepimeral bristles in the adult stage. It differs in addition from *calathicola* Edwards, 1930 (Borneo and Singapore) in having a light yellowish brown instead of dark brown integument and general coloration. From *inepta* Annandale, 1911 (Ceylon) and *novaezealandiae* Tonnoir, 1927 (New Zealand), both of which are yellowish and have spotted wings, it is distinct in the infuscation of the legs. The larvae have proportionately much shorter and broader antennae than *inepta* but are quite similar to *calathicola*, from which they differ, however, in having no distinct caudal boundary to the dorsal and ventral sclerotizations of the head capsule, hairs 7-C and 6,7-III,IV branched, and other details in chaetotaxy. The pupa is distinct from *inepta* and *calathicola* in having short, widely divergent paddles and very long hairs 2-II-VII; the trumpet appears to be distinctive as well.

As indicated in the description above, the larvae exhibit a great deal of variation in chaetotaxy, not only in the branching and length of individual hairs but also in their position. Unfortunately only 1 specimen was reared, and no other material is available from the type breeding place. The variations noted are in larvae from several other habitats, which are indicated below under Bionomics. Since plant-breeding species of mosquitoes are sometimes species-specific regarding their host plant, it is quite possible that these larvae are not conspecific with the holotype; therefore they are not included as paratypes. However, I believe that only 1 variable species is involved. The specimens from Bougainville have considerably longer hairs than the majority of those from Guadalcanal, but the latter show considerable variation in this respect.

BIONOMICS.—The larva, from which the type specimen was reared, was collected in a leaf axil of a smooth-leaved pandanus (possibly *Sararanga* sp.) growing in a shaded swamp (JNB, 920). Breeding in the axils of the same plants were *Uranotaenia wysockii, Aedes solomonis,* and *Culex hurlbuti.* On Guadalcanal 2 additional larval collections were made, but no adults could be reared. As indicated above, these larvae are believed to be of the same species, but there is a possibility that they represent 1 or more additional species. In both instances no other mosquitoes were found. One collection (JNB, 371) came from the bases of fronds of a diminutive marsh palm with narrow stem and with fronds bearing spines 2 to 4 inches in length at their base. The other collection (JNB, 834) was made in frond bases of sago palm seedlings from 1 to 2 feet in height and not in larger palms; only a few drops of water were present in the breeding place. In all collections, the larvae were hidden in the muck at the bottom and the host plants were in rather dense shade. On Bougainville what appears to be the same species was collected in leaf axils of pandanus and an "arum-like plant," which is probably the same plant as the *Sararanga* sp. from which the type specimen was obtained. Collected in the leaf axils of the same plants was *Aedes solomonis.*

DISTRIBUTION (fig. 403).—*Solomon Islands:* Bougainville; Guadalcanal. Not known elsewhere.

TRIBE CHAOBORINI

Genus CHAOBORUS Lichtenstein

1800. *Chaoborus* Lichtenstein, Arch. f. Zool. und Zootomie (Wiedemann) 1:174. TYPE SPECIES: *C. antisepticus* Lichtenstein, 1800, Europe; monobasic.

1903. *Sayomyia* Coquillett, Canad. Ent. 35:190. TYPE SPECIES: *Corethra punctipennis* Say, 1823, U.S.A.; original designation.

1942. *Edwardsops* Lane, Rev. de Ent. 13:135. TYPE SPECIES: *Chaoborus* (*E.*) *unicolor* Lane, 1942, Brazil; original designation.—As subgenus of *Chaoborus*.

For complete synonymy to 1930, see Edwards (1932:23).

FEMALES.—Small to medium-sized Chaoborinae with the following special features. *Head:* distance between eyes above antennae more than width of 1 eye; eyes slightly emarginate around antennae; no differentiated frontal or orbital bristles; clypeus almost as long as height of head, with numerous hairs; antennal scape reduced, without hairs; torus strongly developed, with a few hairs. *Thorax:* mesonotum with numerous long hairs in dorsocentral, humeral, and prealar areas and fewer on acrostichal, usually a tuft of outstanding narrow scales at end of acrostichal area; scutellum with 2 or more rows of bristles; parascutellum with or without bristles; metanotum with a small erect appendage laterally, no bristles; anterior pronotal lobes (*apn*) large, separated by a narrow sclerite bearing short hairs; pleural bristles numerous, present on *apn*, upper part of *ppn, ppl, stp, pra,* and upper *mep*. *Legs:* femora, tibiae, and tarsi rather densely covered with both long and short slender hairs; scales absent; no tibial combs or "spurs"; midtarsal segment 3 bearing a comb of short hairs (Cook, 1956:11); claws simple, subequal; pulvilli well developed or reduced. *Wing:* membrane with distinct microtrichia; veins with very slender hairlike scales; fringe composed of scales of 2 lengths; alula with short fringe; upper calypter with long fringe, lower without; vein R_1 ending on C at or near apex of wing, distad of level of end of M_{1+2}; vein Rs usually long, with or without basal longitudinal spur. *Haltere:* short, with a few short bristles on apical portion. *Abdomen:* elongate, with numerous long hairs, no hairlike scales. *Genitalia:* 3 spermathecae.

MALES.—Essentially as in the females. *Antenna:* torus without bristles; flagellum densely plumose. *Legs:* claws as in the females.

MALE GENITALIA.—Rotated 180° beyond segment VII. *Segment VIII:* about 0.25 of segment VII. *Sidepiece:* elongate, usually 3 times as long as median width; differentiated setae usually present, sometimes a small apical dorsal lobe. *Clasper:* slender; with or without terminal spiniform. *Phallosome:* with "penis valves" free apically and without separate basal articular sclerites.

PUPAE.—Integument transparent; cephalothorax small in comparison with long abdomen which hangs straight down instead of curving under cephalothorax; details of morphology and chaetotaxy not studied. *Trumpet:* swollen, spindle-shaped, conspicuously and regularly reticulate; apex with a papilla bearing a narrow slitlike opening (Cook, 1956:15). *Paddle:* articulated at base, with strong median, external and internal buttresses.

LARVAE.—"Phantom midges" with integument usually completely transparent; no tracheal system but a pair of hydrostatic "air sacs" in thorax and another in abdominal segment VII; chaetotaxy not studied but apparently homologous with that of Culicinae. *Head:* elongate, compressed, and with a narrow snout bearing the two antennae on its apex ventrally so that they hang down side by side; posterior portion largely unsclerotized dorsally, laterally, and ventrally and continuous with long membranous neck; maxillary suture forming caudal border of head capsule laterally and ending at posterior tentorial pit which is just caudad and slightly dorsad of larval eye; labium composed of 2 restricted midventral sclerites, no toothed labial or mental plates present. *Antenna:* integument smooth; hair 1-A on shaft, small or minute; apex with 4 hairs as long as shaft and another smaller; 2 supernumerary hairs apparently present. *Thorax:* segments consolidated; setae inconspicuous. *Abdomen:* sclerotizations absent; setae inconspicuous. *Spiracular Apparatus:* absent; spiracular lobe represented by a rudiment. *Anal Segment:* well developed but without sclerotization; dorsal brush as in the Culicinae; ventral brush extending the whole length of segment; gills short, pointed; anal apparatus with a pair of large ventral recurved hooks and a large number of finely serrate spines of two different sizes and forms.

EGGS.—"Hard-shelled, spindle-shaped, the whole batch enclosed in a circular mass of jelly" (Edwards, 1932:24).

SYSTEMATICS.—The genus *Chaoborus* is considered here in the broad sense as used by Edwards (1932) and Cook (1956:20–41). It is probable that it will be split into several genera when detailed studies are made on this dominant modern group of the Chaoborini, perhaps even into the 5 genera recognized by Lane (1953:65). At the present too little is known of the species outside the New World to tell whether or not the apparently clear-cut group (subgeneric of Cook) characters within the genus will hold up in the world fauna.

The species mentioned below probably belongs to the subgenus *Sayomyia,* which is the only one reported from Australasia and Indomalaya.

BIONOMICS.—Phantom midge larvae are found in lakes and ponds and even in intermittent or temporary ground pools, both in deep clear water and in shallow weedy pools. They rest motionless in a horizontal position below the water surface, usually close to the muddy bottom, and are practically invisible, only the hydrostatic organs being discernible. They never come to the water surface. Their food consists of small crustaceans and small insect larvae, including the younger instars of some mosquitoes in some species. The pupae float vertically in the water, with the abdomen hanging down, and come to the surface only for the emergence of the adults. Because of their transparency as well as habits, the immature stages are very rarely collected. Even when accidentally collected in a dipper, they are usually missed.

The adults are often extremely numerous, particularly around lakes and reservoirs. They rest on vegetation and various objects in the vicinity of the breeding sites and are readily attracted to artificial lights. Because of the close superficial resemblance to chironomid midges, they are very seldom collected by culicidologists.

DISTRIBUTION (fig. 403).—This genus is probably worldwide in distribution, although it has not been reported from many areas in the Old World tropics. No species have been previously reported from the South Pacific area but 1 (*queenslandensis* Theobald, 1905) is known from Australia.

KEYS TO SPECIES

See keys to tribes and genera, p. 537

1. Chaoborus sp., Solomons form

Figs. 403, 404

LARVA (fig. 404).—*Total length:* about 4.4 mm. *Head length* (dorsal articulation of antenna to posterior tentorial pit): 0.65 mm. *Antennal length* (dorsal): 0.3 mm. Fourth instar as indicated by the strongly pigmented developing imaginal eye; dorsal head bristles double, triple, and single, lateral bristles all single; antennal shaft hair minute, placed at about one-third from base; longest terminal antennal hair and longest "postantennal filament" about as long as antenna; "prelabral appendage" about half length of antenna, very similar in appearance to that of *astictopus* Dyar & Shannon, 1914 (Cook, 1956:81).

SYSTEMATICS.—Several larvae of this species were collected in clear water in a jungle foxhole on Guadalcanal. Since no adults were collected or reared and only a single larva is now available, this form cannot be adequately described. It cannot be placed with certainty even in the proper subgenus, for the larvae of the Australian and Indomalayan species are not described. However, it probably belongs to the subgenus *Sayomyia.* It differs from all *Chaoborus* larvae I have seen in the combination of characters indicated above.

DISTRIBUTION (fig. 403).—*Solomon Islands:* Guadalcanal.

Terminology and Abbreviations

TERMINOLOGY AND ABBREVIATIONS

ADULTS

GENERAL

COLORATION.—Coloration is described in very general terms, as it is usually extremely variable and reference to standard color charts would be of little value or even misleading; metallic colors are described as coppery, bronzy, silvery, or golden; variable iridescent colors are described by the predominant color at the angle of observation showing the deepest color.

CUTICULAR STRUCTURES.—External cuticular projections are of 2 basic types, and it is important to distinguish these: (1) the nonarticulated projections which are described as SPICULES, SPINULES, and SPINES, and (2) the articulated structures with an alveolus at the base; these are generally known as SETAE and comprise HAIRS, BRISTLES, SPINIFORMS (spinelike setae), SPURS, and various types of SCALES (flattened setae). There are all intergradations between hairs and typical striated scales and it is often necessary to speak of hairlike scales or scalelike hairs. Even when setae are broken off, it is possible to determine their number by the basal alveolar depressions in the cuticle; however, the alveoli of scales are usually extremely small and difficult to see. The integument is described as POLLINOSE or PRUINOSE when it appears to have a bloom like a plum owing to modification of the surface.

MEASUREMENTS.—See under name of specific structure.

HEAD

(Figs. **406, 407**)

ANTECLYPEUS.—Small sclerite distad of clypeus and projecting anteriorly over the base of the proboscis.

ANTENNAL LENGTH.—Measured in extended position as a fraction of the proboscis.

BASAL BRISTLES.—A row of bristles ventrally near the base of the labium; used as basal point for measuring length of proboscis.

BUCCOPHARYNGEAL ARMATURE.—In females a transverse complex of teeth and other cuticular processes at the posterior end of the cibarial pump near its junction with the pharyngeal pump (figs. **43, 51**).

CLYPEUS.—Prominent median sclerite ventrad of antennal bases.

DECUMBENT SCALES.—Scales lying more or less flat against the integument or bending down toward the surface distally; recumbent, appressed, flat; may be located on frons, vertex, occiput, sides, and lower surface of head and may be broad or narrow.

ERECT SCALES.—Scales standing upright from surface of integument but not necessarily perpendicularly; they are narrow at base and gradually widened distad, the apex is usually forked or toothed; may be confined to occiput or may extend to the vertex.

FLAGELLAR WHORLS.—Groups of long curved bristles arranged in a ring around the flagellar segments of the antenna; may be located at base, near middle, or toward apex of individual segments.

FLAGELLUM.—The third division of the antenna (the basal 2 being the scape and pedicel), usually composed of 13 or 14 segments; segments are numbered from the proximal to the distal.

FRONS OR FRONT.—The median space between the eyes above the antennal bases; interorbital space; frontal area.

FRONTAL AREA.—Frons (see).

FRONTAL BRISTLES.—One or more pairs of median orbital bristles lying at the dorsal part of the frons if latter is developed or occupying the corresponding position if frons is not distinct; usually somewhat longer than other orbital bristles and projecting more strongly cephalad; vertical bristles.

FRONTAL TUFT.—A group of elongate scales and sometimes scalelike hairs projecting forward over the frons or the corresponding area if frons is not developed.

INTERORBITAL SPACE.—The median space between the eyes above the antennal bases; frons.

LABELLA.—A pair of lobes at apex of proboscis, probably representing the labial palpi and median apical structures of labium; usually each lobe shows evidence of segmentation.

LABIUM.—The main part of the proboscis from the base to the labella; with a median longitudinal groove containing the stylets.

OCCIPUT.—The posterior dorsal portion of the head capsule; its boundary with vertex not definite; usually with erect scales.

ORBITAL BRISTLES.—A row of bristles near the posterior margin of each eye; 1 or more median pairs usually differentiated as frontal bristles.

ORBITAL LINE.—A line along the anterior border of the vertex between the border of the compound eyes and the row of orbital bristles, sometimes with narrow or broad scales.

PALPAL LENGTH.—Expressed as a fraction of the proboscis length in the normal extended position.

PALPIFER.—A small lobe laterad of clypeal area at the base of the maxillary palpus.

PALPUS.—The maxillary palpus; arising laterad of clypeus and between the latter and the labium; apparently primitively 5-segmented, distal segments often not differentiated; segments numbered from base distad; "long segment" of culicine male considered here to be composed of segments 2 and 3.

PEDICEL.—Morphologically the second division of the antenna; usually strongly developed and more or less swollen and then appearing as the first segment of the antenna; usually called the torus in descriptive terminology.

PENDANT.—Drooping or hanging; applied in contradistinction of porrect in description of palpus.

PORRECT.—Projecting and more or less stiff; applied in contradistinction of pendant in description of palpus.

PROBOSCIS.—Labium and labella developed into a slender projecting structure, more or less rigid at least at base.

PROBOSCIS LENGTH.—Measured in extended position from basal bristles to apex of labella.

PROCLINATE.—Directed forward; applied to bristles or hairs.

SCAPE.—Morphologically the basal division of the antenna; usually greatly reduced in mosquitoes and hidden by the enlarged pedicel (torus).

TORUS.—Special term for the pedicel or second division of the antenna; usually enlarged and appearing as the basal segment.

VERTEX.—The dorsal surface of the head behind the eyes and frons if latter developed; boundary with occiput and sides not clearly defined.

VERTICAL BRISTLES.—See frontal bristles.

THORAX
(Figs. **406, 407**)

ACROSTICHAL.—Median longitudinal area of mesonotum from anterior promontory to prescutellar space; bristles arranged in 2 more or less distinct close-set rows along this area, sometimes more or less separable into an anterior and posterior group; scale line along this area, often called the median longitudinal line or stripe.

acx.—Antecoxal membrane (see); scales on this membrane.

ANTEALAR.—Lateral area of mesonotum at level of anterior part of paratergite, frequently not distinguished from area "in front of wing root"; scale patch located in this area.

ANTECOXAL MEMBRANE (*acx*).—Membrane cephalad of the forecoxa, between the latter and the prosternum; difficult to see except from an anterior view; sometimes with scales.

ANTERIOR DORSOCENTRAL.—Part of dorsocentral area cephalad of about level of antealar area; bristles in 1 or more rows on this part; scale line along this part, usually continued to posterior fossal line.

ANTERIOR PROMONTORY.—Median anterior area of mesonotum at the cephalic end of the acrostichal line, sometimes more or less projecting; sometimes including the more lateral portions at the cephalic ends of the dorsocentral lines.

ANTERIOR PRONOTUM OR PRONOTAL LOBE (*apn*).—More or less prominent lobe immediately caudad of head and ventrolaterad of anterior part of mesonotum; morphologically part of pronotum but considered as part of pleuron in descriptive terminology; bristles or scales on this lobe.

apn.—Anterior pronotum (see); bristles or scales on this lobe.

BARE SPACE.—See prescutellar.

BRISTLES.—Bristles and hairs are indicated on drawings only by their basal alveoli.

DORSOCENTRAL.—A pair of longitudinal areas of mesonotum, one on each side of acrostichal line and extending from anterior border to outer part of prescutellar area; areas divided indefinitely into ANTERIOR and POSTERIOR parts (see) at about level of antealar area; row(s) of bristles and scale lines along these areas.

FOSSA.—Anterolateral area of mesonotum extending caudad to level of scutal angle and mesad to dorsocentral area; sometimes with bristles or scales (fossal).

HUMERAL.—Anterolateral corner or shoulder of mesonotum at level of *apn,* sometimes considered to be lateral portion of anterior promontory; bristles in this area (incorrectly labeled in figure of bristles, guide line should run to bristles caudad of *apn*).

HYPOSTIGIAL.—Area immediately ventrad of mesothoracic spiracle; scale patch in this area.

LATERAL PRESCUTAL.—Lateral border of mesonotum from humeral angle to scutal angle; scale line along this border; bristles in this area, incorrectly labeled as humeral in figure of bristles.

mep.—Mesepimeron (see); bristles on this sclerite may be grouped into upper (u), middle (m), posterior (p), anterior (a), and lower (1), and scales into anterior (a), upper (u), lower (l), and posterior (p) patches, as illustrated in figure **407**; both bristles and scale patches may become confluent in various ways.

MERON.—Sclerite at lower end of pleuron between midcoxa and hindcoxa; its upper edge may be overlapped by a flange of the mesepimeron.

MESEPIMERON (*mep*).—Part of mesopleuron caudad of mesopleural suture; for bristles and scales, see under *mep*.

MESONOTUM.—The major part of the dorsum of the thorax, bounded caudally by the scutellum; mesoscutum, scutum, notum.

MESOPLEURON.—The major part of the pleuron of the mesothorax, composed chiefly of the sternopleuron, prealar area, and mesepimeron and including the postspiracular area and at least part of the subspiracular area.

METAMERON.—Small sclerite just caudad of the base of the hindcoxa; morphologically probably the metepisternum.

METANOTUM.—A very narrow transverse sclerite between the postnotum and abdominal segment I.

METAPLEURON.—The entire pleuron of the metathorax, located between the posterior border of the mesepimeron and anterior border of abdominal segment I; poorly studied in mosquitoes.

PARASCUTELLUM.—A small caudolateral lobe or area of the mesonotum caudad of the wing base and cephalolaterad of the scutellum; usually with 1 or more bristles; postalar callus.

PARATERGITE.—Sclerite on side of mesonotum between scutal angle and wing insertion; frequently reflected over pleuron and bearing scales or hairs on the lower surface of this reflection in addition to those on upper.

pcx.—Postcoxal membrane (see); scales on this membrane.

PLEURON.—Entire side of thorax; in descriptive terminology the anterior and posterior pronotum are treated as part of the pleuron.

POSTCOXAL MEMBRANE (*pcx*).—Membrane caudad of the forecoxa, between the latter and the sternopleuron.

POSTERIOR DORSOCENTRAL.—Part of dorsocentral area caudad of the level of the scutal angle or posterior fossal line; bristles in 1 or more rows on this part, usually difficult to separate from prescutellars into which they merge; scale line in this general area, usually laterad of the bristles.

POSTERIOR FOSSAL.—A curved diagonal line from scutal angle to posterior dorsocentral line; bristles and scale line in this area.

POSTERIOR PRONOTUM (*ppn*).—Sclerite laterad of the mesonotum and cephalad of the scutal angle; in descriptive work considered to be part of pleuron; for bristles and scales on this sclerite, see *ppn*.

POSTNOTUM.—A large convex sclerite caudad and below the scutellum, extending to metanotum; morphologically the mesopostnotum; sometimes with bristles or scales (postnotal).

POSTSPIRACULAR AREA (*psp*).—Area caudad of mesothoracic spiracle, usually more or less sclerotized and connected to or continuous with the subspiracular area ventrocephalad; homology obscure (see description of family); bristles and scales in this area.

ppl.—Propleuron (see); bristles or scales located on the ventral and anterior part of this sclerite.

ppn.—Posterior pronotum (see); bristles and hairs located on this sclerite, usually in an arcuate upper posterior line (p), sometimes in an upper extension of this line (u); scales located on this sclerite, in upper (u), middle (m), or lower (l) patches.

pra.—Prealar area (see); bristles located on this area; scales located on this area, in an upper (u) patch among and above the bristles and sometimes a lower (l) patch below the bristles.

PREALAR AREA OR KNOB (*pra*).—The upper posterior caudal extension of the sternopleuron below and in front of the insertion of the wing; sometimes more or less separated by a suture from the sternopleuron; for bristles and scales, see *pra*.

PRESCUTELLAR.—A more or less broad median posterior area of the mesonotum immediately in front of scutellum, frequently without setae or scales on the central and posterior part (bare space); bristles in several rows located laterad of this area on each side, often difficult to separate anteriorly from the dorsocentrals; curved, more or less complete line of scales around the "bare space" and sometimes among the bristles.

PROPLEURON (*ppl*).—In descriptive terminology, an elongate sclerite extending from the base of the forecoxa dorsad to the anterior pronotum and continuous at its lower edge with the prosternum (descriptive) cephalomesad; for bristles and scales, see *ppl*.

PROSTERNUM (*pst*).—In descriptive terminology, the sclerite separating the two forecoxae anteriorly; continuous laterally with propleuron; for scaling, see *pst*.

psp.—Postspiracular area (see); bristles and scaling on this area; sometimes extending on membrane caudad of sclerite.

pst.—Prosternum (see); frequently with scaling which may be continuous with that of *ppl* and *acx*.

SCALING.—The most common type of scaling pattern in the Culicinae is indicated in the figures; the pattern usually follows the lines or patches of bristles.

SCUTAL ANGLE.—A more or less distinct lateral projection of the mesonotum just in front of the mesothoracic spiracular depression; a short suture usually extends caudomesad from scutal angle.

SCUTELLAR.—Bristles and scales on the scutellum; bristles are usually confined to the caudal border; the scaling is varied but frequently is distinctly separated into a median patch and a pair of lateral patches.

SCUTELLUM.—Transverse sclerite caudad of mesonotum and separated from it by a more or less distinct suture; mesoscutellum; sometimes with midlobe and a pair of lateral lobes.

sp.—Spiracular area (see) and bristles or scales on this area.

SPIRACLES.—Mesothoracic spiracle in a depression ventrad and just caudad of scutal angle and caudad of upper end of posterior pronotum; metathoracic spiracle caudad of mesepimeron and cephaloventrad of haltere.

SPIRACULAR AREA (*sp*).—A small sclerite in the anterior and dorsoanterior part of the mesothoracic spiracular depression; bristles or scales on this area.

ssp.—Subspiracular area (see); scales and rarely hairs in this area, usually restricted to lower part between lower end of posterior pronotum and sternopleuron.

STERNOPLEURON (*stp*).—The major part of the mesepisternum forming the largest and most conspicuous central area of the pleuron, separating ventrad the forecoxa from the midcoxa; bristles and scales located on this sclerite (see *stp*).

stp.—Sternopleuron (see); bristles and scales located on this sclerite; bristles usually forming an upper (u) horizontal line and a posterior (p) vertical line, frequently the 2 lines connected to form a single arcuate line; scaling varied but often in an upper (u) patch below the upper bristles and a lower patch (l) in front of posterior bristles.

SUBSPIRACULAR AREA (*ssp*).—A rather indefinite area caudad of posterior pronotum, below the mesothoracic spiracle and cephalad of sternopleuron; usually continuous with or connected to postspiracular area; homology obscure (see description of family); scales and rarely bristles or hairs on this area, the upper patch immediately below spiracle is the hypostigial, the lower the *ssp*.

SUPRAALAR.—A rather indefinite lateral area of mesonotum mesad of paratergite and wing; the anterior part may be referred to as the antealar (see), the remainder as the supraalar proper; bristles in this area; a straight or curved scale line in this area, sometimes connected to antealar scale patch and extended almost to scutellum (fig. **305**).

WING ROOT.—Area of insertion of mesothoracic wing; frequently reference is made to area "in front of wing root," this pertains to the lateral portion of mesonotum cephalad of wing root to the scutal angle and dorsomesad to posterior dorsocentral lines including antealar area and part of supraalar area.

LEGS

(Fig. **406**)

BRISTLES.—See orientation.

CLAWS.—Usually a pair at tip of each leg, morphologically part of pretarsus but appearing to arise from tarsal segment 5; the pair on the foreleg, midleg, and hindleg referred to respectively as foreclaws, midclaws, and hindclaws; the 2 members of each pair referred to as anterior and posterior in the orientation (see) used for describing surfaces of leg segments.

COXA.—Basal segment of leg; poorly studied; surfaces generally described in normal resting position (not as in other leg segments) as outer, inner, anterior, and posterior.

EMPODIUM.—A small median projection, often a branched spicule, of the pretarsus between the 2 claws.

FEMUR.—The third major segment of the leg, separated from the coxa by the trochanter; usually somewhat compressed, at least at base, so that a ventral and dorsal margin can be distinguished; surfaces, scaling, and bristles described in the outstretched orientation (see); forefemur in resting position usually with anterior surface rotated dorsad so that ventral margin is anteroventral.

FOREFEMUR LENGTH.—Measured from articulation of trochanter to apex along the ventral margin (anteroventral in resting position).

NOMENCLATURE.—Legs described respectively as foreleg, midleg, and hindleg for the prothoracic, mesothoracic, and metathoracic appendages; individual segments described as forecoxa, foretrochanter, forefemur, foretibia, foretarsus, foreclaws (pretarsus), and so on.

ORIENTATION.—Surfaces of trochanter, femur, tibia, tarsus, and pretarsus described as anterior, posterior, dorsal, and ventral with the leg projected at a right angle to the thorax; coxal surfaces described in the normal resting position.

PLANTAR SURFACE.—Ventral surface of tarsus.

PRETARSUS.—Terminal segment of leg, appearing as the apex of tarsal segment 5; consisting chiefly of the claws (usually paired), unguitractor plate, empodium, and pulvilli.

PULVILLI.—A pair of small lobes of the pretarsus projecting one under each claw, sometimes spiculate, frequently not developed.

SCALING.—See orientation.

SURFACES.—See orientation.

TARSUS.—The fifth segment of the leg, always divided into 5 segments which are numbered 1–5 from proximal to distal and referred to as foretarsal segment 1,2,3,4,5, and so on.

TIBIA.—The fourth major segment of the leg, distal to the femur; usually more or less cylindrical and with a subapical or apical spiniform (spur) or other specialized setae.

TROCHANTER.—Intermediate segment of leg between coxa and femur, more or less firmly ankylozed with the femur; largely neglected in descriptions.

WING

(Fig. **406**)

ALULA.—A small lobe at posterior base of wing separated from the main part of wing by the axillary or jugal incision and followed basad by the upper calypter.

ANAL VEIN.—Vein 1A; vein 6.

APEX.—The most distant point of wing (exclusive of fringe) in the normal position of orientation (see) and determined by projecting a line at a right angle to longitudinal axis of the costal vein; also the most distant point of a longitudinal vein where it joins the wing margin.

ARCULUS.—A more or less distinct crossvein or transverse fold connecting the bases of veins M and Cu to the radius.

BASAL SPUR.—A longitudinal proximal extension of vein Rs or vein R_{4+5} when these are sharply bent in the form of a crossvein near their points of origin.

BASICOSTA.—A small sclerite at the anterior base of wing separated from the costa by a membranous area and by an extension of vein Sc (from the ventral surface); humeral plate.

CELL M_2.—Measured along the longitudinal axis of vein M from the point of separation of veins M_{1+2} and M_{3+4} to the apex of vein M_{1+2}; this length usually compared to the length of vein M, on the same axis, from the point of junction of crossvein *m-cu* to point of separation of veins M_{1+2} and M_{3+4}.

CELL R_2.—Measured along projection of longitudinal axis of vein R_{2+3} from the point of separation of veins R_2 and R_3 to the apex of vein R_2; this length compared to the stem of the cell (vein R_{2+3}), measured on the same axis, from the point of separation of veins R_{2+3} and R_{4+5} to the point of separation of veins R_2 and R_3.

CELLS.—Membranous parts of the wing bounded by veins or wing margin; named after the vein immediately anterior to the cell.

COSTA.—Vein C; a strong convex vein forming the anterior border of the wing and continued around apex along posterior margin.

CROSSVEINS.—Secondary connecting veins between longitudinal veins, frequently poorly developed; usually more or less transverse to the longitudinal axis of the wing but sometimes displaced longitudinally; the following crossveins are usually present in mosquitoes: (1) humeral (*h*) near the base of the wing between veins C and Sc, (2) subcostal (*sc*) between veins Sc and R usually before the middle of the wing, (3) radio-medial (*r-m*) usually between veins R_{4+5} and M and sometimes between veins Rs and M, (4) mediocubital (*m-cu*) between veins M and Cu_1.

CUBITUS.—Vein Cu and its 2 branches; vein 5.

DARK SPOTS (fig. 235).—There is no general agreement in the terminology of dark scale spots or areas on the anterior part of the wing, but the following has been used here as illustrated: (1) *basal* between the basal and prehumeral pale spots, (2) *prehumeral* just before the humeral crossvein, (3) *subbasal* distad of humeral pale spot, usually large and sometimes including prehumeral or even basal dark spots, (4) *median* near the middle of the wing, usually large, (5) *preapical* (*subapical*) beyond the subcostal pale spot, frequently broken, (6) *apical* distad of preapical (accessory subcostal) pale spot and proximad of apical pale spot; see also pale spots.

FRINGE.—More or less extensive border of scales or hairs projecting from margin of wing, chiefly on posterior margin but extending to apical portion of anterior margin; frequently with pale areas at end of veins.

FURCATION.—Point of separation or branching of veins, particularly R_1 and Rs, R_{2+3} and R_{4+5}, R_2 and R_3,M_{1+2} and M_{3+4}, Cu_1 and Cu_2.

HUMERAL CROSSVEIN.—Crossvein *h*.

HUMERAL PLATE.—Basicosta (see).

LOWER CALYPTER.—Lower of the 2 lobes connecting the alula of the wing to the thorax.

MARGINS.—Anterior or costal margin from the basicosta to the apex; posterior or anal margin from the apex to the alula.

MEDIA.—Vein M and its branches; vein 4.

MEMBRANE.—The transparent or translucent portion of the wing between the veins and/or margins; usually with microtrichia; frequently iridescent; sometimes infuscated.

MICROTRICHIA.—Minute spicules on the wing membrane, usually visible as fine dots at medium magnification.

ORIENTATION.—Wing extended horizontally and costal vein at a right angle to the longitudinal axis of the body.

PALE SPOTS (fig. 235).—There is no general agreement in the terminology of pale scale spots or areas on the anterior part of the wing, but the following has been used here as illustrated: (1) *basal* at extreme base of vein C, (2) *prehumeral* before the humeral crossvein and usually separated from it by prehumeral dark spot, (3) *humeral* at or slightly beyond humeral crossvein, (4) *sectoral* on veins C, Sc, and R before furcation of R_1 and Rs and between subbasal and median dark spots, (5) *accessory sectoral* sometimes developed on vein R just before or at furcation of R_1 and Rs and usually separated by dark spot from sectoral, (6) *subcostal* at and beyond end of vein Sc between median and subapical dark spots, (7) *accessory subcostal* (*preapical*) between preapical and apical dark spots, (8) *apical* usually at extreme apex of wing distad of apical dark spot, sometimes not developed.

PLICAL SCALES.—A group of scales on the ventral surface of the wing at the base of the plical vein and extending to base of vein 1A.

PLICAL VEIN.—A concave vein in the plical furrow immediately behind vein Cu, usually not reaching wing margin.

PLUME SCALES.—Outstanding or erect scales on wing veins, usually conspicuous on ventral surface; sometimes conspicuous on dorsal veins, particularly R_{2+3}, R_2, and R_3; often long and narrow.

PREARCULUS.—A more or less distinct crossvein or transverse furrow between veins R and Sc in line with arculus.

RADIAL SECTOR.—Vein Rs and its branches.

RADIUS.—Vein R; the most prominent dorsal vein near anterior border of the wing, appearing as the first vein caudad of vein C since the subcostal vein is concave and in a deep furrow; R and R_1 correspond to vein 1; Rs, R_{2+3}, R_2, and R_3 to vein 2; R_{4+5} to vein 3.

REMIGIAL BRISTLES.—More or less conspicuous bristles arising on the posterior margin of the basal part of vein R before the arculus.

REMIGIUM.—Basal part of vein R; frequently with posterior bristles (remigial).

SCALE PATTERN.—Sometimes extremely complex and difficult to describe; usually described in relation to veins; for special terminology of the pattern of the anterior part of the wing, see dark spots and pale spots.

SPUR.—See basal spur.

SQUAMA.—See upper calypter.

SQUAME SCALES.—Scales lying close against the veins, usually short and broad.

SUBCOSTA.—Vein Sc.

SUBCOSTAL BRISTLES.—A group of bristles on the ventral surface of the wing on the base of the subcostal vein (Sc).

SUBCOSTAL CROSSVEIN.—Crossvein *sc;* possibly represents vein Sc_2.

UPPER CALYPTER.—The upper (distal) of 2 membranous lobes connecting the alula to the thorax; squama.

VENATION.—The nomenclature of the venation used here is a modification of the Comstock-Needham system, which is illustrated in figure **406**; the homologies with the artificial system of nomenclature are indicated under the individual longitudinal veins.

HALTERE
(Figs. **406, 407**)

KNOB.—Distal part of haltere; usually more or less distinctly swollen in life, shriveled in dry specimens; sometimes some indication of venation evident.

ORIENTATION.—Haltere extended horizontally at a right angle to the longitudinal axis of the body.

STEM.—Elongate proximal part of haltere, its base usually somewhat enlarged.

ABDOMEN
(Fig. **406**)

LATEROTERGITE.—Lateral portion of abdominal tergite I, more or less distinctly separated from median dorsal part, usually not visible from above.

LENGTH.—Measured from base of tergite I to apex of tergite VII; this measurement is very inaccurate as specimens vary in the degree of extension of the abdomen.

STERNITE.—The more or less distinct ventral sclerite of each abdominal segment; frequently poorly developed or entirely membranous on segment I.

TERGITE.—The dorsal sclerite of each abdominal segment; that of segment I with a laterotergite.

I-VII.—Abdominal segments I-VII; tergites and sternites of these segments.

FEMALE GENITALIA
(Fig. **408**)

ATRIUM.—More or less distinct external genital chamber located ventrally between the caudal margin of sternite VIII and the anterior margin of the postgenital plate and containing the gonopore and the spermathecal and mucus gland openings; it is often bounded anteriorly by the sigma which may have a detached anterior median insula and posteriorly by the cowl; the sigma and cowl may articulate laterally; additional atrial plates may be present in the roof of the atrium.

BURSA COPULATRIX.—A large internal pouch probably representing a highly developed atrium.

CERCUS.—A pair of more or less conspicuous lateral appendages of the proctiger.

COWL.—A more or less strongly developed transverse arcuate sclerite caudad of the atrium and forming its posterior lip; sometimes complex or fused with base of postgenital plate; frequently articulating laterally with the sigma

GONOPORE.—A single median opening of the common oviduct in the anterior part of the atrium, separate from the spermathecal opening.

INSULA.—A more or less distinct median sclerite between the posterior border of sternite VIII and the sigma, sometimes fused with latter.

POSTGENITAL PLATE.—A median ventral sclerite caudad of the atrium or the cowl if latter developed; probably representing the ventral part of the proctiger.

PROCTIGER.—The anal lobe comprising all the structures distad of segment IX and including a tergal portion, the cerci, and the postgenital plate.

SEGMENT VIII.—Sometimes with reduced tergite and sternite and with extensive basal membrane so that it may be completely retracted into segment VII.

SIGMA.—A more or less strongly developed arcuate sclerite caudad of sternite VIII and forming the anterior lip of the atrium; sometimes a small proximal median part developed as the insula; the sigma frequently articulating laterally with the cowl.

SPERMATHECA.—One to 3 internal sclerotized bulbous seminal receptacles opening into the atrium by a single median pore caudad of the gonopore.

SPERMATHECAL OPENING.—A single median opening of the spermathecal duct in the posterior part of the atrium, separate from the gonopore.

STERNITE VIII.—Sternite of segment VIII, usually more or less elongate and overlapping ventrally and protecting the atrium; sometimes called the subgenital plate.

TERGITE VIII.—Tergite of segment VIII, usually shorter than corresponding sternite; sometimes highly modified.

TERGITE IX.—A more or less distinct dorsal transverse sclerite between tergite VIII and the proctiger.

VII, VIII.—Abdominal segments VII and VIII and the corresponding tergites (dorsal) and sternites (ventral).

MALE GENITALIA
(Fig. **408**)

AE.—Aedeagus (see).

AEDEAGUS (AE).—Median structure of phallosome, presumably the intromittent organ; often in the form of a troughlike structure or open tube; penis; mesosome.

APICOSTERNAL LOBE, ANGLE, OR AREA.—The most distal sternal area of the sidepiece, sometimes produced into an angle or a lobe.

APICOTERGAL LOBE, ANGLE, OR AREA.—The most distal tergal area of the sidepiece, sometimes produced into an angle or a lobe.

APPENDAGE OF CLASPETTE.—Specialized apical seta of claspette, usually flattened and more or less bladelike; filament.

BASAL MESAL LOBE (BML).—Basal lobe on mesal surface of sidepiece, usually more or less connected sternally with its mate; probably homologous with claspette.

BASAL PIECE (BP).—Basal supporting sclerite of phallosome; often connected to mesal tergal angle of sidepiece; articulating with ventral paramere and sometimes with dorsal paramere and base of proctiger; basal plate.

BASAL STERNAL PROCESS (BSP).—In Culicini, a sternally directed process from the base of the proctiger (fig. **90**).

BASAL TERGOMESAL LOBE OR AREA (BTL).—Basal lobe on mesal angle of tergal surface of sidepiece; not homologous with basal mesal lobe; often called basal lobe.

BASOLATERAL SCLEROTIZATION.—More or less differentiated sclerotized area or bar laterally at base of proctiger; often articulating with tergite IX and the basal piece of phallosome; sometimes confluent with basal part of paraproct sclerotization.

BML.—Basal mesal lobe of sidepiece (see).

BP.—Basal piece of phallosome (see).

BRIDGE.—A transverse sclerotization connecting larger sclerotized lateral areas on tergite IX or aedeagus.

BSP.—Basal sternal process (see).

BTL.—Basal tergomesal lobe or area of sidepiece (see).

C.—Clasper (see).

CERCAL SCLERITE(S).—A pair of more or less distinct sclerites on tergal surface of proctiger, bearing cercal setae.

CL.—Claspette (see).

CLASPER (C).—Movable appendage borne at or near apex of sidepiece; dististyle.

CLASPETTE (CL).—A mesal or sternomesal lobe at base of sidepiece, usually connected sternally with its mate; probably homologous with basal mesal lobe; not homologous with basal tergomesal lobe (basal lobe of authors).

D.—Dorsal surface.

DORSAL ARM.—Tergal arm of outer division of phallosome.

DORSAL PARAMERE.—One or 2 pairs of sclerites of phallosome articulating with ventral paramere and basal piece; possibly homologous with outer division of phallosome.

DV/D (fig. **99**).—Ratio of the distance between the apices of the lateral spine of the inner division of the phallosome (ventral arm) and the tergal arm of the outer division (DV) on one side, to the distance between the 2 tergal arms of the outer division of the phallosome (D), measured in undissected specimens with the genitalia in the normal retracted position.

FILAMENT.—Specialized apical seta of the claspette, often bladelike; appendage of claspette.

FOLIFORM.—Flattened leaflike seta.

ID.—Inner division (see).

INNER DIVISION (ID).—In Culicini the sternal and most mesal part of the lateral plate of the phallosome in the normal resting position.

INTERLOBAR SPACE.—Distance between the pair of lobes of tergite IX.

L.—Lateral surface.

LA.—Lateral arm of outer division of lateral plate of phallosome.

LANCEOLATE SETA.—Seta with spearlike flattened apex, sometimes bladelike for considerable distance proximad.

LATERAL PLATE (LP).—Lateral paired sclerotizations of the phallosome, specifically in Culicini; also applied to lateral sclerotization of aedeagus.

LEAF.—A foliform seta; specifically seta *g* of subapical lobe in Culicini.

LP.—Lateral plate (see).

M.—Mesal surface.

MESAL MEMBRANE.—Unsclerotized area on the mesal surface of the sidepiece.

OD.—Outer division (see).

ORIENTATION.—In the morphological nonrotated position; dorsal and tergal, ventral and sternal, and right and left are used in the morphological sense; in the drawings, the conventional orientation with the proximal part at the bottom of the page is used.

OUTER DIVISION (OD).—In the Culicini, the tergal and lateral part of the lateral plate of the phallosome in the normal resting position.

PA.—Ventral paramere (see) or entire paramere (see).

PARAMERE (PA).—One or more pairs of lateral sclerites of the phallosome, articulating with the basal piece and directly or indirectly with the aedeagus; apparently used in mating to extrude the aedeagus and/or to secure a firm hold in the atrium of the female; see dorsal and ventral paramere.

PARAPROCT.—Pair of lateral or ventrolateral longitudinal sclerotizations of the proctiger, sometimes produced on apex as a spine or a series of denticles or teeth.

PENIS FILAMENT.—In some Dixinae, a long slender median filament which may be the true aedeagus or penis; in resting position it is deeply retracted.

PH.—Phallosome (see).

PHALLOSOME (PH).—The median complex of structures around the gonopore between the proctiger, sidepieces, and sternite IX; composed of aedeagus, ventral and sometimes dorsal parameres, and the basal piece; homologies of various components poorly understood.

PR.—Proctiger (see).

PROCTIGER (PR).—The anal lobe including all the structures distad of segment IX and bearing the anus.

S.—Sternite.

SAL.—Subapical lobe (see).

SETAE *a-h*.—Setae on subapical lobe of sidepiece (fig. **90**) in the Culicini.

SIDEPIECE.—The most conspicuous component of the genitalia; one of a pair of large lateral articulated appendages arising from segment IX and bearing the clasper distally; basistyle.

SP.—Spiniform(s) (see) of the clasper; appendage, claw.

SPINIFORM (SP).—More or less spinelike seta; specifically, the differentiated seta(e) at or near apex of clasper, frequently flattened or variously modified and markedly different in form from other setae.

STEM.—Basal portion of the claspette from which arises apically the specialized seta known as the filament (see).

STERNOMESAL MARGIN.—Margin of sidepiece between the sternal sclerotization and the mesal membrane.

SUBAPICAL LOBE (SAL).—In the Culicini, a more or less prominent lobe of the sidepiece directed mesotergad, frequently near or beyond middle of sidepiece, usually bearing highly modified setae; possibly a highly modified homolog of the basal mesal lobe and claspette.

T.—Tergite.

TA.—Tergal arm of the outer division (see) of the lateral plate of the phallosome in the Culicini.

TERGITE LOBE (IX-TL).—Paired or unpaired caudal lobe on tergite IX, frequently bearing hairs or bristles distally.

TERGOMESAL MARGIN.—Margin of sidepiece between the tergal sclerotization and the mesal membrane.

V.—Ventral surface.

VENTRAL ARM.—Lateral spine of inner division (see) of the lateral plate of the phallosome in the Culicini.

VENTRAL PARAMERE (PA).—Basal sclerite articulating directly with the aedeagus and the basal piece; probably used to extrude the aedeagus in mating; paramere.

IX-S.—Ninth sternite.

IX-T.—Ninth tergite.

IX-TL.—Tergite lobe (see) of segment IX.

IMMATURE STAGES

In this section the general terminology which pertains to both pupae and larvae is mentioned. For specific terminology applied to pupae and larvae, see the following two sections.

GENERAL

CHAETOTAXY.—The pattern and branching of setae; for nomenclature, see the subsection on chaetotaxy below.

COLORATION.—Coloration is described in very general terms, as it is extremely variable and reference to standard color charts would be of little value or even misleading. Structures are described as black, dark, brown, pale, light, yellowish, greenish, heavily pigmented, moderately pigmented, lightly pigmented, very lightly pigmented, unpigmented, or iridescent. In some species brown, gray, or green color phases may be present but are not mentioned. Color patterns are described in general terms only.

CUTICULAR PROJECTIONS.—Two basic types of external projection are distinguished; (1) SPICULES (see below), which are nonarticulated, and (2) SETAE (see below), which are articulated sense organs arising from a basal alveolus.

INTEGUMENTARY SCULPTURING.—External surface ornamentation of sclerotized parts, usually not sharply differentiated and sometimes grading into spicules of various type; generally showing a more or less distinct pattern; usually described as RETICULATE, IMBRICATE, or TRACHEOID, strong, moderate, or weak.

L.—Length.

W.—Width.

SPICULES

All structures considered as spicules are simple external projections of the integument, solid or hollow, always without alveolus or distal filament of sense cell at base; apparently with unsclerotized basal integument in some filamentous or hairlike spicules.

DENTICLE.—Small toothlike spicule.

FILAMENTOUS.—Long, slender, flexible, and attenuate apically.

HAIRLIKE.—Resembling a true hair or seta; long, slender, stiff, and pointed; setiform.

SERRATIONS.—A linear series of denticles usually with somewhat recurved apex.

SETIFORM.—Resembling a seta; hairlike (see).

SPINE.—Very large heavy spicule, usually with sharp apex.

SPINULE.—A small spinelike spicule.

TOOTH.—Large heavy spicule, usually with blunt or divided apex.

SETAE

(Fig. **412**)

All types of setae arise from a basal alveolus and apparently are always supplied with a nerve ending.

b.—Branched (see).

BARBED.—With short but conspicuous and rather heavy lateral branches arising from the main stem or branch.

BRANCHED (*b*).—With branches arising at base or within the basal third.

BRUSH TIP.—With conspicuous moderately long numerous branches near apex of main stem.

d.—Dendritic (see).

DENDRITIC (*d*).—With irregular or dichotomous treelike branching.

f.—Forked (see).

FORKED (*f*).—With a few conspicuous branches arising from main stem beyond basal third.

HAIR.—In broad sense any seta; in restricted sense a seta with long, slender stem and attenuate apex.

PALMATE.—With flattened, movable, usually horizontal branches arising from a short stem.

PECTINATE.—With numerous long branches arising entirely or largely on one side of the main stem.

PLUMOSE.—With numerous long branches arising on opposite sides of the main stem.

SIMPLE.—Without distinct barbs or spicules on main stem or branches; actually under high magnification may show minute spicules.

SINGLE.—Unbranched; may be simple or barbed or spiculate.

SPICULATE.—With very short and inconspicuous, slender lateral spicules on main stem or branch.

SPIKES.—Thickened, stiff hairs or hair branches.

SPINIFORM.—More or less thickened, spinelike, and not markedly attenuate apically; may be single, forked, or even branched.

STELLATE.—With stiff, not markedly attenuate branches radiating from or near base.

CHAETOTAXY

ELEMENTS.—All the individual elements of the chaetotaxy are true setae and are called hairs although some of them are not hairlike in appearance; all are apparently sense organs of some type, since all seem to have a connection at base to the distal filament of a sense cell.

HOMOLOGY (fig. **409**).—The constancy of the chaetotaxy pattern in the different instars of the immature stages throughout the family Culicidae (in the broad sense) suggests that this chaetotaxy is of monophyletic origin and consists of elements that are homologous phylogenetically as well as ontogentically and in part serially (at least on the abdomen). Attempts to homologize the chaetotaxy have been hampered by the complexity of the pattern and the lack of reliable direct criteria. In the course of the present study I have seen several slides of prepupal fourth instar larvae in which nerve connections between the external hairs of the fourth instar larva and the internal developing hairs of the pupa show very clearly (fig. **409**). These connections provide for the first time an absolute criterion of ontogenetic homology of the elements of the mosquito chaetotaxy and demonstrate the sensory nature of the hairs. It is well known that setae and various other cuticular modifications in insects are connected to distal filaments of sensory neurones to form sensilla of different types. Wigglesworth (1953) showed that the cuticular portions of some sensilla in the bug *Rhodnius* are reformed in successive instars by the identical tormogen and trichogen cells which formed the preceding sensillum and that the new sensillum is innervated by a branch from the distal filament of the original sensory neurone. Owing to this relationship of the sensory filament, the sensillum of the older instar remains functional while the new sensillum of the following instar is being formed under the loosened cuticula. In mosquitoes there is a dramatic change in morphology between the fourth instar larva and the pupa, but the majority of the sensilla are carried over from the larva to the pupa as shown by the nerve connections. Owing to differential growth of the integument of the pupa, the new sensilla come to occupy very different positions from those of the larva but retain the nerve connection by the elongation of the original branch of the distal sensory filament. The different sensilla develop at different times; this allows for shifts in position which can be clearly seen in the crossing of filaments from different sensilla (fig. 409). Common innervation thus demonstrates beyond any question the ontogenetic homology of individual hairs from the fourth instar larva to the pupa. It is very probable that it will be possible to demonstrate the homology of individual hairs in a similar fashion all the way from the first instar to the pupa. Unfortunately, nerve connections are visible apparently only during a short critical period, perhaps just before the branch of the filament to the old sense organ is dissolved. It is of interest that remnants of filaments are frequently found on the ental surface of the exuviae of both fourth instar larvae and pupae where they can be seen to be attached to the rim of the alveoli of the various hairs. Serial homology and phylogenetic homology of the chaetotaxy, of course, cannot be proved in this manner but the similarity in the pattern on the abdominal segments, at least, is strongly suggestive of serial homology, and the constancy of the pattern on all body regions throughout the family likewise probably indicates phylogenetic homology.

In the present work, I have attempted to reinterpret the homologies of the larval and pupal hairs on the basis of common innervation seen more or less clearly and more or less completely in specimens representing the following groups: *Bironella* (*Brugella*), *Anopheles* (*Nyssorhynchus*), *Anopheles* (*Cellia*), *Uranotaenia, Culex* (*Culex*), *Hodgesia, Ficalbia* (*Etorleptiomyia*), *Aedes* (*Stegomyia*) (fig. 409), and *Tripteroides* (*Rachionotomyia*). It has not been possible to see the innervation for all the hairs in any of these specimens, but such constancy has been found in all that I believe the interpretations I have reached are likely to be correct in general. There remain many moot points, particularly with respect to hairs on abdominal segments I and II of the larva. Only after much additional study of all stages, particularly the first instar larva, will it be possible to demonstrate the ontogenetic homologies beyond any question in all groups of mosquitoes. Phylogenetic homologies (between different species) are frequently difficult to establish, are made by inference only, and can never be definitely proved; therefore there will always be differences of opinion regarding such homologies. Serial homologies (between different segments in a given species) are also difficult to determine and may not exist except between some segments of the abdomen, within the thorax, and possibly between the thorax and abdomen. In spite of these inherent difficulties, I have attempted to determine both phylogenetic and serial homologies in addition to the ontogenetic homologies for the fourth instar larva and pupa. This has been done by comparing the chaetotaxy patterns of primitive forms in all the groups. I consider that for any given body region (head, thorax, and abdomen) or any given segment the chaetotaxy is homologous throughout the family; this is reflected in the terminology employed by the use of the same number for the corresponding hair in different species. In many instances the homologies are tentative only and many discrepancies are evident, particularly on the head and thorax; usually the questionable homologies have been noted in the text. Serial homologies are implied through the use of the same numbers only within abdominal segments I-VII of the larva and I-VIII of the pupa, although they may be more or less applicable also within the segments of the thorax of the larva. Ontogenetic homologies are indicated by the use of the same numbers everywhere in the larva and pupa except between the head, antenna, thorax, segment VIII, and terminal segments of the larva and the cephalothorax, segment VIII, terminal abdominal segments, and paddle of the pupa; in these regions independent terminologies are used for the larva and pupa (Belkin, 1952).

TERMINOLOGY.—The numerical terminology of Belkin (1951; 1952; 1953*b*; 1954), with modifications in homologies determined by the methods indicated above, is used throughout; in the text and keys the individual elements of the chaetotaxy are indicated by prefixing the number of the hair to the abbreviation for the segment, region, or structure, and this is followed by an abbreviation for the branching, as in:

1-C = head hair 1 of the larva; cephalothoracic hair 1 of pupa.
7-P,M,T = hair 7 on prothorax, mesothorax and metathorax.
3-5-II = hairs 3,4, and 5 on abdominal segment II.
2,4-IV,VI = hairs 2 and 4 on abdominal segments IV and VI.
5-IV-VI usually 5-7b = hair 5 of abdominal segments IV,V, and VI usually with 5 to 7 branches arising near base.
6-II usually 3,4b (2–6) = hair 6 of abdominal segment II usually with 3 or 4 branches arising near base (range of branches 2 to 6).

PUPAE

(Fig. **410**)

GENERAL

(See also section on Immature Stages)

ABDOMEN (I-VIII).—For descriptive purposes not including paddle and terminal segments.

b.—Branched.

C.—Cephalothorax including metanotum (see both).

CEPHALOTHORAX (C).—Combined head and thorax; for descriptive purposes not including trumpet or metanotum; chaetotaxy including metanotum.

CHAETOTAXY.—See section on Immature Stages.

COLORATION.—See section on Immature Stages.

CUTICULAR STRUCTURES.—See section on Immature Stages.

d.—Dendritic.

f.—Forked.

HAIR TYPES.—See section on Immature Stages.

INTEGUMENTARY SCULPTURING.—See section on Immature Stages.

L.—Length.

MEASUREMENTS.—See under name of specific structure.

METANOTUM (C).—Separate small dorsal sclerite, appearing as part of abdomen; chaetotaxy considered with remainder of cephalothorax.

P.—Paddle (see).

PADDLE (P).—Movable or immovable pair of appendages appearing to arise from the caudolateral part of segment VIII.

s.—Dorsal sensillum of abdomen (see).

sp.—Spiracular sensillum of abdomen (see).

TERMINAL SEGMENTS.—For descriptive purposes abdominal segment IX, genital lobes, and proctiger but not including paddle.

TRUMPET.—Paired dorsolateral appendage of the cephalothorax, usually movable, containing the functional or nonfunctional (rarely) spiracle of mesothorax.

W.—Width.

I-VIII.—Abdominal segments I-VIII.

IX.—Highly modified abdominal segment IX, appearing as lobe of segment VIII; for descriptive purposes considered under Terminal Segments (see).

X.—Anal segment or proctiger; for descriptive purposes considered under Terminal Segments (see).

CEPHALOTHORAX (C)

(Fig. **410**)

ANTENNAL CASE.—Elongate paired case for the developing adult antenna, curving over the imaginal eye and extending ventrad of wing case; sexual differences apparent as in the adult.

HEAD SHIELD.—Median dorsal anterior sclerite, probably representing the dorsum of the head capsule; projects anteriorly in dissected mounted pupal skin.

IMAGINAL EYE.—Developing compound eye of the adult, represented internally by heavily pigmented optic lobe and externally by slight cuticular facets.

LEG CASES.—Elongate paired cases for the developing adult legs; terminal segments folded; prothoracic case most anterior and dorsal, metathoracic most posterior and ventral.

MIDDORSAL RIDGE.—More or less elevated and transversely striated longitudinal area surrounding the ecdysial line on the prothorax and mesothorax.

MOUTHPARTS CASES.—Complex median ventral cases for the developing adult mouthparts; the palpal case is usually conspicuously differentiated at base on each side.

PUPAL EYE.—Presumably the functional pupal eye; represented internally by a detached pigmented area caudad of the imaginal eye, apparently not indicated externally.

WING CASE OR PAD.—Broad paired case for the developing mesothoracic wing, forming most of the caudolateral part of the cephalothorax, overlying the leg cases and projecting under the metanotum and base of abdomen.

TRUMPET

(Fig. **410**)

INDEX.—Ratio of maximum length to median width (see length and width); difficult to determine as width varies depending on angle at which measured.

INNER WALL.—The internal lining of the lumen of the trumpet; usually more or less distinctly separated from outer wall in basal part; with numerous ental spicules distally, the latter sometimes fused into a perforated plate.

LENGTH.—Maximum length measured from point of articulation at base anteriorly to extreme apex.

MEATUS.—Part of trumpet from base to most proximal point of pinna (see); extent expressed as fraction of total length of trumpet.

PINNA.—Truncate part of the trumpet, sometimes funnel-shaped but frequently partially closed by ental spicules; shape difficult to determine in mounted or even preserved material; extent expressed as total length of trumpet.

RETICULATE.—Distal part of meatus of trumpet without distinct tracheoid integumentary sculpturing; extent expressed as fraction of total length of trumpet.

SLIT OF MEATUS.—More or less distinct slit or line extending proximad into meatus from the most basal part of the pinna.

TRACHEOID.—Proximal part of meatus of trumpet with more or less distinct tracheoid annulations on the external wall; maximum extent from base expressed as fraction of total length of trumpet.

WIDTH.—Median width of trumpet, measured at a right angle to the projection of the total length.

METANOTUM
(Fig. **410**)

HALTERE CASE.—Ventrolateral paired caudal projection from the metanotum for the developing haltere of the adult.

10-12-C.—Metanotal hairs.

ABDOMEN (I-VIII)
(Fig. **410**)

DORSAL SENSILLUM (*s*).—Small paired pitlike or alveoluslike sense organs usually restricted to segments III-V.

FLOAT HAIR.—Hair 1-I.

LENGTH.—Measured on middorsal line from anterior border of segment I to transverse projection connecting the most distal parts of segment VIII.

s.—Dorsal sensillum (see).

sp.—Spiracular sensillum (see).

SPIRACULAR SENSILLUM (*sp*).—Small dorsal or dorsolateral sense organ, apparently associated with a rudimentary, nonfunctional spiracle, usually present on segments I-VII; that of segment I usually large.

I-VIII.—Abdominal segments I-VIII.

PADDLE
(Fig. **410**)

ACCESSORY PADDLE HAIR.—Hair 2-P; frequently ventral in position.

EXTERNAL BUTTRESS.—Thickened sclerotized basal external part of paddle.

INDEX.—Ratio of maximum length (parallel to axis of midrib) to maximum width (at right angle to length).

INNER MARGIN.—Margin from apex to midrib (or its projection) to base along the inner or mesal part of paddle.

INNER PART.—Part of paddle mesad of midrib.

LENGTH.—Maximum length from basal articulation to most distal point, measured along a projection of the midrib.

MARGINAL SERRATIONS.—Toothlike spicules along the margin of the paddle, usually confined to external margin.

MARGINAL SPICULES.—Fine short acute or filamentous spicules along the margins of the paddle.

MIDRIB.—Thickened, sclerotized, central, more or less rodlike, supporting structure of the paddle involving usually both dorsal and ventral surfaces.

ORIENTATION.—In normal extended position with midrib more or less parallel to longitudinal axis of body.

OUTER MARGIN.—Margin from apex of midrib (or its projection) to base along the outer or lateral part of paddle.

OUTER PART.—Part of paddle laterad of midrib.

PADDLE HAIR.—Hair 1-P.

WIDTH.—Maximum width measured along a projection at a right angle to midrib.

TERMINAL SEGMENTS (IX, X)
(Fig. **410**)

ANAL LOBE (X).—Proctiger (see).

CAUDAL HAIR.—Hair 1-IX on median caudal lobe (see).

CERCAL HAIR.—Hair 1-X on the cercal lobe of females and corresponding area of the proctiger in males.

CERCAL LOBE.—In females a more or less distinct pair of lateral lobes on the anal lobe or proctiger.

FEMALE GENITAL LOBE.—Small inconspicuous lobe ventrad of anal lobe (proctiger) and indistinctly separated from it.

MALE GENITAL LOBE.—Conspicuous, often large composite lobe ventrad of anal lobe and usually distinctly separated from it; represented chiefly by the paired separate sidepiece lobes and a median phallosomal lobe which is indistinctly separated from anal lobe.

MEDIAN CAUDAL LOBE (IX).—Transverse lobe caudad of tergite VIII and dorsad of proctiger (anal lobe).

PROCTIGER (X).—Anal lobe, caudad and ventrad of median caudal lobe; in females usually with more or less distinct pair of lateral cercal lobes; sometimes with a pair of cercal hairs (1-X).

IX.—Abdominal segment IX; represented in both sexes chiefly by the tergal part or median caudal lobe (see); in males its sternite may be represented but is usually not distinct.

X.—Proctiger or anal lobe (see).

LARVAE

GENERAL

(See also section on Immature Stages)

A.—Antenna (see).

AU.—Aulaeum (see under Head).

b.—Branched.

C.—Head capsule.

CHAETOTAXY.—See section on Immature Stages.

COLORATION.—See section on Immature Stages.

CS.—Comb scale (see under Segment VIII).

CUTICULAR STRUCTURES.—See section on Immature Stages.

HAIR TYPES.—See section on Immature Stages.

INTEGUMENTARY SCULPTURING.—See section on Immature Stages.

L.—Length.

M.—Mesothorax.

MEASUREMENTS.—See under name of specific structure; all measurements in mm.

MP.—Mental plate (see under Head).

P.—Prothorax.

PT.—Pecten tooth (see under Spiracular Lobe and Siphon).

s.—Dorsal sensillum (see under Abdomen).

S.—Spiracular Lobe or Siphon in broad sense (see).

sp.—Spiracular sensillum (see under Abdomen).

W.—Width.

I-VII.—Abdominal segments I to VII.

VIII.—Abdominal segment VIII in restricted sense.

X.—Anal segment.

HEAD (C)

(Figs. **411, 412**)

ANTERIOR CLYPEALS.—In Anophelini, hairs 2,3-C.

AU.—Aulaeum (see).

AULAEUM (AU).—A more or less distinct plate between the mental plate and the anterior part of the labial plate (see).

C.—Head capsule.

CERVICAL AREA.—Area between the collar and thorax (prothorax), rarely with detached sclerite(s).

CLYPEAL SPINE OR HAIR.—Labral spine (see); hair 1-C.

COLLAR.—A more or less collarlike sclerite at the posterior end of the head, forming a ring around the foramen magnum.

ECDYSIAL SUTURE.—The forked dorsal suture of head capsule along which splitting occurs at ecdysis (molting); consisting of the large paired frontoclypeal sutures and a short median caudal coronal suture.

FRONTAL HAIRS.—In Anophelini, hairs 5-7-C.

FRONTOCLYPEAL SUTURE.—The conspicuous paired portion of the ecdysial suture (see); epicranial or frontal suture.

FRONTOCLYPEUS.—The conspicuous large median dorsal part of the head capsule separated laterally from ocular lobe by the frontoclypeal sutures.

HEAD CAPSULE.—External sclerotized integumentary part of the head exclusive of the appendages; composed of dorsal anterior labrum, large dorsal median frontoclypeus, paired lateral ocular lobes, and median ventral labial plate.

IMAGINAL EYE.—Developing eye of adult; indicated internally by pigmented tissue of optic lobe; indicated externally only by lighter pigmentation and sculpturing of head capsule on the ocular lobe.

INDEX.—Ratio of length to width as indicated in figure **412.**

INNER (ANTERIOR) CLYPEAL.—In Anophelini, hair 2-C.

LABIAL PLATE OR SCLERITE.—Median ventral part of head capsule, frequently separated from ocular lobe on each side by maxillary suture.

LABRUM.—More or less distinct area, usually sclerotized, at extreme anterior end of head capsule dorsally, usually indistinctly separated by internal ridge from frontoclypeus; preclypeus.

LARVAL EYE.—Small functional lateral stemma of the larva, caudad of the imaginal eye, indicated internally by pigmented tissue, indistinguishable externally.

LENGTH (L).—Measured along middorsal line from anterior edge of labrum to a transverse line drawn across the posterior border of the collar or, if latter not developed, of the ocular lobes.

MANDIBLE.—The more dorsal and lateral of the paired mouthpart appendages, appearing ental to the maxilla in resting position; not studied in detail in most groups.

MAXILLA.—The more ventral and mesal of the paired mouthpart appendages, appearing ectal to the mandible in resting position; with a distinct palpus and usually with a conspicuous seta on a basal subdivision which appears to be part of the head capsule; not studied in detail in most groups.

MAXILLARY PALPUS.—More or less cylindrical structure laterad of maxilla; more or less antennalike in Dixinae and Anophelini.

MAXILLARY SUTURE.—More or less distinct and complete suture separating the median ventral labial plate from the lateral ocular lobe on each side; extending from an anterior point just mesad of the ventromesal point of articulation of the maxilla posteriorly to the posterior tentorial pit and sometimes beyond the latter dorsally.

MEASUREMENTS.—See length and width.

MENTAL PLATE (MP).—More or less strongly sclerotized and pigmented toothed plate of the labial-hypopharyngeal complex, entad of aulaeum.

MOUTHBRUSHES.—A group of more or less filamentous or bladelike long flattened spicules borne on specialized sclerites laterad and ventrolaterad of labrum; frequently with differentiated apices; not shown in majority of drawings.

MP.—Mental plate (see).

OCULAR BULGE.—More or less prominent lateral rounded projection of the ocular lobe in dorsal aspect.

OCULAR LOBE.—Large paired sclerites of the head capsule between the dorsal frontoclypeus and the ventral labial plate.

OUTER (ANTERIOR) CLYPEAL.—In Anophelini, hair 3-C.

POSTERIOR CLYPEAL.—In Anophelini, hair 4-C.

POSTERIOR TENTORIAL PIT.—More or less distinct pair of integumentary pits from which arise the internal posterior tentorial arms; located on the ventral or ventrolateral part of the head capsule toward the caudal margin; interpreted here as being in the intersegmental area between the maxillary and labial portions of the head capsule.

WIDTH (W).—Measured at a right angle to the length at point of maximum width, usually at ocular bulge.

ANTENNA (A)
(Fig. **412**)

ANTENNAL HAIR.—Hair 1-A; shaft hair.

BASAL PART.—Part of antenna from base to point of insertion of hair 1-A, except where specified otherwise.

BASAL SENSILLUM.—A small dorsal basal pitlike or alveoluslike structure.

DISTAL PART.—Part of antenna from point of insertion of hair 1-A to apex, except where specified otherwise.

LENGTH.—Measured from dorsal lateral angle to apex; usually compared to length of head capsule.

ORIENTATION.—Surfaces described as dorsal, ventral, outer (lateral), and inner (mesal) with the antenna in its normal resting position; there is a tendency for the detached antenna to rotate out of this normal position.

PROXIMAL PART.—Basal part (see).

THORAX
(Figs. **411, 412**)

M.—Mesothorax.

NOTCHED ORGAN.—In Anophelini, a membranous eversible bilobed structure on each side of the prothorax, overlain by hair 0-P; often retracted in preserved specimens (fig. **41**).

P.—Prothorax.

PLEURAL GROUPS (fig. **412**).—Ventral or ventrolateral groups of setae 9–12 usually borne on a common tubercle; sometimes considered to represent vestiges of thoracic legs.

SHOULDER HAIRS.—Hairs 1-3-P.

sp.—Spiracular sensillum (see under Abdomen).

T.—Metathorax.

ABDOMEN (I-VII)
(Fig. **411**)

ACCESSORY TERGAL PLATE.—In Anophelini, each of one or more small median dorsal sclerites caudad of the tergal plate.

DORSAL SENSILLUM (*s*).—Small pitlike or alveoluslike sense organ, usually found on segments III-V only.

LATERAL HAIR.—Hair 6 or sometimes 7.

s.—Dorsal sensillum (see); usually restricted to segments III-V.

sp.—Spiracular sensillum (see); usually present on segments I-VII.

SPIRACULAR SENSILLUM (*sp*).—Small dorsal or dorsolateral sense organ, apparently associated with a rudimentary, nonfunctional spiracle, usually present on segments I-VII of abdomen and on mesothorax and metathorax.

SUBDORSAL HAIR.—Usually hair 1.

TERGAL PLATE.—In Anophelini, a small dorsal sclerite near the anterior border of one or more of the segments.

SEGMENT VIII
(Fig. **411**)

COMB.—A row or patch of enlarged specialized spicules in the middle of each side; sometimes arising from the posterior border of a plate or saddle.

COMB PLATE.—A sclerotized lateral plate bearing comb scales along its posterior border; sometimes connected with its mate dorsally to form a saddle; not homologous with tergal plate.

COMB SCALE (CS).—Individual enlarged specialized spicule forming part of the comb; may be scalelike, spinelike, spatulate, lanceolate, and so on.

CS.—Comb scale (see).

PENTAD HAIRS.—Hairs 1-5-VIII.

sp.—Spiracular sensillum (see under Abdomen).

TERGAL PLATE.—More or less extensive sclerotization with center tergally near anterior border of segment, not involving the comb.

SPIRACULAR LOBE OR SIPHON (S)
(Figs. **411, 412**)

ACCESSORY DORSOLATERAL HAIRS.—Hairs 2a-S.

ACCESSORY VENTROLATERAL HAIRS.—Hairs 1a-S.

ACUS.—A small attached or detached sclerotized area at the base of the siphon ventrolaterally (fig. **412**), rarely a complete basal ring (*Mansonia*).

DORSOLATERAL HAIRS.—Hairs 2a-S.

DORSOLATERAL VALVE OR LOBE.—The more dorsal of the 2 pairs of lateral lobes on the apex of the siphon or spiracular lobe.

MEDIAN CAUDAL FILAMENT.—A slender process projecting between the ventrolateral valves of the siphon, arising apparently from the basal retractile sclerites of the spiracular apparatus.

MEDIAN DORSAL VALVE OR LOBE.—Unpaired median dorsal lobe on the apex of the siphon or spiracular lobe.

PECTEN.—A paired comblike row of spicules along the ventrolateral border of the siphon; in Anophelini, the pecten plate.

PECTEN PLATE.—In Anophelini, a pair of lateral sclerotized toothed plates connected ventrally at base and located on the sides of the spiracular lobe; probably homologous with sclerotization of siphon.

PECTEN TOOTH (PT).—The individual enlarged and specialized spicule of the pecten or pecten plate (Anophelini); may be scalelike, spinelike, spatulate, denticulate, and so on.

PT.—Pecten or pecten tooth (see).

S.—Siphon or spiracular lobe (see).

SIPHON (S).—Air tube of the typical non-anopheline mosquitoes; morphologically includes part of abdominal segments VIII and IX; homologous with spiracular lobe; sclerotized part of the siphon probably homologous with pecten plate of Anophelini.

SIPHONAL TUFT.—Hair 1-S.

SIPHON INDEX.—Ratio of dorsal length to median width (see siphon length and siphon width).

SIPHON LENGTH.—Measured dorsally from base to apex (fig. **411**).

SIPHON WIDTH.—Measured at a right angle to projection for length measurement at midpoint of length (fig. **411**).

SPIRACULAR LOBE.—The homolog of the siphon in forms without a sclerotized air tube; bears the functional spiracles, lobes corresponding to the valves, and sometimes a pecten plate.

STIRRUP-SHAPED PIECE.—Complex internal sclerite near apex of siphon, involved in retraction and protraction of the spiracular apparatus including valves and tracheae.

TRACHEA.—Each of a pair of tracheae within the siphon, usually very strongly developed.

VENTROLATERAL HAIRS.—Hairs 1,1a-S.

VENTROLATERAL VALVE OR LOBE.—The more ventral of the 2 pairs of lobes on the apex of the siphon or spiracular lobe.

ANAL SEGMENT (X)
(Figs. **411**, **412**)

ACCESSORY LATERAL OR SADDLE HAIRS.—One or more pairs of hairs (*x*, *y*, *z*) located on the side of the anal segment on the membranous portion or on saddle; usually not developed.

ACUS.—A small attached or detached sclerotized area at the base of the saddle ventrally, varied in shape.

BOSS.—A more or less strongly developed elevated area at the base of the ventral brush, usually more or less sclerotized but without grid.

DETACHED HAIRS OF VENTRAL BRUSH.—Hairs of ventral brush (4-X) proximad of grid, either on membrane or on complete saddle; precratal tufts.

DORSAL BRUSH.—Hairs 2,3-X; hairs arise from a more or less distinct sclerotized tubercle or process, usually withdrawn, at the dorsocaudal angle of the anal segment; this process probably homologous with postanal process of the Dixinae.

GILLS.—Two pairs of variously developed, usually elongate processes around the anal opening, exposed or rarely retractile, sometimes with large tracheae; anal gills or anal papillae.

GRID.—Basal integumentary sclerotizations of the ventral brush, in the form of transverse bars at the base of individual hairs, sometimes with more or less strongly developed lateral longitudinal bars which may be joined to caudal margin of saddle.

LATERAL HAIR.—Hair 1-X; saddle hair.

MARGINAL SPICULES.—More or less strongly developed spicules along caudolateral margin of the saddle.

MEDIAN DORSAL CAUDAL PROCESS.—A middorsal process from the caudal margin of the saddle to the tubercle of the dorsal brush.

POSTANAL PROCESS.—In Dixinae, a conspicuous cylindrical dorsal process beyond the anus; apparently homologous with the basal tubercle or process of the dorsal brush in the Culicinae and Chaoborinae.

PRECRATAL TUFTS.—Detached proximal hairs of the ventral brush not located on grid; detached hairs of ventral brush.

RING.—A complete saddle, continuous ventrally as well as dorsally.

SADDLE.—Sclerotized plate usually covering most of the dorsal and lateral surfaces of the anal segment, sometimes continuous ventrally to form a ring; when incomplete then interrupted ventrally.

SADDLE LENGTH.—Measured on dorsal surface from base to apex.

SUBANAL SPICULES.—In Chaoborinae, specialized enlarged spicules ventrad of anal opening.

SUPRAANAL SPICULES.—In Dixinae, specialized spicules dorsad of anal opening and at ventral base of postanal process.

VENTRAL BRUSH.—Hairs 4-X; usually a group of several hairs, more or less distinctly but irregularly paired, occupying an extensive area in the posteroventral area of the anal segment; hairs numbered *a, b, c,* and so on, from most distal to proximal.

SYSTEMATICS, BIONOMICS, AND DISTRIBUTION

GENERAL

DERIVATIVE.—Derived from a more primitive (see) type.

DOMINANT.—Conspicuously successful as judged by numbers of individuals or species.

ENDEMIC.—Known only from area under consideration; precinctive.

EXTRALIMITAL DISTRIBUTION.—World distribution outside the South Pacific area.

GENERALIZED.—Unspecialized; not adapted to specialized and limited mode of life.

INDIGENOUS.—Occurring naturally in area under consideration; not introduced by man; native; includes endemic.

INDIGENOUS, NOT ENDEMIC.—Occurring naturally in area under consideration as well as elsewhere.

INTRODUCED.—Brought by man into area where form is not native; includes introduced through commerce and spread by natives (see).

INTRODUCED THROUGH COMMERCE.—Special instance of introduced; brought into South Pacific usually from a considerable distance on large craft (water and air) subsequent to discovery of area by Europeans.

PHYLAD.—A natural group of genetically closely related organisms.

PRIMITIVE.—Early in evolutionary development, from which later derivatives may have been produced.

RELICT.—Primitive form persisting after extinction, replacement, or evolution of most or all of its populations or of its close contemporary relatives.

SPECIALIZED.—Adapted to a special and limited mode of life.

SPREAD BY NATIVES.—Special instance of introduced; transported, usually within the South Pacific, on native craft, probably chiefly before entry of Europeans into area.

WORLD MOSQUITO FAUNAL AREAS
(Fig. 18)

The areas are delineated in very general terms for the purpose of showing the general relationships of the mosquito fauna of the South Pacific to the rest of the world. These areas do not necessarily correspond to the faunal regions or their subdivisions as used for other groups of organisms. The areas nearest the South Pacific are more finely subdivided than elsewhere to show relationships in greater detail.

AMERICAN MEDITERRANEAN.—Intercontinental area of the New World and adjacent portions of the North American and South American continents; usually considered in large part as one or more subdivisions of the Neotropical.

ETHIOPIAN.—Africa south of the Sahara, but including the Sudan, and southern Arabia; not including Madagascar.

HOLARCTIC.—Palaearctic and Nearctic combined.

INDOMALAYAN.—In the sense of Mattingly (1957*a*:6–7); Malay peninsula, Greater and Lesser Sunda Islands, Borneo, Celebes, and the Philippines; probably should be expanded to include Burma, Andaman and Nicobar Islands, and western Indochina.

NEARCTIC.—North America north of the tropic of Cancer excluding tropical coastal areas.

NEOTROPICAL.—In restricted sense South America exclusive of the American Mediterranean and Patagonia–So. Chile areas; in broad sense including these areas in addition.

N. AUSTRALIAN.—Tropical and subtropical north and northeast Australia south to northern N. S. Wales; sometimes considered in part as a subdivision of the Papuan.

ORIENTAL.—In the restricted sense tropical and subtropical Asia exclusive of the Indomalayan area; including India, Ceylon, islands in the eastern Indian Ocean, Assam, Burma, Andaman and Nicobar Islands, Indochina, southern China, Formosa, and the Ryukyus; may be further limited and subdivided into WEST ORIENTAL and EAST ORIENTAL with the intermediate area (Burma, Andaman and Nicobar Islands, and western Indochina) added to the Indomalayan area; in the broad sense including the Indomalayan.

PALAEARCTIC.—Continental and insular Eurasia north of the tropics, with addition of North Africa and most of Arabia.

PAPUAN.—In the restricted sense New Guinea and adjacent islands, Moluccas, islands of the Banda Sea, and sometimes Admiralty Islands and the Bismarck Archipelago; in a broader sense including also part of the N. Australian.

PATAGONIA–SO. CHILE.—Tip of South America and adjacent islands south of about 35°–40° S.

S. AUSTRALIAN–TASMANIAN.—Tasmania and Australia exclusive of N. Australian.

SOUTH PACIFIC.—Islands of the Pacific Ocean south of the equator, west of Sala y Gomez and Easter Island, east of the Bismarck Archipelago, New Guinea, Australia, and Tasmania, and north of Antarctica.

WESTERN PACIFIC IS.—Bonin, Mariana, Palau, and Caroline Islands.

GAZETTEERS

(Figs. 22-27)

There are literally thousands of native names applied to islands and islets and to topographic and hydrographic features in the South Pacific area. Identical names are frequently used not only in widely separated areas but also in adjoining islands or groups. Very commonly two or more alternative native or European names have been used for the same geographic feature. Furthermore, romanization of native names has not been standardized. I have made no attempt to prepare a gazetteer for the localities used by the collectors of the material I have examined. The majority of these localities have been identified, and all have been entered on the permanent record sheets. However, the distribution data in the text are confined usually to the citation of the island and group. The majority of these islands are indicated in the general or sectional maps of the South Pacific (figs. 22-27). I have tried to adhere to the preferred names and spellings as recorded in the following gazetteers, sailing directions, charts, and general works but in several instances have followed current usage instead:

Gt. Britain, Naval Intelligence Division. Geographical Handbook Series. Pacific Islands, vols 1–3 (classified).

Reed, A. W. Atlas of New Zealand. Wellington, A. H. & A. W. Reed. 64 pp. 1952.

Robson, R. W. Pacific Islands Yearbook, ed. 8. Sydney, Pacific Publications. 479 pp. 1959.

U.S. Army Map Service. Gazetteer of Melanesia.

U.S. Hydrographic Office. Gazetteers 1, 6, and 7; Sailing Directions: The Pacific Islands (vols. 1–3), New Zealand, East Coast of Australia.

U.S. Air Force. Aeronautical Planning Charts; World Aeronautical Charts.

INSTITUTIONS AND COLLECTIONS

ABG.—Collection of A. B. Gurney *et al.*, 23rd Malaria Survey Unit; chiefly in USNM.

ALEX.—C. P. Alexander collection, Department of Entomology and Plant Pathology, University of Massachusetts, Amherst.

AMGS.—Walter Reed Army Institute of Research, Washington, D.C. (formerly Army Medical Service Graduate School).

BASEL.—Naturhistorisches Museum, Basel.

BERLIN.—Zoologisches Museum der Humboldt-Universität, Berlin.

BISHOP.—Bernice P. Bishop Museum, Honolulu, Hawaii.

BMNH.—British Museum (Nat. Hist.), London.

BUDA.—Magyar Nemzeti Museum, Budapest.

BYU.—Brigham Young University, Provo, Utah.

CANT.—Canterbury Museum, Christchurch, New Zealand.

CNHM.—Chicago Natural History Museum.

COPEN.—Zoologisk Museum, Copenhagen.

CU.—Department of Entomology, Cornell University, Ithaca, N.Y.

HOPK.—School of Hygiene and Public Health, Johns Hopkins University, Baltimore.

JGF.—Collection of J. G Franclemont *et al.*, 21st Malaria Survey Unit; chiefly in UCLA and USNM.

JNB.—Collection of J. N. Belkin *et al.*, 20th Malaria Survey Unit; chiefly in UCLA, USNM, and CU.

KANSAS.—Department of Entomology, University of Kansas, Lawrence.

KLK.—Collection of K. L. Knight *et al.*; chiefly in USNM.

LIVER.—Liverpool School of Tropical Medicine, London; types in BMNH.

LOND.—London School of Hygiene and Tropical Medicine, London.

MACL.—MacLay Museum of Natural History, University of Sydney, Sydney.

MANILA.—National Museum, Manila (formerly Philippine Bureau of Science).

MELB.—National Museum, Melbourne, Australia.

MINN.—Department of Entomology and Economic Zoölogy, University of Minnesota, St. Paul.

NELSON.—Entomology Division, Department of Scientific and Industrial Research, Nelson, New Zealand.

NMS.—U.S. Naval Medical School, Bethesda, Maryland.

PARIS.—Museum National d'Histoire Naturelle, Paris.

PASTEUR.—Institut Pasteur, Paris.

QUEEN.—Department of Entomology, University of Queensland, Brisbane.

RKL.—Collection of L. E. Rozeboom, K. L. Knight, and J. Laffoon, U.S. Naval Medical Research Unit No. 2; chiefly in USNM and HOPK.

SYDN.—School of Public Health and Tropical Medicine, University of Sydney, Sydney.

TOKYO.—Institute for Infectious Disease, Tokyo University, Tokyo.

UCLA.—Collection of J. N. Belkin, Department of Entomology, University of California, Los Angeles.

USNM.—U.S. National Museum, Washington, D.C.

UTAH.—Division of Biological Sciences, University of Utah, Salt Lake City.

VIENNA.—Naturhistorisches Museum, Vienna.

WELL.—Dominion Museum, Wellington, New Zealand.

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A rather complete annotated bibliography through 1955 of the mosquitoes of the South Pacific exclusive of New Zealand is given by Iyengar (1956). The present list includes only the references cited in the text by authors and date and does not repeat those which include a citation of the periodical or title of the book. In this list, as well as in the text, the bibliographical entries follow the "ALA Catalog Rules for Author and Title Entries," the analytical entries conform to "Bibliographic Style" (U.S.D.A. Bibliogr. B. 16, 1951), and the abbreviations for periodicals are those used by the U.S.D.A. Library (U.S.D.A., Misc. P. 765, 1958; used in entries in Bibliography of Agriculture). An asterisk (*) indicates that the publication was not seen and that the data were derived from Iyengar (1956), Laird (1956), Miller (1950), or Taylor (1934). I am greatly indebted to Dora M. Gerard of the Agriculture Library, University of California, Los Angeles, for much expert advice and assistance in bibliographic matters.

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Conspectus of Distribution Maps

CONSPECTUS OF DISTRIBUTION MAPS

Conspectus of Taxonomic Changes

CONSPECTUS OF TAXONOMIC CHANGES

NEW NOMINAL TAXA

GENERIC

Edwardsaedes, subgenus of Aedes 408
Halaedes, sugenus of Aedes 328
Lorrainea, subgenus of Aedes 430

SPECIFIC

Aedes
  aobae (Stegomyia) 452
  argyronotum (Finlaya) 354
  becki (Geoskusea) 334
  burnetti (Finlaya) 363
  buxtoni (Finlaya) 356
  chionodes (Christophersiomyia) 434
  cooki (Stegomyia) 454
  cuccioi (Verrallina) 414
  franclemonti (Finlaya) 367
  fuscipalpis (Finlaya) 370
  fuscitarsis (Finlaya) 371
  futunae (Stegomyia) 455
  hoguei (Stegomyia) 460
  hollingsheadi (Finlaya) 372
  mccormicki (Verrallina) 420
  mcdonaldi (Ochlerotatus) 396
  neogeorgianus (Finlaya) 375
  oceanicus (Finlaya) 377
  perryi (Geoskusea) 336
  roai (Finlaya) 353
  robinsoni (Stegomyia) 447
  rotumae (Stegomyia) 472
  rubiginosus (Finlaya) 346
  schlosseri (Finlaya) 382
  varuae (Stegomyia) 478

Corethrella
  solomonis 540

Culex
  becki (Lophoceraomyia) 265
  bergi (Lophoceraomyia) 258
  dumbletoni (Neoculex) 244
  franclemonti (Lophoceraomyia) 256
  gaufini (Neoculex) 243
  hurlbuti (Lophoceraomyia) 266
  kesseli (Culex) 200
  laffooni (Lophoceraomyia) 261
  lairdi (Lophoceraomyia) 257
  leonardi (Neoculex) 245
  millironi (Neoculex) 242
  omani (Culex) 210
  oweni (Lophoceraomyia) 259
  perryi (Lophoceraomyia) 268
  roseni (Culex) 203
  walukasi (Lophoceraomyia) 264
  whittingtoni (Culex) 204
  winkleri (Lophoceraomyia) 260

Dixina
  solomonis 111

Ficalbia
  bougainvillensis (Etorleptiomyia) 294
  gurneyi (Mimomyia) 296
  solomonis (Etorleptiomyia) 292

Hodgesia
  solomonis 280

Mansonia
  fijiensis (Coquillettidia) 308
  lutea (Coquillettidia) 309
  melanesiensis (Mansonioides) 314

Tripteroides
  bonneti (Tripteroides) 501

CHANGES IN TAXONOMIC STATUS

SUPRAGENERIC

Chaoborinae	
Chaoborini	543
Corethrellini	538
Culicinae	
Aedeomyiini	273
Aedini	317
Anophelini	123
Culicini	177
Culisetini	282
Ficalbiini	287
Hodgesiini	278
Mansoniini	299
Orthopodomyiini	117
Sabethini	485
Toxorhynchitini	527
Uranotaeniini	152
Dixinae	
Dixini	95
Meringodixini	95
Paradixini	95

GENERIC

Aioretomyia, tentative synonymy	412
Lophoceratomyia, type species	248
Maorigoeldia, to generic rank	492
Mimeteomyia, synonymy	506
Mochlostyrax, synonymy	179
Neomacleaya, tentative synonymy	412
Polylepidomyia, synonymy	506
Pseudoficalbia, type species	152
Rachionotomyia, to subgeneric rank	506
Skeiromyia, synonymy	506
Squamomyia, synonymy	506
Tricholeptomyia, synonymy	506
Verrallina, to subgeneric rank	412
Zeugnomyia, to Aedini	117

SPECIFIC

Aedes	
ashworthi Edwards, synonymy	329
brugi Edwards, synonymy	409
ceramensis Brug, to specific rank	417
geoskusea of Amos, not available	399
hebrideus Edwards, to specific rank	457
nocturnus (Theobald), to specific rank	427
painei Knight, to specific rank	405
samoanus (Gruenberg), restricted	381
suvae Stone & Bohart, valid	399
tulagiensis Edwards, to specific rank	446
Culex	
australicus Dobr. & Drum., to specific rank	194
buxtoni Edwards, to specific rank	253
perkinsi Stone & Penn, to specific rank	226
quinquefasciatus Say, to specific rank	195
solomonis Edwards, to specific rank	262
Tripteroides	
ater (Taylor), synonymy	519
brugi (Edwards), synonymy	519
floridensis Belkin, to Rachionotomyia	511
mabinii Baisas & Ub.-Pag., distinct subgenus	520
sylvestris (Theobald), to specific rank	520

LECTOTYPE DESIGNATIONS

Aedes	
alboscutellatus (Theobald)	425
carmenti Edwards	416
marinus (Theobald)	393
nigrescens (Edwards)	405
painei Knight	405
pseudoscutellaris (Theobald)	469
queenslandensis (Theobald)	441
tasmaniensis (Strickland)	329
uniformis (Strickland)	393
Culex	
pacificus Edwards	191
solomonis Edwards	262
Tripteroides	
caledonicus (Edwards)	514
purpuratus (Edwards)	498
Uranotaenia	
colocasiae Edwards	157
painei Edwards	162
quadrimaculata Edwards	159

Systematic Index

SYSTEMATIC INDEX

INDEXING. Names of all suprageneric taxa and valid genera are indexed individually only. Specific group taxa without formal names are indexed by the species number (as given in the text) at the end of the alphabetical list under the name of the appropriate genus or its subgeneric division (when applicable). Names of all other formal or informal taxa, valid or not, are indexed individually as well as classified under the name of the appropriate genus or its subgeneric division (when applicable).

Gender terminations are disregarded in indexing. Identical names are alphabetized first under the names of the genera and subgenera which follow the names of the authors and then under the latter.

Misidentifications or invalid taxonomic interpretations are indicated by the use of the term "of authors" or "of" followed by a specific author and are listed as separate entries following the entry for the correctly applied identical name.

NAMES. Names of valid taxa represented in the South Pacific or treated in some detail in the text are in **boldface type.** Names of valid extralimital taxa are in roman type. *Italic type* is used for names of all taxa considered invalid in this work (synonyms, homonyms, misidentifications, gross erroneous spellings, and so on), and for valid generic and subgeneric names that follow the main part of each individual entry and serve as cross references to classified entries.

PAGE REFERENCES. **Boldface numerals** refer to figure numbers in the second volume, without a suffix to drawings, with the suffix "**m**" to a map, and with the suffix "**t**" to a table. *Italic numerals* refer to the principal text reference in the first volume. Roman numerals refer to secondary text references in the first volume; the suffix "k" indicates mention in a key.

+ 412