PARASITISM OF *SIREX NOCTILIO* F. BY *SCHLETTERERIUS CINCTIPES* (CRESSON) (HYMENOPTERA: STEPHANIDAE)

By K. L. TAYLOR*

[*Manuscript received August* 5, 1966]

Abstract

Schlettererius cinctipes (Cresson), reputed to be a parasite of Coleoptera, has been successfully reared in Tasmania on *Sirex noctilio* F. in *Pinus radiata* D. Don., from a single female received from California in 1963. The adults emerge in late September and early October. Females begin to oviposit 12-24 days after emergence and the egg, which is deposited on the surface of the host larva, hatches in approximately 14 days. The larva completely destroys the host larva in 6-7 weeks after oviposition. Parasitized *Sirex* larvae were found at depths of up to 3.4 cm from the bark surface.

No evidence has been found that *S. cinctipes* attacks *Sirex* larvae parasitized by *Ibalia leucospoides* (Hochenw.), or fully-fed larvae of *Rhyssa persuasoria* (L.), and its potential value as a member of the parasite complex is discussed.

INTRODUCTION

While searching for parasites of Siricidae at Sagehen Creek, California, in 1963 Mr. E. A. Cameron of the Commonwealth Institute of Biological Control collected one female of *Schlettererius cinctipes* (Cresson). Although all species of the family Stephanidae "are presumed to be parasitic on wood-boring Coleoptera" (H. Townes in Muesebeck *et al.* 1951, p. 89) he sent it to Tasmania with other parasites in the hope that it might attack *Sirex noctilio* F. It was collected in the vicinity of *Pinus jeffreyi* Murr. and *Abies* spp. infested by siricids, the only species recorded being *Xeris morrisoni* (Cresson) and *X. spectrum* (L.) (Cameron, E. A., personal communication).

On receipt, the single female was placed, in quarantine, on a billet containing *Sirex* larvae, and in the spring of 1964 four females and two males emerged. This established beyond doubt that *S. cinctipes* can be a primary parasite of *Sirex*, at least under insectary conditions, but it was still necessary to examine its relationships with *Rhyssa persuasoria* (L.) and *Ibalia leucospoides* (Hochenw.), the two primary parasites established in Tasmania at that time.

BIOLOGY

Within the limits imposed by insectary rearing under quarantine, most aspects of the biology of *S. cinctipes* have been studied over the past two seasons.

Mating

No difficulty was experienced in obtaining mating of the four females with the two males which emerged in 1964. Each one was placed in a small container with one or two males, and mating occurred within 2-3 hours. In 1965 mating was observed frequently within the cage. As 30 matings were actually seen, and only 23 females were present over the season, it is evident that the females mate more than once. The sex ratio of individuals emerging in 1965 was 1.3: 1 in favour of males.

Oviposition

The first oviposition in 1964 was observed 21 days, and in 1965 17 days after the first female emerged. From other observations and deduction it seems likely that the females begin to oviposit when they are approximately 12 days old. Oviposition was not observed frequently, the insects being found resting on the logs or on the cage for most of the time.

*Division of Entomology, C.S.I.R.O., Canberra, A.C.T. (formerly at Tasmanian Regional Laboratory, Hobart).

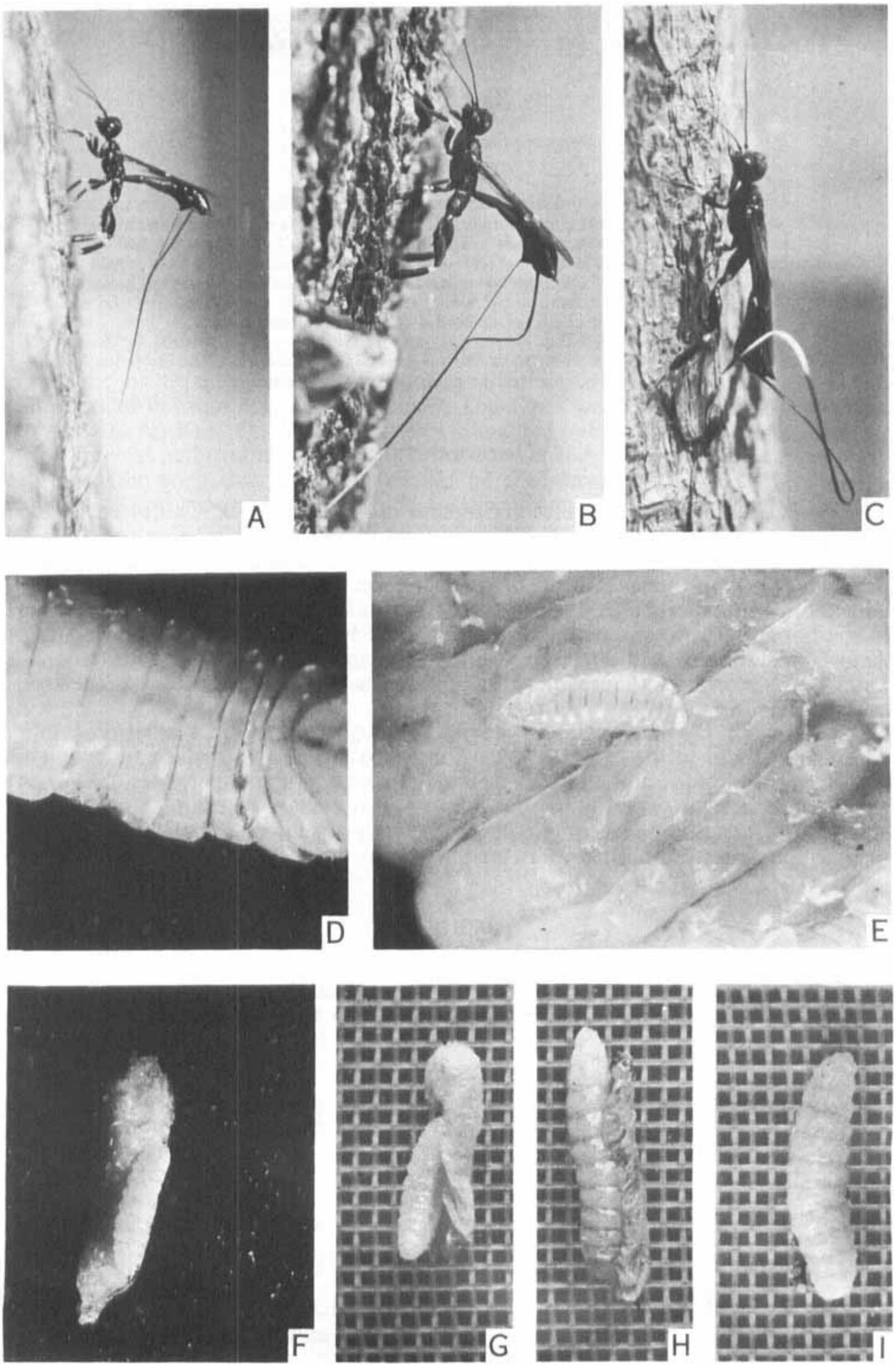


PLATE I

Schlettererius cinctipes (Cresson): (A-C) progressive stages of probing and oviposition (x *ca* 2); (D) egg attached to host larva (x *ca* 10); (E) 1st instar larva attached to host (x *ca* 18); (F-I) progressive stages of feeding. Note remains of sclerotized portions of host larva attached to fully-fed parasite larva (I). (x *ca* 2.7).

One female was observed with her ovipositor inserted for at least two hours. The time taken for probing and oviposition is normally shorter than this, but detailed observations were not made.

The mechanism by which the adult parasite determines the position of a host larva in the wood is not known. The females spend little time, in comparison with the other parasites of *Sirex*, in searching or palpating with the antennae on the bark surface. Several females were placed on two separate billets, and, although they were not under continuous observation, a number of points were marked where probing occurred. When the billets were later split and the larvae examined, a parasitized *Sirex* larva was found beneath the majority of these points, although in several instances none appeared to be present. These observations, though limited, indicate that *S. cinctipes* females are reasonably efficient in locating host larvae.

When she begins to insert her ovipositor, the female lifts her abdomen until it is approximately at right angles to the axis of her body, thus bringing the long ovipositor to an angle of about 30° with the bark surface (Plate I, A). As the ovipositor is inserted into the wood, the sheaths are pushed back in a loop at the top, and the insect moves backwards, while the abdomen is gradually lowered (Plate I, B, C). The depths of penetration recorded (*vide infra*) suggest that the ovipositor penetrates the wood at right angles to the surface. Full insertion of the ovipositor was only observed on rare occasions, and is apparently not essential for successful parasitism.

Adult longevity

The adults which emerged in 1964 were not provided with any food or water. Those which emerged in 1965 were provided with honey and water, but none was observed feeding. Since individual insects were not isolated, the longevity can only be estimated on the assumption that the insects which emerged first were the first to die, although, as might be expected, smaller individuals tended to die first. On this basis the mean longevity of females both in 1964 and 1965 was 30 days. Males, which emerge usually a few days earlier than females, lived a few days longer.

Depth of penetration into wood

After emergence of *S. cinctipes* in the spring of 1965, 15 emergence holes were examined by careful splitting of the billet. The chamber occupied by the parasitized *Sirex* larva was easy to identify (Plate II B), and in each case a measurement was taken from the bark surface to the nearest point of the chamber, this being taken as the depth of penetration by the parasite ovipositor. These measurements ranged from 0.2 cm to 3.4 cm, the mean being 1.7 cm. The billet contained very few *Sirex* larvae deeper than 3.4 cm, so it is likely that the parasite can reach larvae even deeper. The ovipositor of the largest female which has emerged in Hobart was 4.4 cm long and the average length of ovipositor was about 3.2 cm.

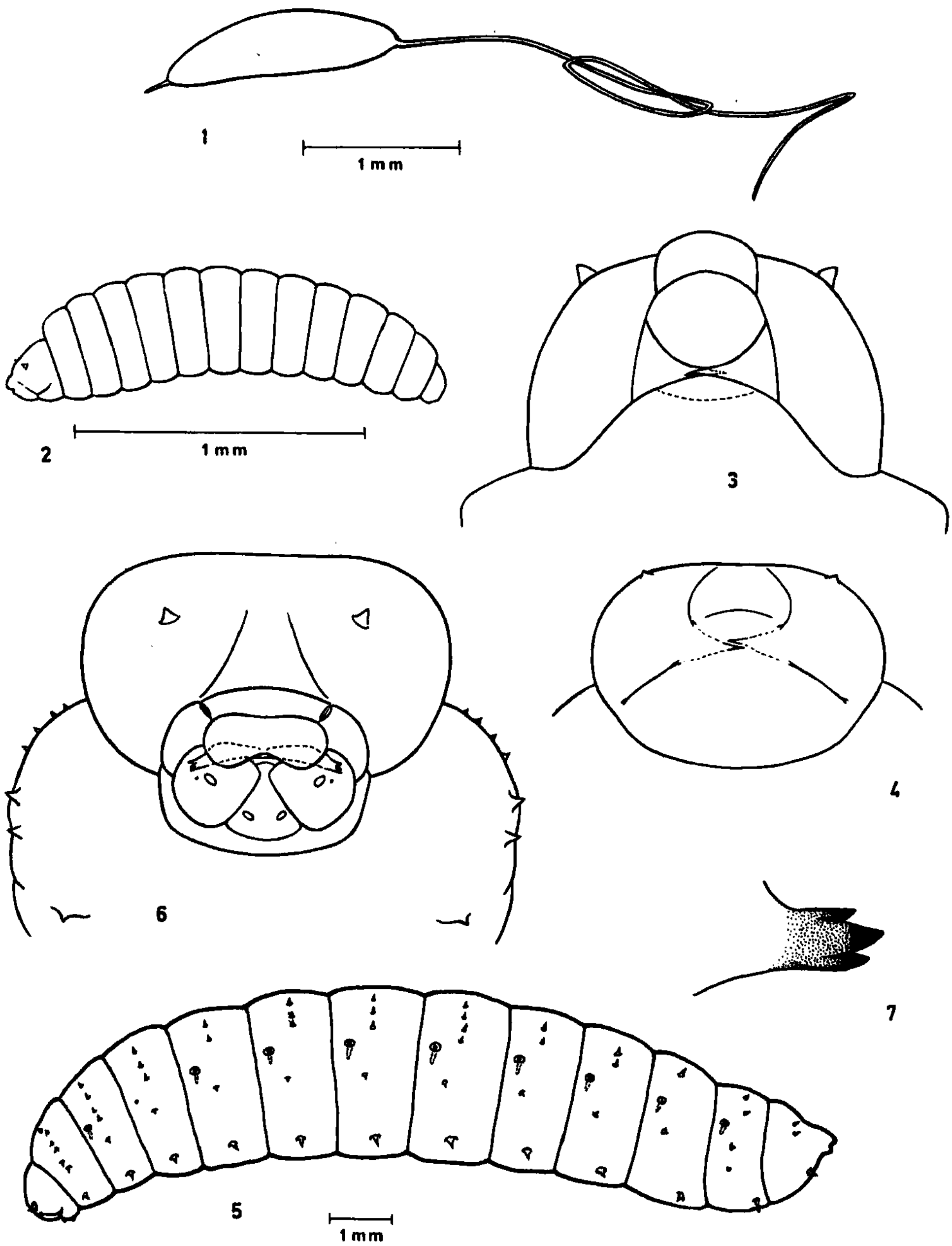
Egg

Two females, dissected after death, had a number of eggs in the ovaries. Each egg bears a very long stalk which is neatly folded in the ovary (Fig. 1). Eggs were found on two of the *Sirex* larvae cut out from beneath points where probing was seen. In each case the egg was simply lying on the surface of the host larva, (Plate I D) which was immobile, suggesting that it had been paralysed by the female parasite at the time of oviposition.

Larva

Larvae in various stages of development have been split out of billets on which oviposition by the females had been marked and, in most instances, the date noted. Although some unobserved oviposition occurred, development was progressively more advanced with age as determined by the dates marked in this way, and there is little doubt that the larvae removed from beneath these marked points were parasitized at the time oviposition was observed. From these observations, it can be stated with reasonable certainty that the egg hatches 10-14 days after oviposition and that the larva is fully fed 6-7 weeks after oviposition.

After hatching the parasite larva attaches itself to the host larva and feeds by piercing the cuticle with its sharp mandibles and presumably sucking out the body fluids. The host larva becomes progressively more flaccid. In the final stages feeding



FIGS. 1-7.—*Schlettererius cinctipes* (Cresson): (1) egg; (2, 3) 1st instar (2) lateral aspect, (3) mouthparts; (4) 2nd or 3rd instar, mouthparts; (5-7) final instar (5) lateral aspect (Note: spines on body segments are about half size figured, in relation to size of larva), (6) mouthparts, (7) mandible.

is very rapid and when only the skin remains the parasite larva consumes it all except the sclerotized mandibles and the "horn" on the last abdominal segment. (Plate I, E-I).

Three instars could be recognized amongst the 20 larvae examined, though there is probably one more. The smallest of these, which is almost certainly the first instar, was very active, and possessed long sharp mandibles without teeth (Figs. 2, 3). In the intermediate instar(s) the mouthparts are very small in relation to the size of the larva, without any distinctive characters (Fig. 4). The head in each instar is hypognathous. The fully-fed larva (Figs. 5-7) possesses strong tridentate mandibles but the mouthparts are simple as in the Evaniidae (Short, 1952, pp. 45-49). The labral sclerites are absent, as also are the stipital and labial sclerites. The maxillary and labial palps can be distinguished, but not the galea as described by Short in *Aulacus*. The salivary orifice is either absent or rudimentary. Each segment of the body bears from 3 to 7 small sclerotized spines on each side, one ventrally, one laterally (two on the first segment) a little below and slightly posterior to the spiracle, and 2 to 4 dorsally (only one on the tenth segment) just above the spiracle (Fig. 5). The presence of these, and the characteristic shape of the mandibles, readily distinguishes this species from *Rhyssa* or *Ibalia*. The spines are not present on earlier instars.

Pupa

A living pupa has not yet been seen, but exuviae in the billet from which the 1965 population emerged have been examined. The final stage larva pupates in the chamber in which it has consumed the host larva. The chamber differs from that of *Rhyssa* in that it is not lined with silk, which is not surprising in view of the absence of a salivary orifice or an opening of the silk press. There is some evidence that the pupa is at least partly formed within the exuviae of the final instar larva. In chambers from which females have emerged, the ovipositor of the pupal exuviae remains inside the larval exuviae.

Adult emergence

The emergence hole of the adult *S. cinctipes* can be readily distinguished from that of *Sirex, Ibalia* spp., *Rhyssa* spp. or *Megarhyssa* spp. All of these cut clean holes right to the surface of the bark. *S. cinctipes* does not cut through the outer layers of bark, but apparently pushes them out, leaving a ragged exit hole (Plate II A). Inside the wood, it is also easy to recognize the holes where *S. cinctipes* has been, because the frass left by the adult is very loose in the chamber, that of *Sirex* being packed tightly behind the emerging adult. (Plate II, B, C).

Parasitism of Sirex

The total number of insects which emerged from the billet exposed to *S. cinctipes* in 1964 was:— *Sirex* 87, *Ibalia leucospoides* 28, *S. cinctipes* 54. This represents parasitism of 32 per cent. by *S. cinctipes* under insectary conditions. In the two small billets used for experiments in 1965 *S. cinctipes* larvae or eggs were found on 13 per cent. of the 172 *Sirex* larvae cut out of the wood. While these figures do not show particularly high parasitism, they are comparable with figures obtained in the insectary for either *Ibalia leucospoides* or *Rhyssa persuasoria,* and prove that *S. cinctipes* will parasitize *Sirex* when there is no other host available.

Relationships with Other Parasites

As the one billet used for rearing *S. cinctipes* in 1964 contained some *Sirex* parasitized by *I. leucospoides,* a careful examination was made of the frass and exuviae in holes, from which *S. cinctipes* had emerged, to see whether the mouthparts of *Ibalia* larvae could be identified. In all, 15 holes were examined, and nothing resembling *Ibalia* mouthparts or exuviae was found. In view of their small size, however, they would be difficult to find so this cannot be regarded as con-

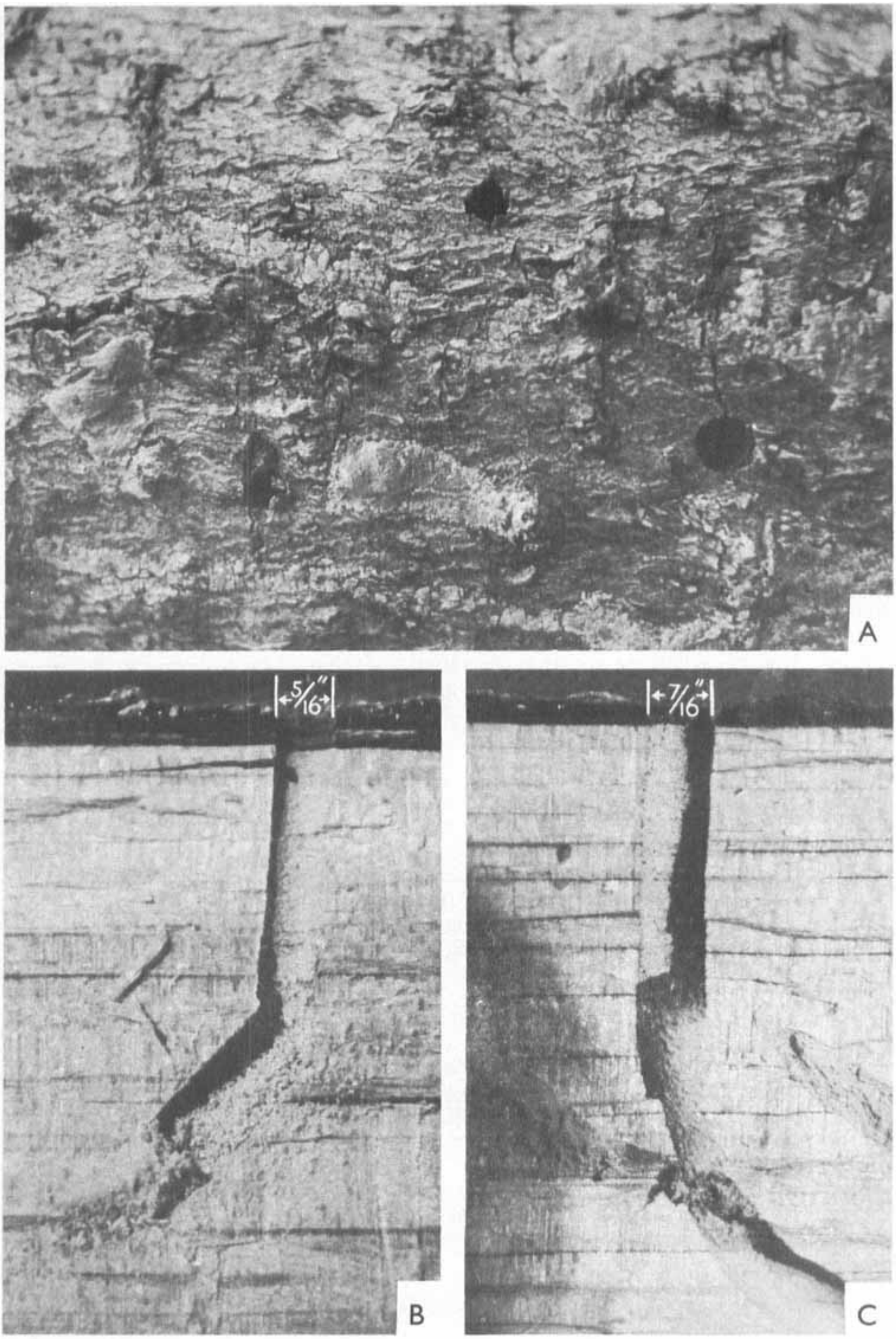


PLATE II

Schlettererius cinctipes (Cresson) and *Sirex noctilio* F.: (A) emergence holes of *S. cinctipes* (left and centre) and *S. noctilio* (right); (B) *S. cinctipes*, pupal chamber and emergence hole, note loose frass; (C) *S. noctilio*, emergence hole, note tightly-packed frass. (All slightly enlarged.)

clusive. The billet concerned was not exposed to *Ibalia* in the insectary, and the proportion of *Ibalia* which emerged, in relation to the numbers of *Sirex*, is above the average for field collected material. This suggests that even if *S. cinctipes* oviposits on a larva parasitized by *Ibalia*, the latter survives.

In 1965 two small billets were exposed to *S. cinctipes* females for special studies. One of these had been exposed to *Rhyssa persuasoria* two or three months earlier, and therefore contained *Sirex* and fully-fed *Rhyssa* larvae. The other was thought to contain *Sirex* larvae parasitized by *Ibalia*. After varying periods the billets were split, and the larvae removed for examination. The results were inconclusive because the number of *Rhyssa* in the first billet was very low, and no *Ibalia* could be found in the second.

Discussion

The parasitism of *Sirex* larvae by *S. cinctipes* in the insectary is high enough to justify its liberation to form part of the complex of parasites attacking *Sirex*, provided that it has no adverse effect on the recognized parasites. If, like other members of the family Stephanidae, it is primarily a parasite of Coleoptera, it may tend to seek out cerambycids, buprestids and curculionids, which are found in the dead *Pinus radiata* D. Don. trees in southern Tasmania. However this would cause no harm if *S. cinctipes* also played a part in the control of *Sirex*.

The numbers of *S. cinctipes* and *Rhyssa* found in the first experimental billet were so small that it cannot be concluded that *S. cinctipes* will not parasitize *Rhyssa*. Its emergence in the insectary was only a little earlier than that of *Rhyssa* and it is probable that the two will emerge at about the same time in the field. Any harmful effect on *Rhyssa*, therefore, is more likely to take the form of competition for host larvae than direct attack on *Rhyssa* larvae. However, as the proportion of *Sirex* larvae parasitized by *Rhyssa* is small, competition between *Schlettererius* and *Rhyssa* is not likely to be significant.

There is no evidence that *S. cinctipes* parasitizes larvae already parasitized by *Ibalia*. The available evidence, if anything, suggests that *Ibalia* survives attack if it occurs, and makes it reasonably clear that *S. cinctipes* does not seek out *Sirex* larvae parasitized by *Ibalia* in preference to unparasitized larvae.

Another important species now being released in Tasmania, *Megarhyssa nortoni nortoni* (Cresson), has a much longer ovipositor, adapted for parasitizing larger larvae which normally occur deeper in the wood than *Schlettererius* could reach.

Numbers of *S. cinctipes* available in the spring of 1966 are not likely to be high enough to justify liberation. Therefore it is proposed to carry out further tests with billets containing the other parasites, in order to obtain more conclusive information about its effect on them.

Acknowledgements

The author is indebted to Mr. E. Alan Cameron, who collected the single female parasite which established the culture in Tasmania; to technicians who have helped with the work in Hobart, in particular Mr. O. Miezitis and Mr. A. Kane, and to colleagues who have given helpful criticism of the manuscript. The help of Mrs. M. Quick and Mr. C. Lourandos in preparing the figures is gratefully acknowledged.

References

CRESSON, E. T., (1880).—*Trans. Am. ent. Soc.* **8**, Monthly Proceedings, p. xviii. *Stephanus cinctipes.*

MUESEBECK, C. F. W. *et al.* (1951).—Hymenoptera of America North of Mexico. Agriculture Monogr. U.S.D.A. No. 2.

SHORT, J. R. T. (1952).—The morphology of the head of larval Hymenoptera with special reference to the head of the Ichneumonoidea, including a classification of the final instar larvae of the Braconidae. *Trans. R. ent. Soc. Lond.* **103**: 27-84.