

## Triassic beds in the basement of the Adriatic-Dinaric carbonate platform of Mt. Svilaja (Croatia)

### Triasne plasti v podlagi Jadransko-dinarske karbonatne platforme na planini Svilaja (Hrvaška)

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*Key words:* External Dinarides, basement of the Adriatic-Dinaric carbonate platform, Triassic, conodont biostratigraphy, Dalmatia, Croatia

*Ključne besede:* Zunanji Dinaridi, podlaga Jadransko-dinarske karbonatne platforme, trias, konodontna biostratigrafija, Dalmacija, Hrvaška

#### Abstract

On the southwestern slope of Mt. Svilaja a Triassic sequence is exposed. It is composed of Lower Triassic carbonate siliciclastic shelf beds that are unconformably overlain by Anisian breccia. The overlying pelagic Anisian and Ladinian strata with pyroclastic rocks can be interpreted as a result of rift tectonics of Adria micro-plate. A 500 m thick sequence is capped by an emersion surface by karstification and terrigenous sediments including conglomerate as a result of Late Triassic transgression and marking the lower boundary of a new, Late Mesozoic, megasequence of the External Dinarides.

By means of conodont study, in the lowermost part of the studied Mesozoic sequence, a Lower Triassic shallow-water conodont fauna yielding *Pachycladina obliqua* apparatus was recorded. Pelagic limestone beds overlying the »Otarnik breccia« are marked by conodont elements of the Anisian *constricta* Zone. The Ladinian interval is characterized (from bottom to top): *trammeri* A. Z., *hungaricus* A. Z. and *mungoensis* A. Z. The uppermost part of the section below the emersion surface is identified by *Pseudofurnishius murchianus*, indicating the Upper Ladinian-Lower Carnian *murchianus* Zone.

#### Kratka vsebina

Na jugovzhodnih obronkih planine Svilaja je razvit profil spodnjetriasnih karbonatno siliciklastičnih šelfnih plasti, na katerih diskordantno leži anizijska »Otarnička breča«. Nad njo si sledijo pelagične anizijske in ladinijske plasti s piroklastiti, ki pričajo o riftni tektoniki Jadranske mikroplošče. 500 m debel profil zaključuje z emerzijo, za katero so značilni pojavi zakrasevanja in terigenih sedimentov, vključno s konglomeratom, ki je rezultat zgornjetriasne transgresije in predstavlja spodnjo mejo nove mladomezozojske megasekvence Zunanjih Dinaridov.

S konodontnimi raziskavami je bila v najnižjem delu raziskanega mezozojskega zaporedja plasti ugotovljena plitvovodna spodnjetriasna konodontna združba z vrsto *Pachycladina obliqua*. Pelagične apnenčeve plasti nad »Otarničko brečo« vsebujejo konodontne elemente anizijske cone *constricta*. V ladinijem intervalu si od spodaj navzgor sledijo konodontne združbe: *trammeri* A. Z., *hungaricus* A. Z. in *mungoensis* A. Z. Najvišji del profila pod emerzijsko mejo vsebuje vrsto *Pseudofurnishius murchianus*, ki ga uvrščamo v zgornjeladinijsko–spodnjekarnijsko cono *murchianus*.

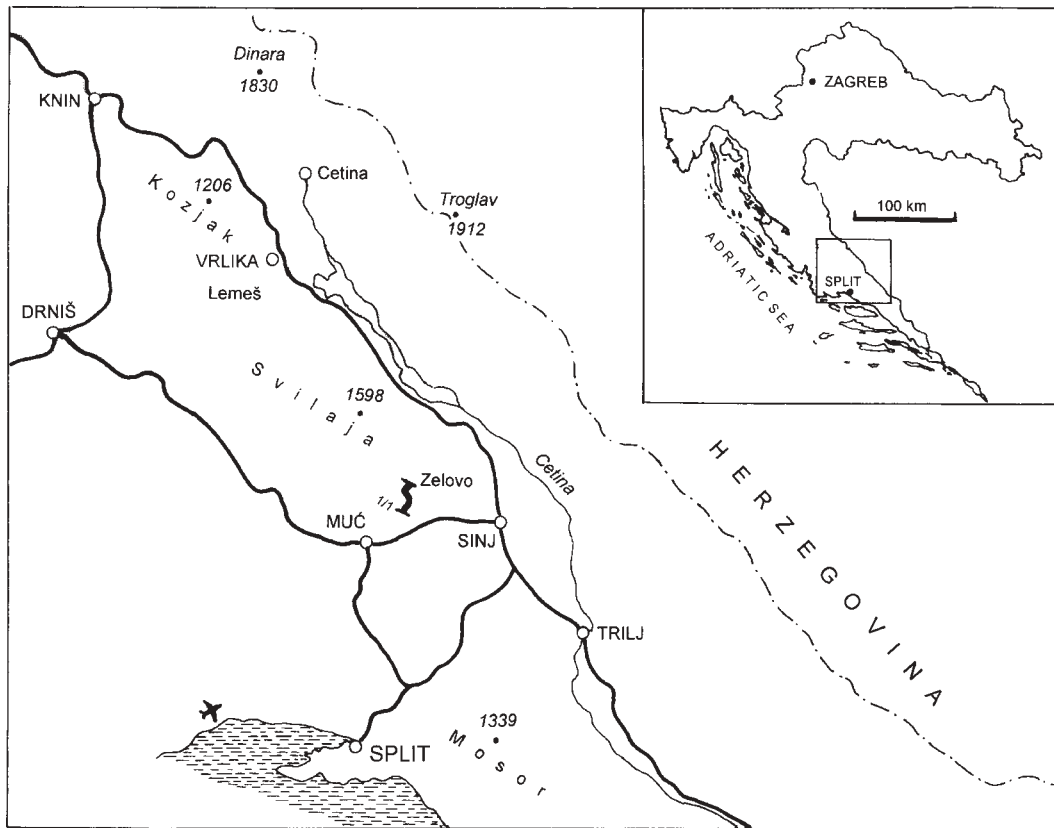


Fig. 1. Location sketch map of the studied Triassic section.

Sl. 1. Geografska skica raziskanega triasnega profila.

### Geological setting

The Upper Permian shallow marine carbonates of the External Dinarides are gradually replaced with thick succession consisting of Scythian shelf siliciclastics and carbonates. During the Early Triassic, sedimentation was characterized by strong terrigenous influx. Such conditions characterize depositional processes on wide passive continental margins, which are, depending on the predominant influence, dominated by either shelf siliciclastic or carbonate deposition.

Foothills of Mt. Svilaja (Muć area) is a well known locality of the Lower Triassic, described since the Hauer geologic map (1868). Kittl's (1903) monograph comprised description of ammonoids collected from the Upper Scythian of the Muć area. Ker-

ner (1916) mapped the area under consideration. Within Scythian deposits, he distinguished Seisian and Campilian beds. The carbonate breccias, so-called "Otarnik breccia" Kerner also ascribed to the Scythian. As distinct from that, Ivanović et al. (1978), considered that "Otarnik breccia" belongs to the Anisian. Krystyn (1974) recognized 3 horizons with ammonoids in the Upper Scythian (he took samples near Mijići village (east of Muć). Herak et al. (1983) proposed the Lower Triassic of Muć as a standard stratigraphic section of the Upper Scythian. Šćavničar et al. (1984) carried out sedimentological and petrographic examinations of the Lower Triassic of the Zmijavac Valley (behind of Muć).

The Lower Triassic deposits of External Dinarides usually can be divided into two lithostratigraphic units: (1) The Lower unit

– composed of reddish and violet micaceous clastics (this unit corresponds to Seiser beds of the Southern Alps, and (2) The Upper unit – consisting of grayish to brownish limestones and marls, and corresponding to the so-called Campilian beds.

The thickness of the entire Lower Triassic deposits of Muć area is up to 300 m.

(1) The Lower unit consists of thin bedded, calcareous and micaceous, fine-grained sandstones, siltstones and silty or calcareous pelites. Approximately in the middle part of the Lower unit, there is an interval composed of somewhat thicker bedded grainstones and mudstones (the former consist of voids, ooids, skeletal remains and intraclasts). The top part of the Lower unit contains predominantly terrigenous rocks again. The most common cement is calcite. In the whole unit, various structures can be observed, but intraformational deformed structures prevailed.

(2) The Upper unit consists of constantly alternating skeletal grainstones, silty and/or argillaceous wackestones to packstones, and marls. Silty admixtures are sporadically present. Thin bedding prevails (up to 3 dm), with the increase of the clayey component the bedding becomes thinner (up to few cm). The upper bedding planes are, as a general rule, flat, whereas the lower bedding planes of grainstones have sharp contact. These fossiliferous grainstones are marked by gradation resembling the so-called allodapic limestone. Deformation structures are not frequent, but various bioturbations are abundant.

The Middle Triassic of the External Dinarides mostly consists of shallow marine carbonate successions. This widespread environment could be characterized as an epeiric sea and therefore the carbonates could be attributed to a phase of “attached” (or shelf) carbonate platform deposits.

The boundary between the Scythian “upper unit” and the Middle Triassic “Otarlik” unit of the Muć area is marked by a local disconformity (Zelovo locality). The “Otarlik” intraformational carbonate breccias and mud-pebble conglomerate laterally pass into the so-called “Diplopora Limestone” (or “Klimenta Limestone” according to Kerner, 1916).

Zelovo is a well known locality of the Middle Triassic outcrops of pyroclastic

rocks. Vitrocrystalloclastic tuffs (“pietra verde”) are accompanied with platy pelagic limestones, with or without cherts, whereas sandstones and shales are less abundant. Limestones contain abundant bioclasts, which originated from the adjacent areas. This pyroclastic rocks can be interpreted as a result of rift tectonics (Jelaska, 2003) and accompanying basalt magmatism (Ščavničar et al., 1984; Belak, 2000).

The above described “pietra verde” interval contains bioclastic limestones characterized by an abundance of calcareous algal skeletons, but also particles of corals, mollusks, and brahiopods (Jacks et al., 2003). This limestones represents the termination of the Middle Triassic at the foothills of Mt. Svilaja. The topmost surface is intensely karstified during an emergence phase. On the karstified surface there are some occurrences of bauxites and terrigenous materials, including conglomerates due to the Late Triassic transgression.

### Conodont fauna

Rock samples, with minimum weight of 2.5 kg, from the Svilaja section were collected and treated for conodonts. A standard conodont technique was used, followed gravity enrichment. Only 16 out of 40 samples proved to yield conodont elements. The conodont material is catalogued and deposited at Geološki zavod Slovenije / Geological Survey of Slovenia, under the designations GeoZS 3436-3446, 3454-3476, 3483-3487, 3498.

The most important characteristics are summarized below, in a stratigraphic order.

### Lower Triassic

**Samples SSP 1/1–1/4:** *obliqua* Zone. Most numerous are elements of the *Pachycladina obliqua* Staesche apparatus. This zone is also characterized by rare occurrence of *Hadrodontina* sp. (*biserialis* type) and *Parachirognathus ethingtoni* Clark. The examined conodont fauna contains characteristic Lower Triassic shallow-water elements. It is comparable with the assemblages obtained from some Slovenian localities (Kolar-Jurkovšek, 1990a; Kolar-Jurkovšek & Jurkovšek, 1995, 1996; Jurkovšek et al.,

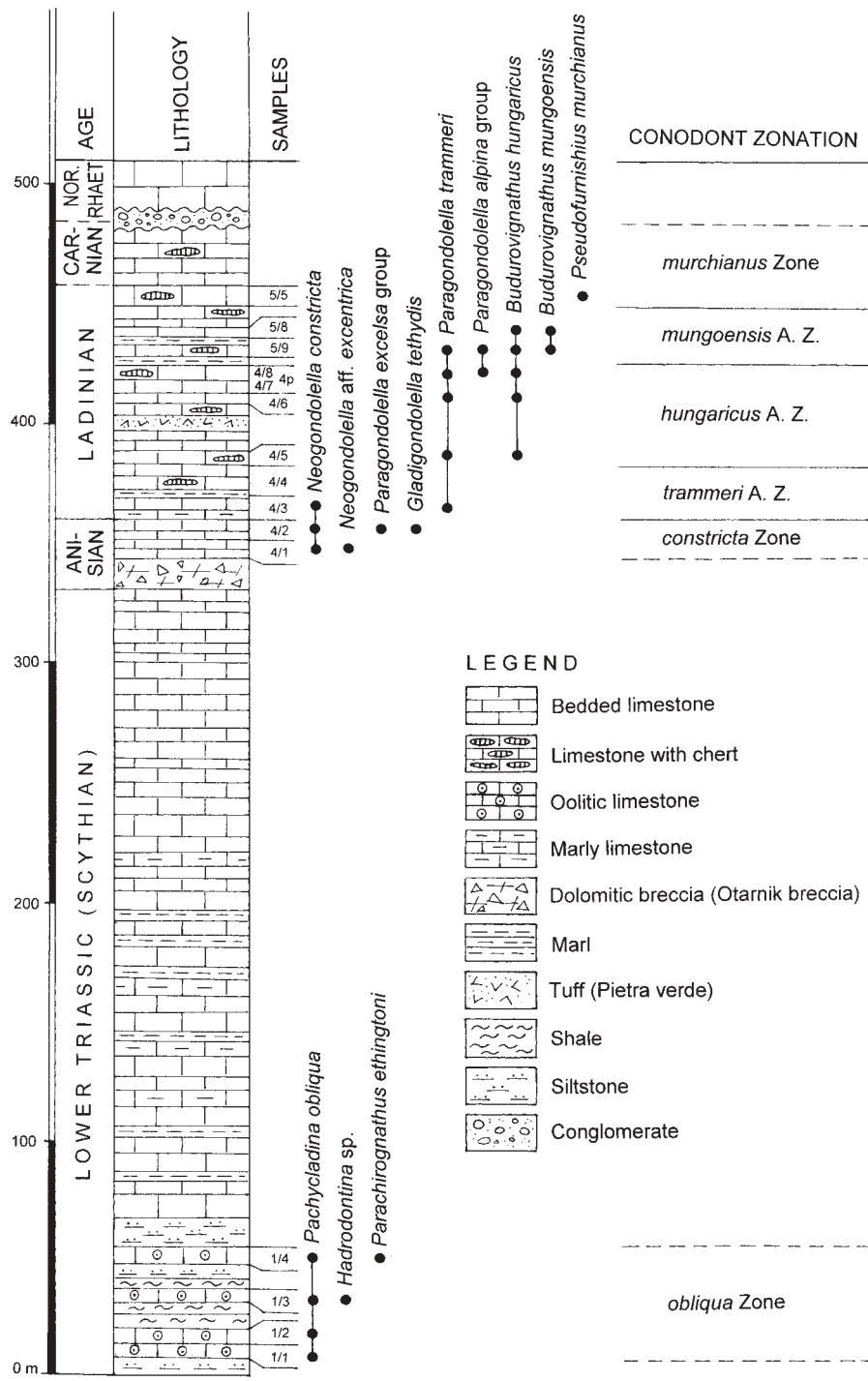


Fig. 2. Stratigraphic succession of Triassic beds with conodont zonation in the basement of Adriatic-Dinaric carbonate platform of Mt. Svilaja.

Sl. 2. Stratigrafsko zaporedje triasnih plasti s konodontno conacijo v podlagi Jadransko-dinarske karbonatne platforme na planini Svilaja.

1999). *P. obliqua* is a geographically widely distributed species, ranging, according to Perri and Andraghetti (1987), from the upper Nammalian to the Spathian. As reported by Solien (1979), in the Thaynes Formation of Utah, *Pachycladina* and *Hadrodontina* characterize the Smithian.

#### Anisian

The Anisian-Ladinian boundary is marked by the first appearance of *P. trammeri*. The definition of this boundary was proposed by Krystyn (1983) and it coincides with the boundary between the *Parakelnerites* and *Nevadites* Zones. As this boundary is easily applicable in conodont biostratigraphy, it has been accepted later by some authors (Nicora & Kovacs 1984, Kovacs et al. 1990). It should be noted that in the last decade, Middle Triassic strata have been the object of intensive multidisciplinary studies; therefore the base of the Ladinian stage is the main topic of several debates (Brack et al. 2003; Vörös et al., 2003; Mietto et al., 2003).

**Samples SSP 4/1, 4/2:** *constricta* Zone is provided by the occurrence of the nominate species that is accompanied by *Paragondolella excelsa* Mosher group and *Neogondolella* aff. *excentrica* Budurov & Stefanov.

#### Ladinian

Conodont zonation of the Ladinian part of the section corresponds well with the results obtained from the pelagic sequence of Epidaurus, Greece by Krystyn (1983). Accordingly, the recognized Ladinian zones of Svilaja were stated based on the first appearance of the nominate species: *Paragondolella trammeri* (Kozur), *Budurovignathus hungaricus* (Kozur & Vegh) and *Budurovignathus mungoensis* (Diebel).

**Samples SSP 4/3, 4/4:** *trammeri* A. Z. – *Neogondolella constricta* (Mosher & Clark) is still present, but the first appearance of *P. trammeri* is recorded in the sequence.

**Samples SSP 4/5, 4/6, 4/6, 4/7, 4/8, 4/9, 4p:** *hungaricus* A. Z. Specimens of *B. hungaricus* were obtained starting with the sample SSP 4/5, along with *P. trammeri*, and rare exemplars of *Paragondolella alpina* (Kozur & Mostler) group.

**Samples 5/9, 5/8:** *mungoensis* A. Z. is marked by the first appearance of *B. mungoensis*, that is accompanied by *B. hungaricus* and *P. trammeri*.

#### Upper Ladinian–Lower Carnian

**Sample 5/5:** *murchianus* Zone. The youngest conodont zone is indicated by the presence of a single element of *Pseudofurnishius murchianus* Van den Boogaard. The genus *Pseudofurnishius* is very typical element of the Southern Tethys and its marginal seas (Kozur, 1993). The most characteristic Upper Ladinian to Lower Carnian species, *P. murchianus*, is the marker of the *murchianus* Zone (Kolar-Jurkovšek, 1990b).

The uppermost part of the sequence measured and sampled was barren of conodonts, but it yielded abundant holothurian fauna (*Theelia* sp.). A detailed study of the conodont fauna, as well as other microfossils, is in progress and will be presented in a forthcoming paper.

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