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Biostratigraphy on ammonoids and foraminifers of Middle Triassic (Pelsonian) Jelovica Limestone Formation (Stara Planina Mts), Eastern Serbia

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Abstract: Biostratigraphy and sedimentology of the Pelsonian (Middle Anisian) carbonate Jelovica Fm sequence have been documented in detail in the Spomen Dom section (Jelovica–Visočka Ržana region of the Stara Planina Mts, Eastern Serbia). Abundant ammonoids and foraminifers, together with rare brachiopods, nautiloids, bivalves and crinoids characterize faunal associations of the ammonoid *Balatonites balatonicus* Zone and the foraminiferal *Pilammina densa* Zone. This is the first report based on ammonoid and foraminiferal faunas, which allowed initial biostratigraphic subdivision of the Middle Anisian strata from the whole Eastern Serbia region.

Keywords: Middle Triassic, ammonoids, foraminifers, paleontology, biostratigraphy, Stara Planina Mts, Eastern Serbia.

Introduction

Triassic deposits are widespread in the Stara Planina–Poreč Unit (Upper Danubian) on the East Serbian part of the Stara Planina Mts. Their specific paleontological and lithological/sedimentological characteristics are unique in Eastern Serbia. Therefore, they have been the subject of intensive geological studies. Generally, after the uppermost Permian and lowermost Triassic continental deposits, there are the uppermost Lower and entire Middle Triassic marine deposits of the shallow marine sandstones and shallow marine ramp carbonates in the region of Visok within the southern area of the Stara Planina Mts. These, Middle Triassic shallow-water marine carbonate rocks contain diverse and specimen-rich macro- and micro-fossil assemblages (e.g., brachiopods, bivalves, gastropods, crinoids, algae, foraminifers). During field investigations in the Jelovica–Visočka Ržana region of the Stara Planina Belt, special attention was paid to find ammonoids. Before this study, Middle Triassic ammonoids, except the citation of one Illyrian specimen on the genus level (*Paraceratites* in Urošević et al. 1992), had been practically unknown in these areas of the Stara Planina Mts.

After successful investigations of the new section suggested by D. Rabrenović, who had visited the locality earlier, numerous and diverse fauna of ammonoids and abundant foraminiferal micro-associations were determined. The aim of this paper is to present paleontological, biostratigraphic and sedimentological data of the Middle Triassic (Pelsonian) carbonate sedimentary succession in the Spomen Dom section, located on the southern slopes of the Stara Planina Mts in the vicinity of Jelovica village (Fig. 1A,B,C).

Geological setting

The East Serbian Carpatho–Balkanides, as a part of Dacia Megaunit (Kovács et al. 2011), consist of several large Alpine geotectonic units composed of different metamorphic, igneous and sedimentary rocks of Proterozoic, Paleozoic and Mesozoic age. The Stara Planina–Poreč Unit (Upper Danubian) is the easternmost of them. It is composed of two segments: (a) northern, in the narrow belt between the Danube and Timok Rivers and limited by Kučaj, Vrška Čuka–Miroč and Krajina units, and (b) southern part between the Vrška Čuka–Miroč and Kučaj units and the Serbian–Bulgarian State border in the south-east (Fig. 1A). The investigations presented in this study were undertaken in the newly described Spomen Dom section within Jelovica–Visočka Ržana region of the Stara Planina Belt (southern parts of the Stara Planina–Poreč Unit, Upper Danubian).

The lithostratigraphy of the Triassic sedimentary succession of the mentioned region, shown in Figure 2 (column **A**), was recently summarized by Anđelković et al. (1996), and Kovács et al. (2011). The Upper Permian and the first two Lower Triassic units are according to Kovács et al. (2011), whereas the uppermost Lower and Middle Triassic units are

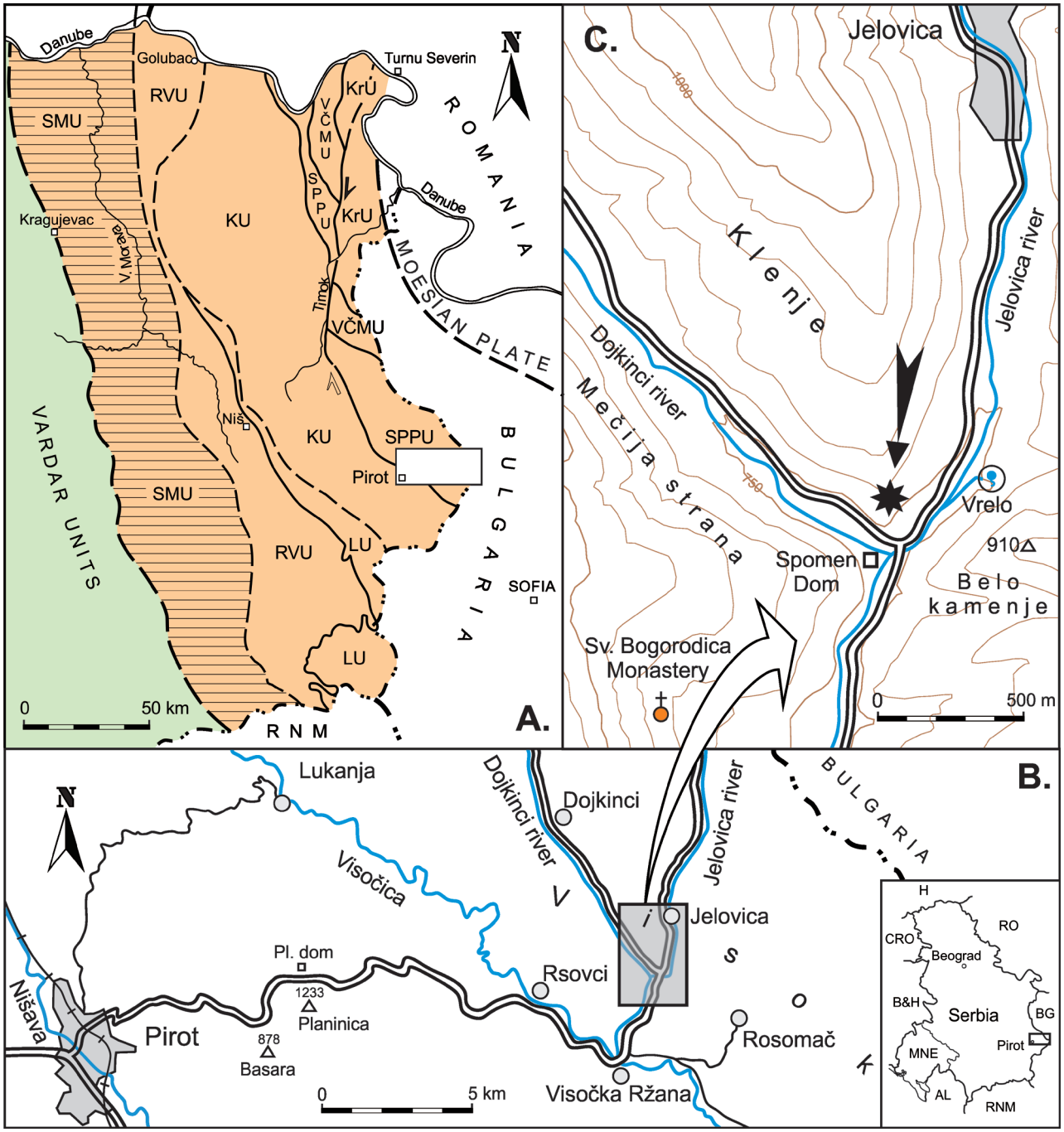


Fig. 1. Geological and geographical location of the Spomen Dom section on the Stara Planina Mts in Eastern Serbia. **A** — Units/terranes of the Dacia Megaunit (Kovács et al. 2011): SMU=Serbo–Macedonian Unit (brownish with lines); East Serbian Carpatho–Balkanides (brownish): RVU=Ranovac–Vlasina Unit (Supragetic); LU=Lužnica Unit (Kraishte); KU=Kučaj Unit (Getic); SPPU=Stara Planina–Poreč Unit (Upper Danubian); VČMU=Vrška Čuka–Poreč Unit (Lower Danubian); KrU=Krajina Unit (Severin). **B** — Regional sketch map of the southern part of the Stara Planina Mts where the grey shadowed field marks the study area of the Visok Massif; small right sketch: H=Hungary; RO=Romania; BG=Bulgaria; RNM=Republic of North Macedonia; AL=Albania: MNE=Montenegro; B&H=Bosnia and Herzegovina; CRO=Croatia. **C** — Enlargement of the shadowed field from B. with marked positions of the Spomen Dom section (asterisk) and Vrelo locality (the encircled sign for the well-spring).

according to Anđelković et al. (1996). These Triassic sedimentary occurrences in Jelovica–Visočka Ržana region extended north from Jelovica village along the road and Jelovica River in the direction of Visočka Ržana all to the deviation toward the Sv. Bogorodica Monastery (Fig. 1C). From there, after the fault, further to Visočka Ržana, the Jurassic and Lower Cretaceous deposits continue. The Upper Triassic sediments spread from the Sv. Bogorodica Monastery

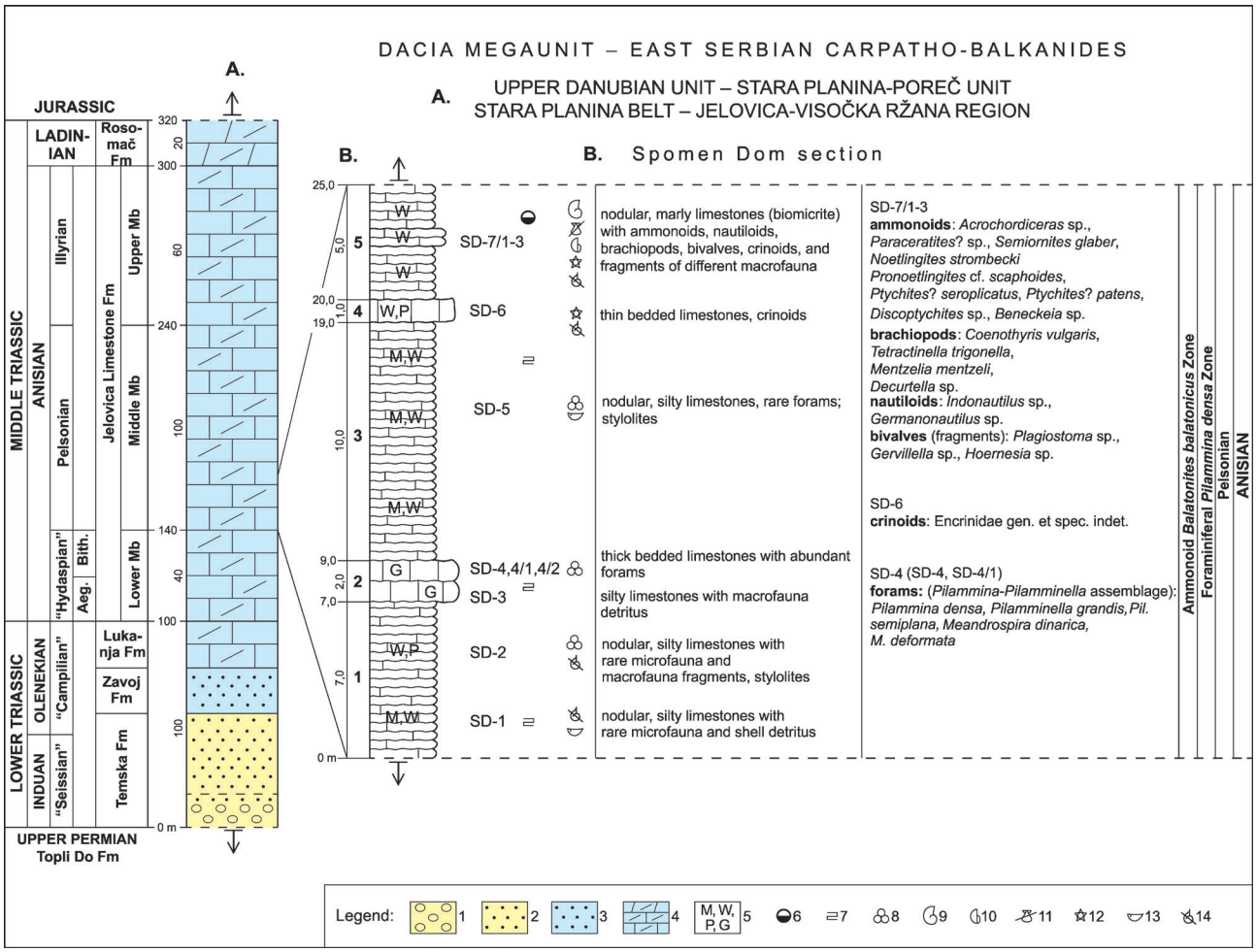


Fig. 2. Stratigraphic columns with lithology and fauna distributions in the Stara Planina–Poreč Unit of the East Serbian Carpatho–Balkanides. **A** — Generalized column for the Jelovica–Visočka Ržana region in the Stara Planina belt (Kovács et al. 2011), thickness of the Lower and Middle Triassic sedimentary succession according to Anđelković et al. (1975). **B** — Sedimentary succession and fauna contents in the Pelsonian interval (ammonid *Balatonites balatonicus* Zone and foraminifer *Pilammina densa* Zone) of the investigated Spomen Dom section. Legend: 1–4: Lithofacies units: 1, 2: continental deposits: 1 – conglomerates; 2 – sandstones; 3, 4: shallow marine deposits of the continental marine domains: 3 – sandstones; 4 – ramp carbonates: upper: dolomites, lower: limestones; 5 – limestone types: M=mudstone; W=wackestone; P=packstone; G=grainstone; 6 – geopetals; 7 – parallel lamination; 8 – foraminifers; 9 – cephalopods (ammonoids and nautiloids); 10 – brachiopods; 11 – bivalves (fragments); 12 – crinoids (fragments and ossicles); 13 – ostracodes; 14 – biodetritus (different bioclasts i.e., fragments of fauna). Abbreviations: Aeg.=Aegean; Bith.=Bithynian; Fm=Formation; Mb=member; Sz=Subzone; Z=Zone.

towards Rosomač and Senokos villages in the east (Anđelković et al. 1996).

The lowermost Lower Triassic siliciclastic sediments (Temska Formation) overlie various parts of the Topli Do Formation (Permian red clastics) or Riphean–Cambrian schists. Temska Formation has characteristics of fluvial–alluvial sedimentation in semi-arid or arid conditions, for example, with storm episodes, braided rivers, meandering rivers (Kovács et al. 2011 after Maslarević & Čendić 1994). This formation is overlain by marine siliciclastic, partly clayey and rarely calcareous layers, of Zavoj Formation deposited on tidal flats, which contain Lower Triassic flora (Urošević in Maslarević & Čendić 1994). The Lower Triassic ends with Lukanja (Limestone) Formation characterized by carbonate deposition on shallow marine ramp within continental margin domain. It is represented by "bivalve limestones" (because of the presence of pelecypod fragments known in this part of Serbia as "myophorian" or "gervilleian limestones") which are often strongly bioturbated and the coquina beds are common. The thickness of the Lower Triassic sediments is approximately 100 m. Such conditions continue through the rest of the Triassic of this part of Stara Planina Mts (Kovács et al. 2011).

The following carbonate deposits, namely the Jelovica Limestone Formation according to Anđelković et al. (1996), were separated into three members: Lower, Middle and Upper, which correspond to the Anisian substages. The Lower Member is represented by the lowermost Anisian ("Hydaspian") thin-bedded, "nodular limestones" with sporadic appearances of bivalve coquinas (the bivalves are concentrated on bed

surfaces or they form whole beds), foraminifers, algae and rare conodonts. The Middle Member is Pelsonian thick-bedded "brachiopod limestones" mainly with rich brachiopod associations, foraminifers and conodonts. The Upper Member corresponding to the topographically highest portion of the Jelovica–Visočka Ržana region is composed of "crinoidal or trochite limestones" with crinoid trochites, calyces and stems, and calcareous algae, Illyrian in age.

According to previously mentioned investigations, the Jelovica Limestone Formation is followed by the Rosomač (Dolomite) Formation composed of massive dolomites and slightly dolomitic limestones with gastropods, bivalves and brachiopods of Ladinian age (Anđelković et al. 1996). These rocks represent the end of the Triassic sequence in this part of the Stara Planina Mts region. The thickness of Middle Triassic rocks is approximately 220 m, of which only about 20 m are Ladinian in age (in this region).

Materials and methods

The Spomen Dom section was investigated for macro and microfossils twice: firstly, between 2005–2007 (D. Rabrenović) and secondly, in 2019 (all authors). Besides numerous macrofossils, partly fragmented or in different state of preservation, 10 samples were taken to prepare thin sections for micropaleontological and sedimentological analyses. The stratigraphic position of the samples is indicated in Figure 2.

From the upper part of this section (sample SD-7 of the unit 5) more than 50 specimens of ammonoids were collected, but most of them are more or less fragmented. This was the reason that only 18 specimens can be assigned to distinct genera and species, and eight were left in open nomenclature. Furthermore, three species and one genus of brachiopods, two genera of nautiloids and three genera of bivalves were determined. Abundant microfossils were also discovered from the lower part of the section (thin sections SD-4 and SD-4/1 from sample SD-4 of the upper part of unit 2). They contain a very uniform, but rich, *Pilammina–Pilamminella* assemblage of foraminifers composed, above all, of numerous ammodiscids and individual cornuspirids.

The laboratory preparation and photo-documentation of the macrofossils were carried out at the Geological Survey of Montenegro in Podgorica. Photos were taken with Carl Zeiss Jena Stereomicroscope SM XX and Sony DSC-W830 digital camera. Thin sections preparation and all micropaleontological and sedimentological analyses were performed by the Geological Survey of Serbia in Belgrade, where they are inventoried under repository numbers SD-1 to SD-7/1.2.3 (11 thin sections). Microphotos were taken with Carl Zeiss Jena Polarization microscope Amplival pol.d. The illustrated foraminifers and their micro-association presented herein were photographed using the Olympus light microscope BH-2 and Olympus E-410 digital camera at the Faculty of Mining and Geology, Belgrade. The described and figured macrofaunal specimens are stored in the Geological Survey of Montenegro in Podgorica.

Results

Spomen Dom section

The studied Spomen Dom section contains a newly discovered Middle Triassic (Pelsonian) interval exposed north of the confluence of the Dojkinci and Jelovica rivers opposite the old, abandoned building of Spomen Dom (=Memorial Home) (43°10'55.5"N, 22°49'43.5"E), about 30 km east-north-east from the town of Pirot (Fig. 1B,C). The sedimentary succession is 25 m thick and located on the southern slope of Klenje Hill. It is subdivided into five separate units, on the basis of macroscopic (lithological) characteristics that were determined during field investigations and later on sedimentological and micropaleontological studies (Figs. 2, 3).

Lithology and sedimentology

The Spomen Dom section is predominantly built of platy, thin-bedded nodular, clayey–silty limestones. Very thin layers of calcisiltite or limy shale are only locally present being almost washed out. The section is composed of 5 units, with two characteristic thick beds, 2 and 1 m thick respectively (Fig. 3). Both are expressed in relief and separated as individual units (units 2 and 4), because they indicate temporal changes in sedimentary conditions. The limestones are mostly light to dark grey coloured, but only in the upper part they are light reddish (app. 40 cm thick; sample SD-7). Wackestone to mudstone (rarely packstone) prevails in the thin-bedded parts of the section (units 1, 3, 5), while bioclastic grainstone predominates in units 2 and 4.

Unit 1 (7 m thick, samples SD-1 and SD-2). The lower part of unit 1 (SD-1) is made of mudstone to wackestone and contains scarce silty components (quartz, sericite). Detritus of thin shells and unrecognizable biodetritus are rare. In the upper part of the unit (SD-2) limestones are bioclastic wackestones to packstones; they are thin-bedded, nodular and siltier. Unequally distributed, fragments of bivalves with thin and thick shells and fine biodetritus are typical. Crinoidal ossicles (echinoderms) and microfauna (foraminifers, ostracodes) appear sporadically. Rare stylolites are filled with ferruginous matter.

Unit 2 (2 m thick, samples SD-3 and SD-4), as mentioned earlier, is made of bioclastic grainstone (partly packstone). It contains numerous fragments of brachiopods, bivalves, echinoderms and juvenile gastropods, usually oriented and concentrated in mm-cm lenses parallel to stratification. Characteristic abundant benthic foraminifers representing *Pilammina–Pilamminella* assemblage are more frequent in the upper part of the unit (thin sections SD-4 and SD-4/1 from sample SD-4). Sparite calcite and plenty of transported

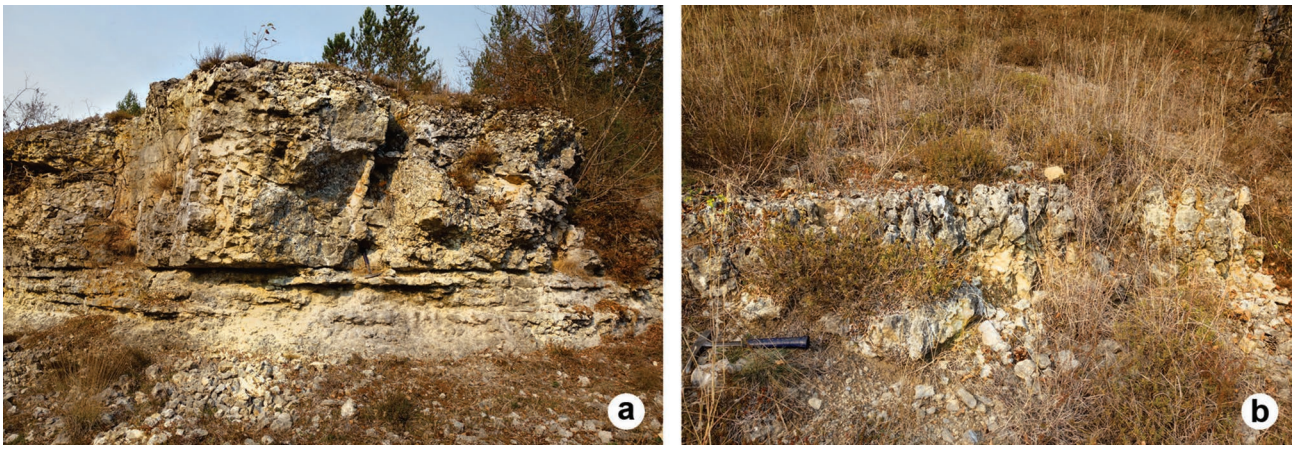


Fig. 3. Field photographs of the Spomen Dom section. **a** — Unit 2 (2 m thick limestone bed); **b** — Unit 4 (1 m thick nodular, marly limestone bed) (photo: D. Jovanović).

macrofauna fragments indicate higher energy conditions and influence of tidal and wave currents.

Unit 3 (10 m thick, SD-5), made of mudstone to wackestone, is similar to unit 1. It contains silty components (angular quartz grains, sericite), scarce fragmented macrofauna (crinoid or echinoid plates) and microfauna (ostracods, unrecognizable biodetritus). Infrequent stylolite seams are filled with ferruginous matter. They were probably formed during the early diagenesis or are the result of late pressure dissolution and recrystallization.

Unit 4 (1 m thick, SD-6), made of bioclastic wackestone to packstone (partly) is similar to the upper part of unit 1. Micrite predominates as cement, but fragments of abundant macrofauna (e.g., shells of brachiopods, bivalves, gastropods, ammonoids, crinoids and other echinoderms) indicate the occasional high energy activities (storms, waves and tidal currents) in protected low energy parts of low-angle shelf or ramp. Fragments are not sorted, mm in size (0.5–5 mm), probably transported short distances and accumulated in sediment traps on the shelf. Foraminifers were not observed.

Unit 5 (5 m thick, sample SD-7) has similar lithology to units 1 and 3. The limestones are bioclastic wackestones to packstones; micrite is predominant as cement, with a lot of fragmented macrofauna. Due to the presence of ammonoids (in a pale red coloured level), which were the topic of our investigations, we made three thin sections from the fossiliferous level. They have the same characteristics as the previous strata; only the level with ammonoid concentrations differs from other units. Associated macrofauna is unsorted and partially fragmented, indicating a short transport. Foraminifers are missing. The sample SD-7/1 contains nice sections of ammonoids with crushed biodetritus inside the shell. In the sample SD-7/3, in a bivalve shell one very characteristic geopetal fabric is present.

The whole succession was deposited in a protected part of the shelf or low-angle ramp under low energy conditions (prevalence of mudstone to wackestone). Only, occasionally, due to tidal and wave activities (also storms, local tectonics) grainstones were deposited in high water energy conditions with accumulations of variously preserved and mostly fragmented macrofauna (e.g., ammonoids, brachiopods, nautiloids, bivalves, crinoids, echinoids), and microfauna (foraminifers).

Chronostratigraphy and biostratigraphy

The typical feature of the sedimentary succession in the Spomen Dom section is the random appearance of concentrations of macro and/or microfossils, mainly consisting of ammonoids, brachiopods and foraminifers. Specimens are often fragmented, however some complete ones were documented as well. Besides these, fragments of other molluscs (bivalves, nautiloids), crinoids (stem fragments or isolated ossicles) and ostracodes were also found. The micro-association with frequent foraminifers is especially characteristic for the lower part of the succession.

It is important to note that, for the first time in this region of the Stara Planina Mts, rich and diverse ammonoids, Pelsonian in age, are described.

Layer SD-7 of the Unit 5 (Figs. 2, 3) yielded the following ammonoid taxa: *Acrochordiceras* sp. (Fig. 4A–C), *Pronoetlingites* cf. *scaphoides* (Fig. 6E–H), *Semiornites glaber* (Arthaber) (Fig. 5A–G), *Ptychites*? *seroplicatus* Hauer (Fig. 7A–F), *Ptychites*? *patens* Hauer (Fig. 7G–J), *Discoptychites* sp. (Fig. 7K–Q), *Paraceratites*? sp. (Fig. 4D–G), *Noetlingites strombecki* (Griepenkerl) (Fig. 6A–D) and *Beneckeia* sp. (Fig. 7R–S). From the same limestone layer, representatives of nautiloids [*Indonautilus* sp. (Fig. 8L–M), *Germanonautilus* sp.], brachiopods [*Coenothyris vulgaris* (Schlotheim) (Fig. 8A–F), *Tetractinella trigonella* (Schlotheim) (Fig. 8G–I), *Mentzelia mentzeli* (Dunker) (Fig. 8J–K), *Decurtella* sp.], bivalves (*Plagiostoma* sp., *Gervillella* sp., *Hoernesia* sp.) and crinoids (Encrinidae gen. et sp. indet.) have been collected.

Besides this macrofauna, a low-diversity but specimen-rich foraminiferal *Pilammina–Pilamminella* assemblage is

documented in the layer SD-4 (thin-sections SD-4 and especially SD-4/1 from the upper part of unit 2). The dominant forms are ammodiscids with a very large number of individuals of two genera, represented with one species of *Pilammina* Pantić: *Pilammina densa* Pantić (Fig. 9c–e,g–l) and two species of *Pilamminella* Salaj: *Pilamminella grandis* Salaj (Fig. 9d–f,l,m), *Pilamminella semiplana* (Kochansky-Devidé & Pantić) (Fig. 9c,h). Besides ammodiscids, individual cornuspirids namely, *Meandrospira dinarica* Kochansky-Devidé & Pantić (Fig. 9g,n), *Meandrospira deformata* Salaj (Fig. 9o) are present. The publication of Loeblich & Tappan (1987) is applied for the classification of foraminifers. As with the ammonoid fauna, the documented association of foraminifers in their abundance and composition made it possible to distinguish the *Pilammina densa* Zone of Pelsonian age, which is a novelty for this part of the Stara Planina Mts.

The underlying and overlying strata of the investigated section could not be studied as they are covered by Quaternary alluvial sediments (underlying) or dense vegetation (overlying). Therefore, the exact position of the examined Spomen Dom section (column B on Fig. 2,) within the stratigraphical succession of the Jelovica–Visočka Ržana region (column A on Fig. 2) can only be inferred based on the nearby outcrops, already published data and our new biostratigraphic subdivisions. Macro and microfossil associations confidently indicate the *Balatonites balatonicus* Zone based on ammonoids (Ogg et al. 2020) and the *Pilammina densa* Zone, based on foraminifers. The forminiferal Zone in the Spomen Dom section corresponds to the *Pilammina densa* Range-Zone in Bulgaria (e.g., Trifonova 1978; Budurov & Trifonova 1995). Both zones belong to the middle Pelsonian (Middle Anisian).

The status of the newly established foraminiferal Zone in the Spomen Dom section stays only in the broad frame of the name Zone. The determined species of *Pilammina* Pantić and *Pilamminella* Salaj probably catch the maximum of population in the investigated stratigraphic extent. However, without their real and precise ranges it is not possible to determine the strict biostratigraphic character of this unit based on their assemblage.

Similar development of the Middle Triassic sediments is present in the nearby Vrelo section, on the eastern side of the Jelovica River, only 200 m away. In Figure 1C it is designated with the encircled sign for the well-spring. In this famous locality, besides other fossils, a very rich lower and upper Pelsonian, and Illyrian brachiopod faunas (e.g., Urošević et al. 1992), and Bithynian and Pelsonian conodonts (Urošević & Sudar 1991) were described several times, but never Pelsonian ammonoids.

Systematic paleontology of ammonoids

Systematic descriptions follow the classification given by Tozer (1981), as well as by Vörös (2003) and Monnet & Bucher (2005). For all specimens wherever measurements were possible, dimensions of the diameter of the shell (D), whorl height (H), whorl width (W) and umbilical diameter (U) are given in millimetres and for H/D, W/D and U/D in percentages of D.

Each specimen has an inventory number, which consists of abbreviations for the locality (SD – Spomen Dom) and fossil group, number of the specimen and the abbreviations for the year when the specimen was found (e.g., SD-A1/19). Specimens collected by D. Rabrenović contain additional labels (e.g., SD-DR/1/07). The occurrence for the specimens with only a generic determination is not given.

Class: Cephalopoda Cuvier, 1797
Subclass: Ammonoidea Zittel, 1884
Order: Ceratitida Hyatt, 1884
Superfamily: Ceratitaceae Mojsisovics, 1879
Family: Acrochordiceratidae Arthaber, 1911
Genus: *Acrochordiceras* Hyatt, 1877
Acrochordiceras sp.
Fig. 4A–C

Material: One partially preserved specimen (SD-DR/9/07) and one complete juvenile specimen (SD-DR/10/07).

Description: The description of the species is a composite of two very different specimens, one being a very large, poorly preserved, part of the living chamber and the other a very small juvenile specimen. Shell is moderately involute, almost rounded in shape. The whorl section is subquadrate to subrectangular. The venter is rounded, worn by erosion. The flanks are slightly convex and pass gradually towards the arched venter. The umbilicus is medium sized, rounded and deep, with rounded shoulders towards the flanks. The ornamentation consists of rectiradiate, slightly concave, strong ribs, that do not pass to the venter, probably due to poor preservation. These ribs seem to bear nodes near the venter on the larger specimen. Near the umbilical side, there is a single node preserved, from which two ribs arise. Juvenile specimen contains weak umbilical nodes. The suture line is only partly preserved on the juvenile specimen, in the umbilical part and is similar to the specimen described as *Acrochordiceras* cf. *ippeni* by Dzik (1990). Due to bad preservation, dimensions could only be measured on the juvenile specimen.

Dimensions:

Inv. Number	D	H	W	U	H/D	W/D	U/D
SD-DR/10/07	12.5	5.7	?5.2	3.9	45.6	?41.6	31.2

Remarks: Since the suture line of the Spomen Dom specimens is not preserved in the most part, the precise determination is not possible. Strong ribbing, two ribs rising from the umbilical node and large size are similar to *Acrochordiceras damesii* specimens described from Poland (Noetling 1880; Spath 1934; Dzik 1990; Kaim & Niedźwiedzki 1999). The subquadrate shape of the whorl section of the large specimen is similar to specimens shown by Dzik (1990, therein described as *Acrochordiceras* cf. *ippeni*) and Kaim & Niedźwiedzki (1999, therein described as *Acrochordiceras* aff. *damesi*). The subrectangular whorl section of the juvenile

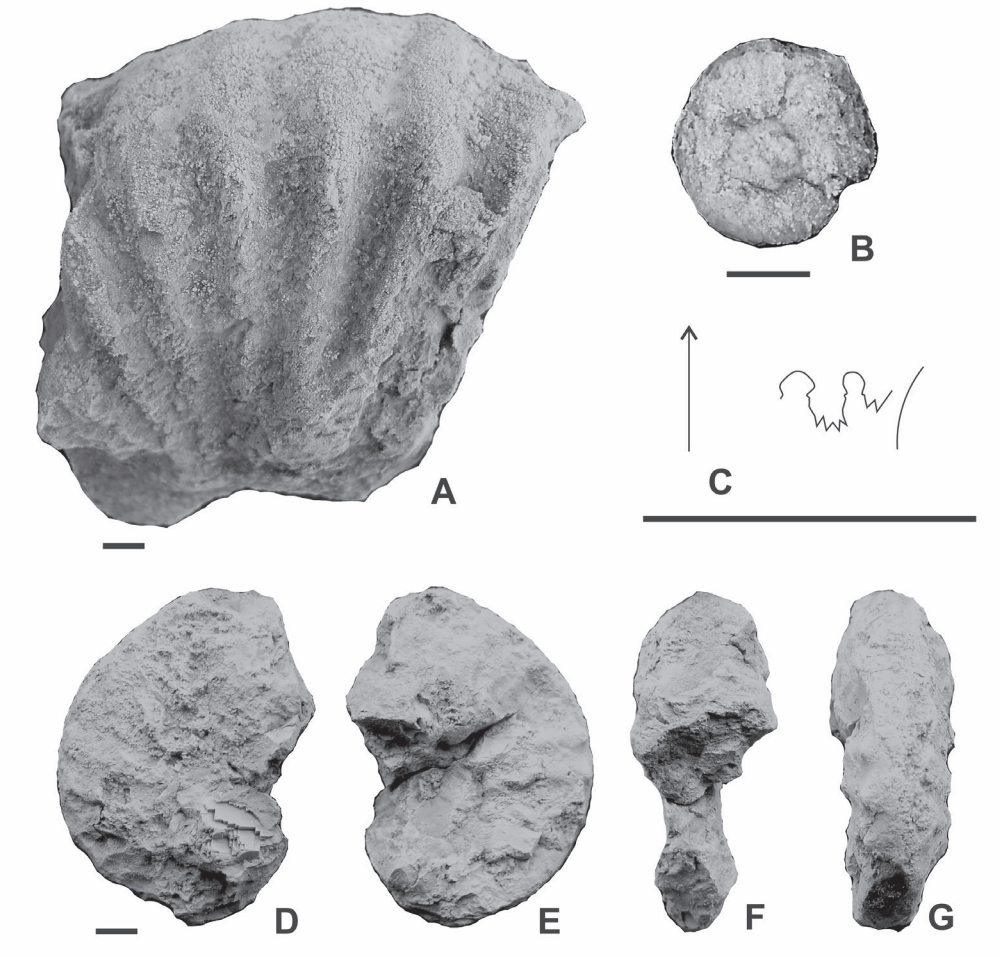


Fig. 4. A–C — *Acrochordiceras* sp.: A – SD-DR/9/07; B, C – SD-DR/10/07. **D–G** — *Paraceratites*? sp.: SD-DR/7/07. Scale bar equals 0.5 cm.

specimen is similar to the holotype of *Acrochordiceras damesii*. Vörös (2003) also describes a specimen from Balaton as *Acrochordiceras* cf. *damesii*, which has a high oval whorl section, but also bears weak nodes on the ribs, near the venter. Although the whorl section is different, the ornamentation is similar to the larger specimen from the Spomen Dom locality. All of the characteristics mentioned indicate that the Spomen Dom specimens show great similarity to *Acrochordiceras damesii*, as revised by Monnet et al. (2010). However, precise determination is not possible due to poor preservation, so the specimens found are determined as *Acrochordiceras* sp.

Family: Ceratitidae Mojsisovics, 1879
Subfamily: Paraceratitinae Silberling, 1962
Genus: *Paraceratites* Hyatt, 1900
Paraceratites? sp.
Fig. 4D–G

Material: Two very poorly preserved specimens (SD-DR/7/07 and SD-A3/19).

Description: Shell small, compressed, involute, elliptical in shape. The whorl section is subrectangular, with maximum thickness in the middle of the section. The venter is low-arched, with angular ventral shoulders towards the flanks, which are almost straight. The umbilicus is small in comparison to the rest of the shell, rounded and with slightly rounded shoulders. The ornamentation consists of weak rectiradiate ribs, that contain nodes on the mid-flank and clavi on the ventrolateral edge. The suture line is not preserved.

Dimensions:

Inv. Number	D	H	W	U	H/D	W/D	U/D
SD-DR/7/07	41.5	24.7	11.1	7.2	59.52	26.75	17.35
SD-A3/19	X	X	X	11.5	X	X	X

Remarks: The described specimens show most resemblance to species assigned to the genus *Paraceratites*. However, large number of them have been assigned to this genus in the past and need a systematic revision. Because of this and the poor preservation of the Spomen Dom specimens, they can only be determined as *Paraceratites*? sp.

Genus: *Semiornites* Arthaber, 1912
Semiornites glaber (Arthaber, 1896b)
Fig. 5A–G

1896a *Ceratites glaber* Arthaber, p. 46, pl. 3, fig. 8.
? 2003 *Semiornites* sp.; Vörös, p. 100, pl. A8, fig. 8.

Material: One almost completely preserved specimen (SD-DR/2/07) and two partially preserved ones (SD-DR/4/07 and SD-A2/19).

Description: Shell medium in size, compressed, involute, platycone, elliptical to almost round in shape. The whorl section is high oval to subtrapezoidal, with maximum thickness in the middle of the section. The venter is slightly rounded to subtabulate, with gradual transition towards the flanks, which are slightly convex. The umbilicus is rounded and small, with rounded edge towards the flanks and steep umbilical wall. The ornamentation consists of weak, sinuous ribs, that are poorly preserved. One specimen (SD-A2/19) contains weak clavi on the ventrolateral edge. Suture line is ceratitic, with a small external lobe, broad and serrated first and second lateral lobes and broad and rounded saddles.

Dimensions:

Inv. Number	D	H	W	U	H/D	W/D	U/D
SD-DR/2/07	72.9	34.7	23.0	15.2	47.59	31.55	20.85
SD-DR/4/07	?64.9	?31.9	X	12.3	?49.15	X	?18.95

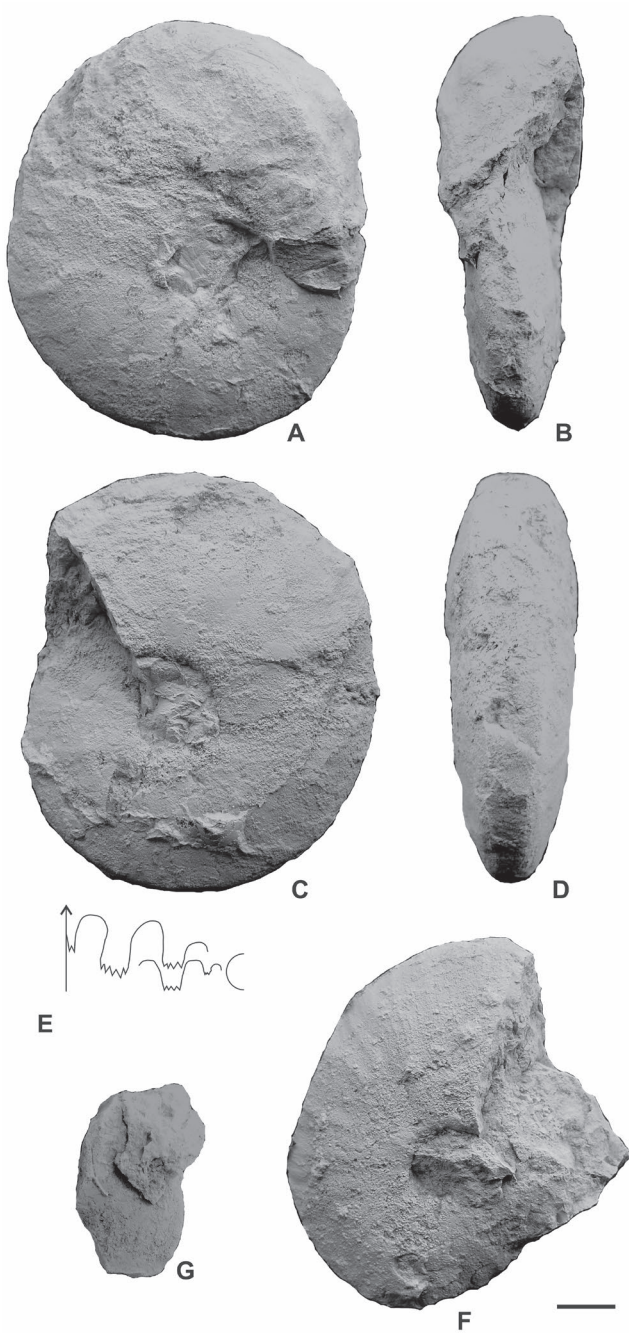


Fig. 5. A–G — *Semiornites glaber* (Arthaber): A–E – SD-DR/2/07; F – SD-DR/4/07; G – SD-A2/19. Scale bar equals 1 cm.

Remarks: *Semiornites glaber* differs from other species of the genus. It is very similar to *Semiornites semiornatus*, but it is less ornamented and has a slightly different suture line. It differs from *Semiornites cordevolicus* by slightly more pronounced ornamentation, different whorl section and venter, and slightly different suture line. In a certain sense, this species might represent the transitional form between the two above mentioned ones.

Vörös (2003) describes the specimens determined as *Semiornites* sp., that have practically the same characteristics as the specimens from Spomen Dom section, without the suture line that is not preserved, but the author shows only a photograph of one partially preserved specimen. However, because of the described characteristics, these specimens are tentatively included in the present species.

Occurrence: The species is known from the Pelsonian of Austria (Arthaber 1896a) and probably Hungary (Vörös 2003, therein described as *Semiornites* sp.).

Family: Longobarditidae Spath, 1951
Subfamily: Noetlingitinae Parnes, 1975
Genus: *Noetlingites* Hyatt, 1900
Noetlingites strombecki (Griepenkerl, 1860)
Fig. 6A–D

1860 *Ammonites Strombecki* Griepenkerl, p. 167, pl.7.
1977 *Hungarites strombecki* Griepenkerl; Kelber, fig. 2-3.
2001 *Noetlingites strombecki* (Griepenkerl); Tatzreiter, p. 159, fig. 9-10.

Material: One partially preserved specimen (SD-A4/19) and one almost complete juvenile specimen (SD-A5/19).

Description: Shell small, slightly compressed, involute, elliptical in shape. The whorl section is subhexagonal, with maximum thickness in the middle of the section. The venture is fastigate and sharp, with distinct angular ventral shoulders towards the flanks, which are convex. The umbilicus is rounded and small, only partially preserved on the juvenile specimen. Ornamentation is not visible. The suture line is not preserved.

Dimensions:

Inv. Number	D	H	W	U	H/D	W/D	U/D
SD-A4/19	X	18.9	12.1	X	X	X	X
SD-A5/19	8.4	4.0	X	?2.9	47.62	X	?34.52

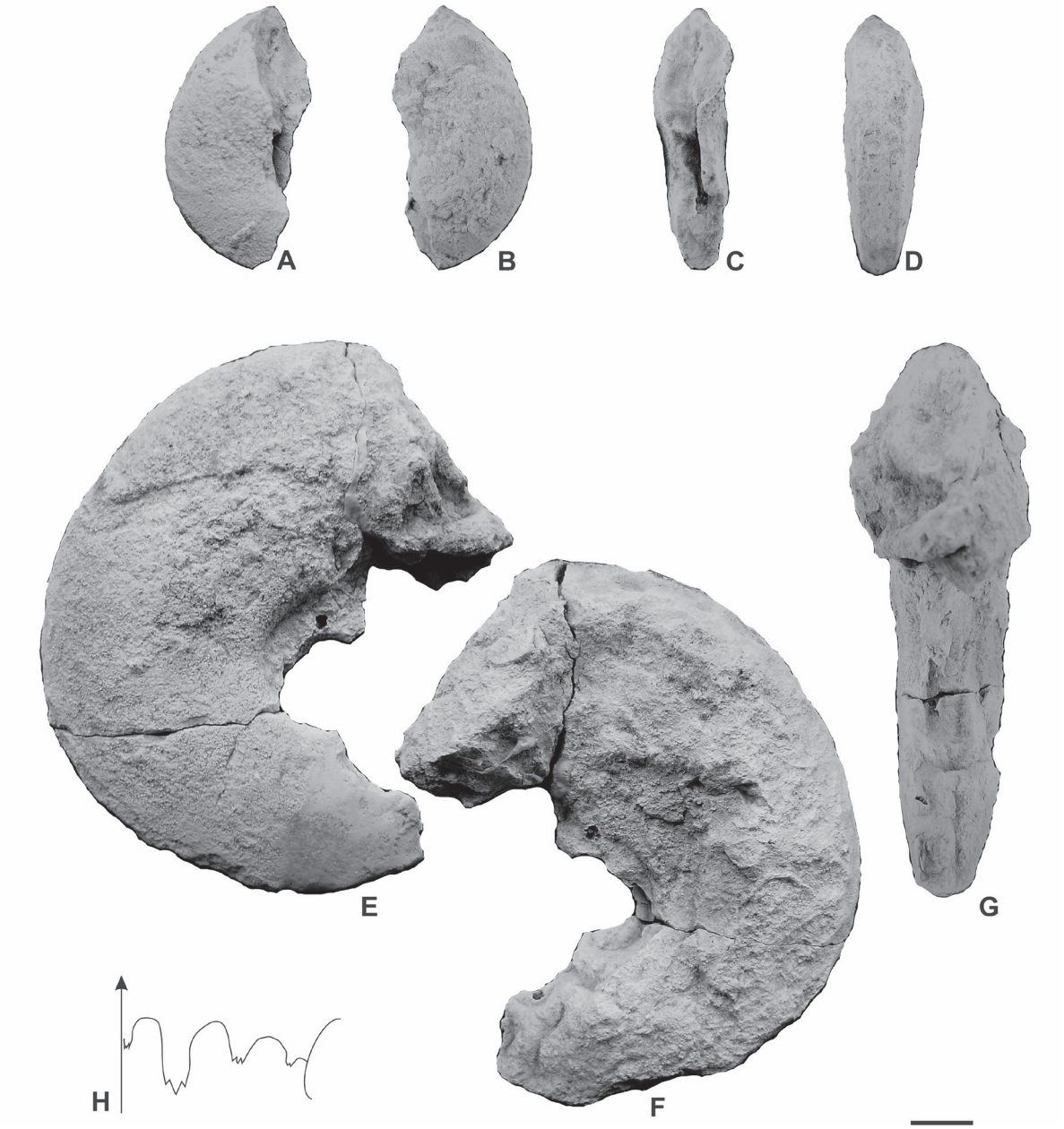


Fig. 6. A–D — *Noetlingites strombecki* (Griepenkerl): SD-A4/19; **E–H** — *Pronoetlingites* cf. *scaphoides* Parnes: SD-DR/1/07. Scale bar equals 1 cm.

Remarks: Even though the suture line is not preserved in the Spomen Dom specimens, the characteristic shape of the whorl section and fastigate venter allow certain determination of this species. The fragment of the adult specimen (SD-A4/19) shows the same characteristics described by Griepenkerl (1860) and Tatzreiter (2001). Other descriptions of *Noetlingites strombecki* can be found in published literature (e.g., Noetling 1880; Holdefleiss 1916; Claus 1932). However, even though the descriptions clearly indicate that the specimens belong to this species, the figures are not shown in the above, later mentioned publications, which makes the comparison of material from Spomen Dom locality with them impossible at present.

Occurrence: *Noetlingites strombecki* is known from Lower Muschelkalk of Germany and Poland, but also from the Bithynian of Austria (Tatzreiter 2001).

Genus: *Pronoetlingites* Parnes, 1975
Pronoetlingites cf. *scaphoides* Parnes, 1986
1986 *Pronoetlingites scaphoides* n. sp.; Parnes, p. 33, pl. 21, fig: 1-4, pl. 23, fig: 7.
Fig. 6E–H

Material: One very poorly preserved specimen (SD-DR/1/07).

Description: Shell large, compressed, moderately evolute, round in shape. The whorl section is high, subtriangular, with maximum thickness near the umbilicus. The venter is very slightly fastigate, with barely visible angular ventral shoulders towards the flanks, which are slightly convex. The umbilicus is medium-sized, with subrounded shoulders. The shell is smooth, without ornamentation. The suture line is partially preserved, very simple, ceratitic, with broad saddles and lobes only slightly serrated.

Dimensions:

Inv. Number	D	H	W	U	H/D	W/D	U/D
SD-DR/1/07	89.5	39.4	?27.1	23	44.02	?30.28	25.7

Remarks: The Spomen Dom specimen has a very similar suture line to *Noetlingites strombecki* and *Pronoetlingites arifensis*, which both probably belong to the same genus, but differs from them by being more evolute, and closer to *Pronoetlingites scaphoides*. However, the suture line of this species shown by Parnes (1986, pl. 23, fig. 7) is much simpler, which according to the photo of the specimen shown in pl. 21, fig. 4 seems to be a misinterpretation. Other characteristics of Spomen Dom specimen (e.g., fastigate venter, angular ventral shoulders), except missing ornamentation, fit well with this species. Since it is not preserved well and the comparison with the specimen described by Parnes is not made directly, it is determined as *Pronoetlingites* cf. *scaphoides*.

Occurrence: The species *Pronoetlingites scaphoides* is known from the Bithynian of Israel (Parnes 1986).

Superfamily: Ptychitaceae Mojsisovics, 1882
Family: Ptychitidae Mojsisovics, 1882
Genus: *Ptychites* Mojsisovics, 1875
Ptychites? *seroplicatus* Hauer, 1892
Fig. 7A–F

1892 *Ptychites seroplicatus* n. sp.; Hauer, p. 285, pl. 12, fig: 2, pl. 13, fig: 1.

Material: Two juvenile specimens (SD-DR/8/07 and SD-A6/19).

Description: Specimens small, depressed, cadicone, moderately evolute and rounded in shape. The whorl section is broad, subtriangular, with maximum thickness near the umbilicus. Venter is rounded, without distinct transition towards the flanks, which are almost straight. The umbilicus is rounded, medium-sized and very deep, with subrounded edge towards the flanks and very steep umbilical wall. The ornamentation is not preserved. The suture line is ammonitic, very complex.

Dimensions:

Inv. Number	D	H	W	U	H/D	W/D	U/D
SD-DR/8/07	9.2	4.3	7.9	2.7	46.74	85.87	29.35
SD-A6/19	13.6	6.5	X	3.8	47.79	X	27.94

Remarks: *Ptychites*? *seroplicatus* has the general characteristics of the genus, but differs from other representatives by having a broader umbilicus and different suture line. However, W/D ratio is much higher than the one reported by Hauer (1892) which may be considered a characteristic of juvenile forms.

This species, together with some others described by Mojsisovics (1882: *Pt. pauli*), Hauer (1892: *Pt. patens*) and Salopek (1911: *Pt. contractus*), because of their broader umbilicus and differences in the suture lines, can only be described as *Ptychites*?, until the revision of the original material is done or new material is discovered.

Occurrence: The species has so far been known from the Illyrian of Bosnia and Herzegovina (Hauer 1892). Renz (1910) also reported it from Greece, but did not publish an illustration of the described material.

Ptychites? *patens* Hauer, 1892
Fig. 7G–J

1892 *Ptychites patens* n. sp.; Hauer, p. 286, pl. 13, fig: 2.

Material: One completely preserved specimen (SD-DR/3/07).

Description: Shell small, compressed, involute and rounded in shape. The whorl section is oval, subtriangular, with maximum thickness near the umbilicus. Venter is rounded, with gradual transition towards the flanks, which are slightly convex. The umbilicus is rounded and small, very deep, with subrounded edge towards the flanks and steep umbilical wall, mostly covered with sediment. The ornamentation consists of weak, rectiradiate folds with broad depressions between them. The suture line is not preserved.

Dimensions:

Inv. Number	D	H	W	U	H/D	W/D	U/D
SD-DR/1/07	36.8	19.5	?15.5	10.5	52.99	?42.12	28.53

Remarks: *Pt.*? *patens* has the general characteristics of the genus *Ptychites*, but differs from other representatives by having a broader umbilicus. Martelli (1906) also reports it from the Anisian of Montenegro, but doesn't show the figure of the described specimen. Even though it has the characteristics of the species, this occurrence has to be considered doubtful.

As for *Ptychites*? *seroplicatus*, it can only tentatively be assigned to this genus, until the revision of the original material is done.

Occurrence: The species has so far been known from the Illyrian of Bosnia and Herzegovina (Hauer 1892) and probably Montenegro (Martelli 1906).

Family: Sturiidae Kiparisova, 1958
Genus: *Discoptychites* Diener, 1916
Discoptychites sp.
Fig. 7K–Q

Material: Four poorly preserved specimens (SD-DR/5/07, SD-DR/6/07, SD-A1/19 and SD-A7/19).

Description: Specimens medium-sized, compressed, involute and elliptical in shape. The whorl section is subtriangular in shape with maximum thickness just above the umbilicus. Venter is rounded, with gradual transition towards the flanks,

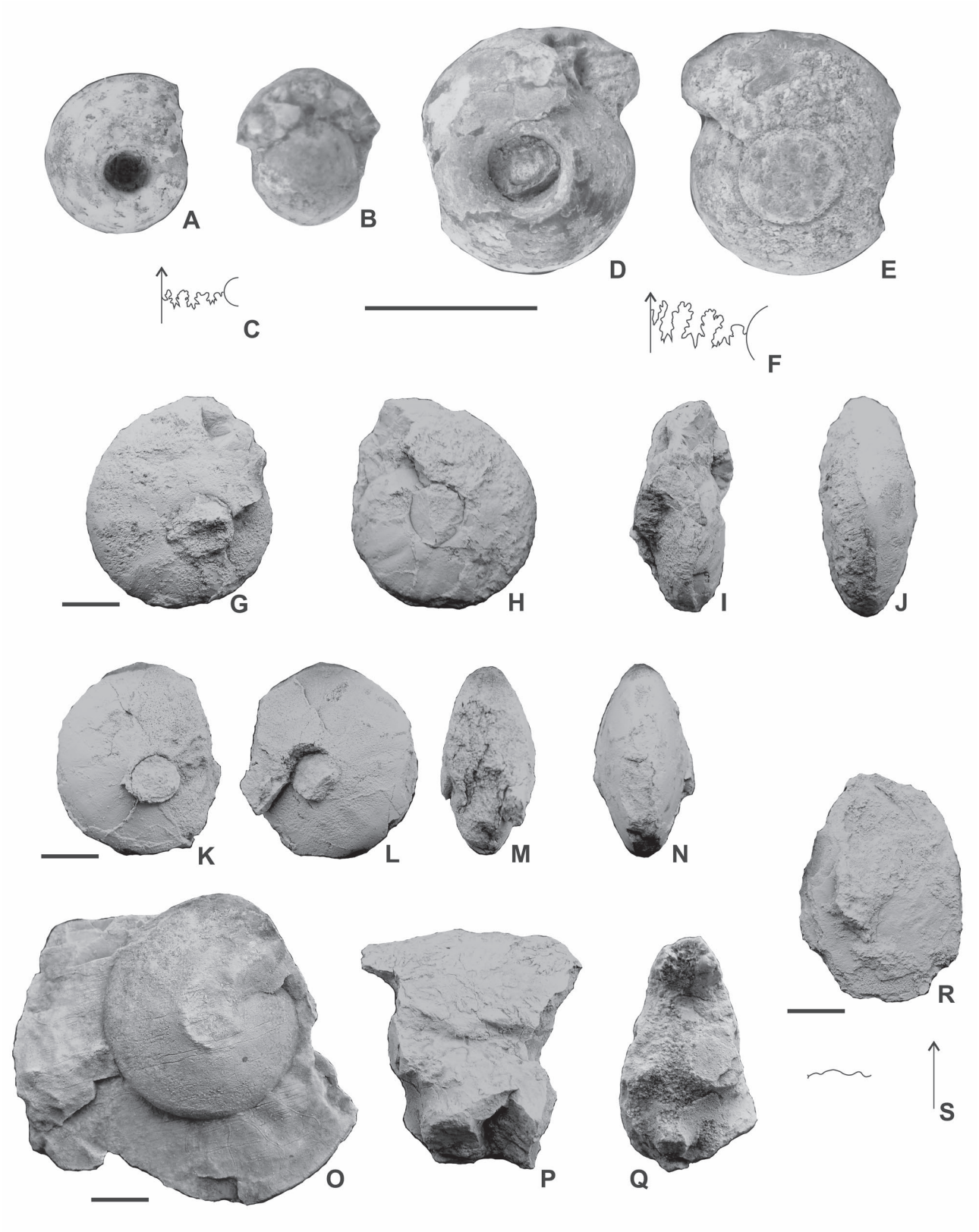


Fig. 7. A–F — *Ptychites*? *seroplicatus* Hauer: A–C – SD-DR/8/07, D–F – SD-A6/19; **G–J** — *Ptychites*? *patens* Hauer; **K–Q** — *Discoptychites* sp.: K–N – SD-DR/5/07, O – SD-DR/6/07, P–Q – SD-A1/19; **R–S** — *Beneckeia* sp.: SD-A8/19. Scale bar equals 1 cm.

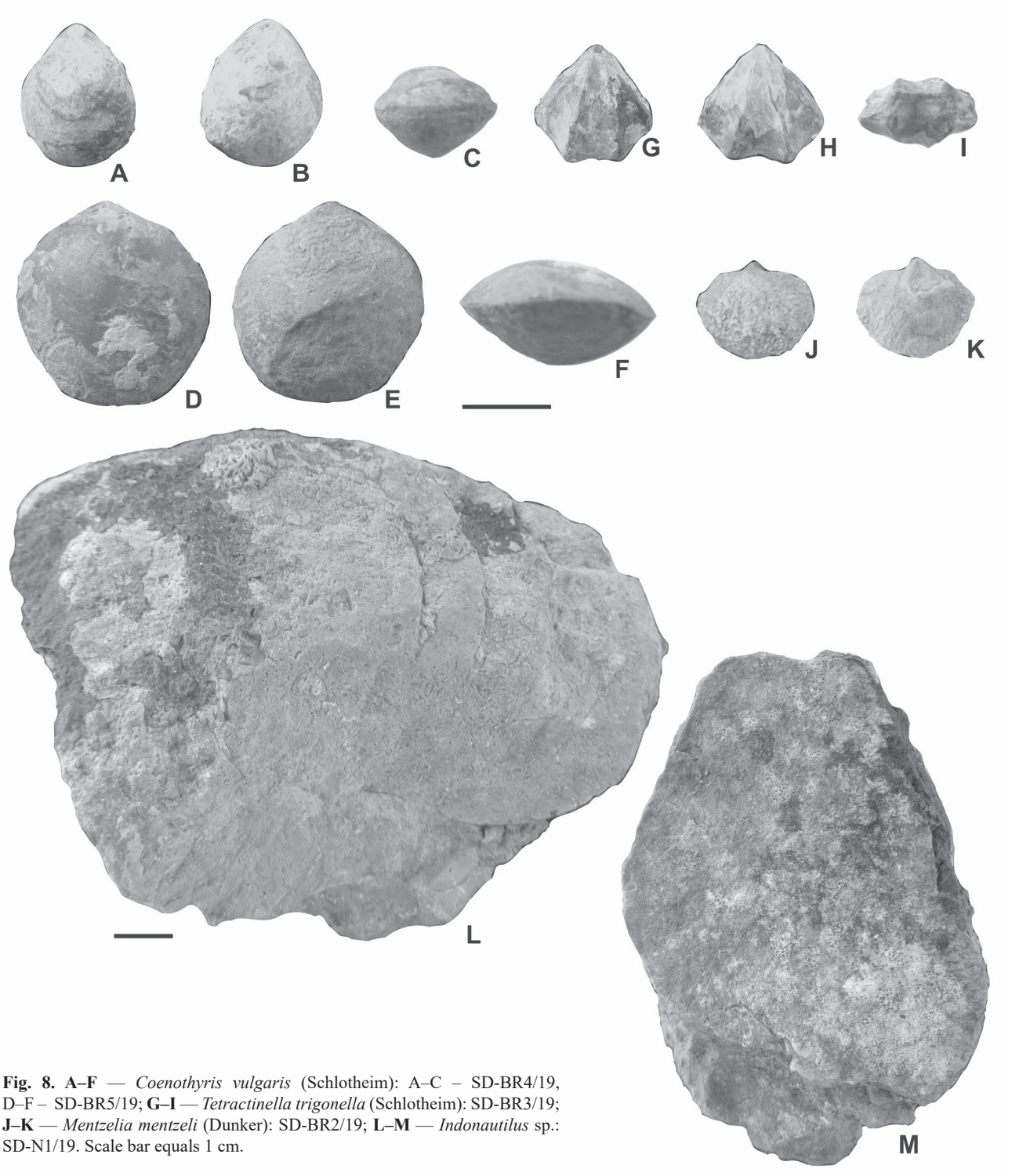


Fig. 8. A–F — *Coenothyris vulgaris* (Schlotheim): A–C – SD-BR4/19, D–F – SD-BR5/19; **G–I** — *Tetractinella trigonella* (Schlotheim): SD-BR3/19; **J–K** — *Mentzelia mentzeli* (Dunker): SD-BR2/19; **L–M** — *Indonautilus* sp.: SD-N1/19. Scale bar equals 1 cm.

which are straight to slightly convex. The umbilicus is small in comparison to the rest of the shell, rounded and deep, with overhanging wall and pronounced shoulder on one of the specimens (SD-DR/5/07). The ornamentation consists of very weak rectiradiate folds, that disappear before the venter. The suture line is only partially preserved on one of the specimens (SD-A1/19). The dimensions could be measured only on the specimen SD-DR/5/07.

Dimensions:

Inv. Number	D	H	W	U
SD-DR/5/07	X	X	13.5	7.3

Remarks: Specimens from Spomen Dom section have the whorl section, venter, ornamentation and partly preserved suture line that show great similarities to specimens of *Discoptychites suttneri*. However, due to poor preservation

precise determination of the species is not possible, hence it is described as *Discoptychites* sp.

Superfamily: Sageceratacеae Hyatt, 1884
Family: Beneckeiidae Waagen, 1895
Genus: *Beneckeia* Mojsisovics, 1882
Beneckeia sp.
Fig. 7R–S

Material: One very poorly preserved specimen (SD-A8/19).

Description: Shell medium-sized, compressed, oxycone, involute and elliptical in shape, without ornamentation. Suture line partially preserved, with smooth lobes and saddles.

Remarks: Representative of the genus are mostly known from the Lower Muschelkalk of the Germanic type of Triassic, but also from other regions. Even though the specimen from Spomen Dom section is very poorly preserved and cannot be determined to the species level, its characteristic suture line clearly indicates that it belongs to the genus *Beneckeia*.

Biostratigraphic and paleobiogeographic discussion

Ammonoids

Descriptions of Middle Triassic ammonoid faunas from the western Balkanides of Bulgaria and especially from the East Serbian Carpatho–Balkanides, are scarce (Stefanoff 1936; Nešić 1954; Ganev 1961; Tronkov 1968, 1976; Entcheva 1972).

Stefanoff (1936) described a rich fauna from Golo Bardo, mostly of late Anisian age, dominated by Alpine forms. The author mentions only three species that belong to a Germanic type of Triassic, of which only one would indicate Anisian age (*Beneckeia wogauana*), while the other two (*Ceratites* cf. *semipartitus* and *Ceratites* cf. *dorsoplanus*) indicate Ladinian age.

Ganev (1961) described rich ammonoid assemblages of "Campilian", Anisian and Carnian age from Luda–Kamčia (Eastern Bulgaria) in the eastern part of the Stara Planina Mts and emphasizes that all described species have Alpine character and that there are no common elements with Germanic type fauna. The Anisian fauna, which was found in resedimented limestone blocks within a terrigenous formation, probably of Tithonian age (Ganev 1961, p. 177), comprises Illyrian species belonging to *Ceratites trinodosus* Zone.

Tronkov (1968) described the species *Beneckeia tenuis* from western Bulgaria, which is common in the Germanic type of Triassic. The author wrongfully assigns it to belong to the Lower Triassic ("Campilian"), although this species instead indicates the Aegean substage within the Anisian stage (Vörös 2000). In his later publication, Tronkov (1976) gives an overview of Triassic ammonite faunas of the western Balkan mountains in Bulgaria, mentioning nine successive levels, with Germanic and Mediterranean type faunas replacing each other. The first levels, with *Beneckeia tenuis*, which was again placed in the Lower Triassic, and *Beneckeia buchi* of Lower Anisian, are considered as Germanic type faunas by the author. Following these are six levels with Mediterranean type assemblages, ranging from Pelsonian to lowermost Ladinian, with *Paraceratites binodosus* fauna being the richest one. Germanic type fauna is represented again by *Acanthoceratites evolutus* species of Fassanian age. Unfortunately, Tronkov did not describe or illustrate collected specimens, but only gave the list of determined taxa and the localities where they were found.

In her monograph on Triassic fossils of Bulgaria, Entcheva (1972) has given the complete description of ammonoids of this age, from Early to Late Triassic. The author does not discuss the relationship between the Germanic type and the Alpine type of faunas, but it is clear from her descriptions that the second ones are dominant during the whole Triassic.

Nešić (1954) described species of Alpine type Anisian (*Ceratites* cf. *binodosus* and *Ceratites trinodosus*), as well as of Germanic type Ladinian (*Ceratites philippi*, *Ceratites nodosus* and *Ceratites dorsoplanus*) from several localities near Ždrelo in the Inner Belt namely the Kučaj Zone (Getic) of the East Serbian Carpatho–Balkanides.

In the investigated Spomen Dom section numerous ammonoid taxa belonging to genera *Acrochordiceras*, *Pronoetlingites*, *Semiornites*, *Ptychites*?, *Discoptychites*, *Paraceratites*?, *Noetlingites* and *Benekeia* were found. The discovery of that fauna was of great importance for the Jelovica–Visočka Ržana region in the Stara Planina Belt because it represents the first findings of the Pelsonian ammonoids in this part of the East Serbian Carpatho–Balkanides, or anywhere in Eastern Serbia.

At first glance, Spomen Dom ammonoid assemblage does not give a clear indication of the age of the fauna. The determined species would, according to the published data indicate Bithynian (*Noetlingites strombecki*, *Pronoetlingites* cf. *scaphoides*), Peslonian (*Semiornites glaber*) or Illyrian (*Ptychites*? *patens*, *Ptychites*? *seroplicatus*) age. However, because of the presence of *Acrochordiceras*, a genus characteristic for Bithynian and Pelsonian according to Monnet et al. (2010), Illyrian age can be excluded. This can also be supported by the fact that until today *Ptychites*? *patens* and *Ptychites*? *seroplicatus* have only been found in the condensed limestone facies and can represent older elements of these fossil assemblages.

A Bithynian age of the Spomen Dom succession is not probable. Parnes (1986) described *Pronoetlingites scaphoides* from a single specimen found in a core of an oil well in Israel and placed it in the Bithynian based on it being found below the *Balatonites* bearing levels. However, this formation is not exposed on the surface. The ammonoid association that it might contain cannot be determined and the age of *Pronoetlingites scaphoides* is not proven. Besides that, the Spomen Dom specimen is not well-preserved and is left in the open nomenclature, and might be a different species of *Pronoetlingites* altogether, not of Bithynian age. The attribution of *Noetlingites*

strombecki to Bithynian is mostly based on the opinion of Tatzreiter (2001) on the ammonite faunas of Großreifling in Austria, where he describes the species in association with *Balatonites egregius*, *Schreyerites*, *Acrochordiceras* and *Norites*. Unfortunately, the full list of species is not given and the genera mentioned are not exclusively characteristic of the Bithynian. The only species mentioned is *Balatonites egregius*, which according to Vörös (2003) is also present in the Pelsonian of Hungary. The opinion of the Pelsonian age of *Noetlingites* is already given by Mietto & Manfrin (1995) and Mietto et al. (2018).

The only ammonoid species that could be considered indicative of the age in the Spomen Dom association is *Semiornites glaber*, known so far only from the Pelsonian sediments of Großreifling with certainty. If the specimen described as *Semiornites* sp. from Balaton in Hungary by Vörös (2003) should also prove to be *Semiornites glaber*, the Pelsonian age of the species could be confirmed.

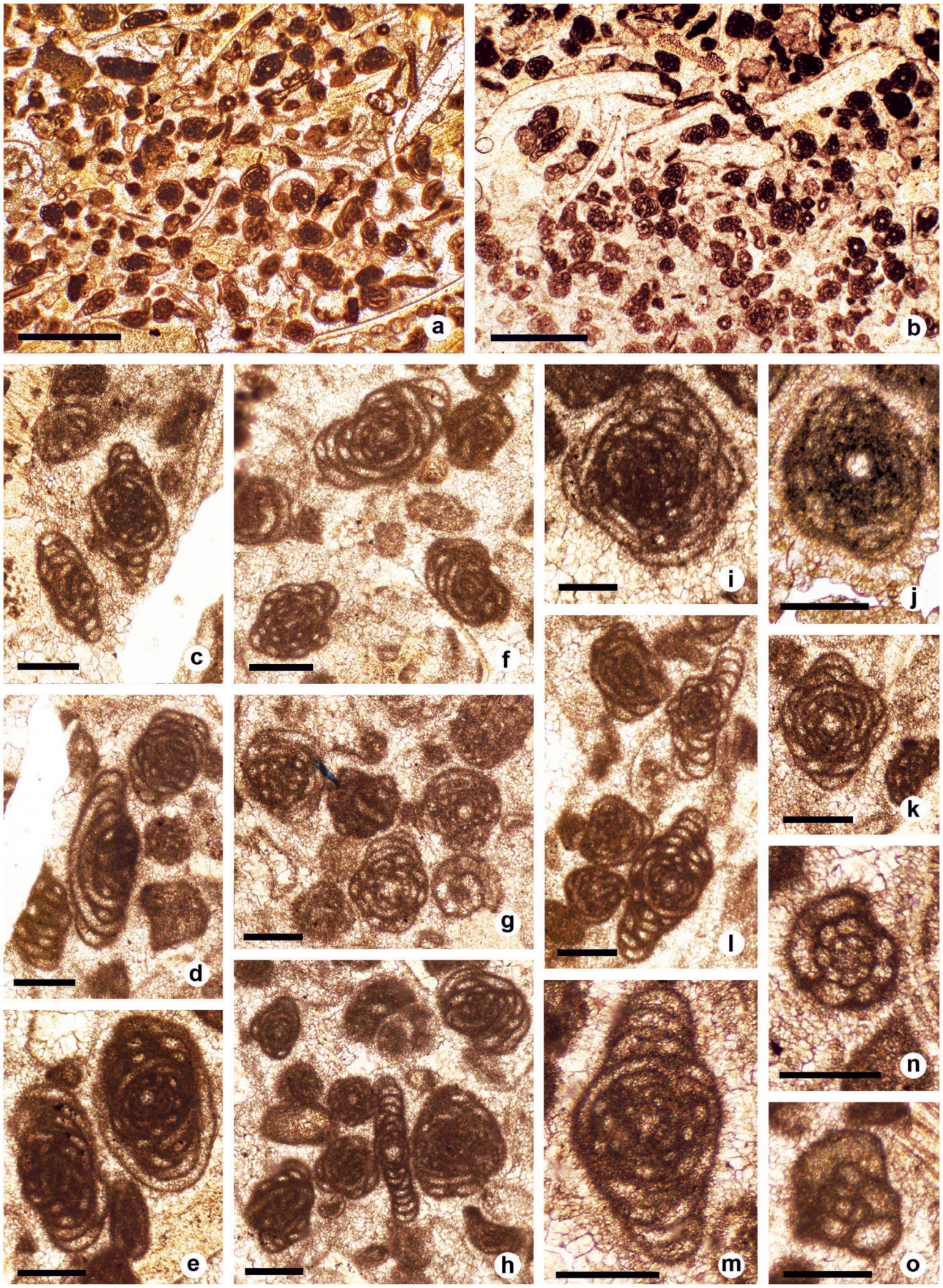
The absence of true representatives of Pelsonian ammonoids, like *Balatonites* and *Bulogites*, makes it difficult to give the right conclusion of the age of Spomen Dom assemblage. However, all of the opinions stated here should point to Pelsonian age, and the association should be considered to indicate the *Balatonites balatonicus* Zone without further subdivision. This age is confirmed by brachiopod species discovered now in the same level with ammonoids, which have already been described from the Pelsonian of the Stara Planina Mts of the Carpatho–Balkanides (Eastern Serbia) (e.g., Urošević et al. 1992: localities Vrelo and Gradeščica). It should be mentioned, however, that the forms that could indicate Bithynian age (e.g., *Noetlingites*, *Pronoetlingites*) are also present in the association and that future research could show that this assemblage is older.

In the sense of paleobiogeography, the Spomen Dom ammonoid fauna shows a clear Tethyan character. The presence of genera like *Beneckeia* or *Noetlingites* could give a false image of mixed fauna of Alpine and Germanic type. However, *Beneckeia* can be found in the Anisian of the Sephardic province (e.g., Parnes 1962, 1986), but also in the western Balkanides of Bulgaria, as already mentioned. This would indicate that the genus actually has a much broader paleogeographic range. *Noetlingites* has previously been considered an exclusively Germanic ammonoid genus. However, it has recently been reported from Austria (Tatzreiter 2001), Hungary (Vörös 2003) and Italy (Mietto et al. 2018), which also makes it an element of the Alpine ammonoid fauna. Rare occurrences of these genera in the Germanic basin, as well as their presence being neglected (*Beneckeia*) or unknown (*Noetlingites*) for a long time outside of this area, led Page (1996) to a conclusion that the Germanic ammonoid bioprovince was already well developed during Middle Anisian. However, the fact they have already been known from other regions, points to a conclusion that this is not the case and that true endemism doesn't exist in this basin, at least not during Pelsonian time. It is important to note that the determination of *Pronoetlingites* cf. *scaphoides* is the first find of this genus outside of Sephardic province also. Future investigations of Ladinian ammonoid faunas in the Carpatho–Balkanides might even challenge the existence of an endemic Germanic bioprovince even during the late Middle Triassic, as can be assumed from already published data (Stefanoff 1936; Nešić 1954; Entcheva 1972).

Foraminifers

In the lower part of the Spomen Dom section, the *Pilammina–Pilamminella* foraminiferal assemblage was documented, dominated by species *Pilammina densa*, accompanied by rare *Pilamminella grandis* and *Pilamminella semiplana*, and very rare *Meandrospira dinarica* and *Meandrospira deformata* (Fig. 9). It is worth noting that these species are very common (especially *Pilammina densa*) in the Anisian deposits of the entire Alpine, Carpathian and Carpathian–Balkan regions. "Mikrofacies mit *Glomospira densa*" was described from the Gutenstein Formation (Hydaspian) and Reifling Formation (Illyrian) of the West Carpathians (Borza 1970), and *Glomospirella–Glomospira* microbiofacies from the Illyrian of Central North Bulgaria (Trifonova & Vaptsarova 1982). A similar foraminiferal assemblage, composed, among others species, of *Pilammina* cf. *densa*, *Glomospirella grandis*, *Glomospirella semiplana* and different trochaminids has been identified most probably also in the Pelsonian interval of the drill core NE of Oraviţa within the Sasca Montana–Moldova Nouă area (Southern Carpathians, Romania) (Bucur et al. 1997). The assemblage is quantitatively dominated by *Glomospirella grandis* (op. cit., p. 40). As is evident from the above mentioned, *Pilammina densa* was considered to belong to genus *Glomospira,* and *Pilamminella grandis* and *Pilamminella semiplana* to genus *Glomospirella* by some authors (e.g.

Fig. 9. *Pilammina–Pilamminella* assemblage of the Pelsonian *Pilammina densa* Zone in the Spomen Dom section (Stara Planina Mts, Eastern Serbia) with a large number of different benthic foraminifers and numerous fragments of macrofossils (e.g., brachiopods, bivalves, crinoids, juvenile gastropods); **a** — thin section SD-4, **b** — thin section SD-4/1. Scale bar for both micro photographs is 1 cm. **c** — Two specimens of *Pilamminella semiplana* (Kochansky-Devidé & Pantić) and one of *Pilammina densa* Pantić; thin section SD-4/1. **d** — The biggest and central specimen is *Pilamminella grandis* Salaj and the others are *Pilammina densa* Pantić; thin section SD-4/1. **e** — *Pilamminella grandis* Salaj (left specimen), and *Pilammina densa* Pantić (right specimen); thin section SD-4/1. **f** — *Pilamminella grandis* Salaj; thin section SD-4/1. **g** — *Pilammina densa* Pantić and *Meandrospira dinarica* Kochansky-Devidé & Pantić (specimen on the lowermost right part of photograph); thin section SD-4/1. **h** — Different sections of *Pilammina densa* Pantić and *Pilamminella semiplana* (Kochansky-Devidé & Pantić); thin section SD-4. **i, j, k** — *Pilammina densa* Pantić; i – thin section SD-4; j, k – thin section SD-4/1. l — *Pilamminella grandis* Salaj (two specimens on the right side) and *Pilammina densa* Pantić (three specimens on the left side of the photo); thin section SD-4; **m** — *Pilamminella grandis Salaj*; thin section SD-4; **n** — *Meandrospira dinarica* Kochansky-Devidé & Pantić; thin section SD-4; **o** — *Meandrospira deformata* Salaj; thin section SD-4. Scale bar for all micro photographs (c–o) is 0.2 mm.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Borza, 1970, see also synonymy of the species in Salaj et al. 1983 for further references).

Pilammina densa was first introduced from the Anisian limestones of the Crmnica area in Montenegro (Pantić 1965), and was subsequently documented in many other areas in the Dinarides of ex-Yugoslavia. Very rich similar foraminiferal associations containing this species were documented from the Middle Triassic of the West Carpathians (e.g., Salaj et al. 1967; Borza 1970; Salaj et al. 1983 with references therein), Bulgaria (e.g., Trifonova 1978; Budurov & Trifonova 1995), and other regions of the Tethys (Rettori 1995 and references therein; Martini et al. 1996). However, and this is important to note, specimen rich monospecific assemblage of *Pilammina densa* were until now reported only in the Pelsonian of the Inner Belt (i.e., in Kučaj or Getic Zone) of the Carpatho-Balkanides (Urošević 1988, p. 372) in Eastern Serbia.

This species (i.e., the mentioned micro-association), is a greatly reliable guide fossil for the chrono- and biostratigraphic subdivisions in the Triassic in many European and also in numerous regions worldwide. The establishment of a zonal scheme for this age based on benthic foraminifers was very successfully introduced for the Bulgarian and West Carpathian (Slovakia) territories. A biostratigraphic subdivision of the Anisian in Bulgaria is characterized by the *Meandrospira deformata* Interval-Zone, *Pilammina densa* Range-Zone and lower part of *Turiglomina mesotriasica* Interval-Zone (Trifonova 1978; Budurov & Trifonova 1995 with references therein) and by the *Meandrospira insolita* Interval-Range Zone, *Meandrospira deformata* Interval-Range Zone, *Meandrospira dinarica* Interval-Range Zone, *Pilammina densa* Acme Zone and *Permodiscus pragsoides* Interval-Range Zone (in stratigraphic order) in the West Carpathians (Salaj et al. 1983). The stratigraphical range of *Pilammina densa* in the framework of the eponymous range-zone in Bulgaria has previously been broadly introduced for the upper half of "Hydaspian" (=Bithynian), Pelsonian and entire Illyrian (Trifonova 1978) with its first acme limited to the Pelsonian (fig. 2, op. cit.). This scheme was incorporated into the Triassic foraminiferal zonation for the whole Carpatho–Balkanian realm reviewed in Salaj et al. (1988). Later, Trifonova (1992, fig. 2) restricted the position of the zone only to almost the entire Pelsonian and Illyrian substages (except the lowermost and the uppermost part of this interval) for the Triassic in Bulgaria. Even later, in Budurov & Trifonova (1995, fig. 2) and in Zagorchev & Budurov (2009, tab. 5.2.5), the stratigraphic distribution of the *Pilammina densa* zone was revised again and widened to late Bithynian, Pelsonian and great part of Illyrian (the Bithynian substage was incorporated into Pelsonian as is evident from the position of the ammonoid zones *Nicomedites osmani* and *Agdharbandites ismidicum* in fig. 2 of Budurov & Trifonova 1995). *Meandrospira dinarica* and *Meandrospira deformata*, identified from the Spomen Dom locality have the character of zonal or subzonal index fossils in Bulgaria for *Meandrospira deformata* Interval-Zone (Trifonova 1992; Budurov & Trifonova 1995) and *Meandrospira dinarica* Interval-Subzone (Trifonova 1992). In cited literature, as well as in Salaj et al. (1988) and Zagorchev & Budurov (2009), the boundary between *Pilammina densa* Range-Zone and *Meandrospira deformata* Interval-Zone is shown with broken lines. That means vertical distribution of zonal/subzonal species are not fixed only for the corresponding zones but their ranges can have prolongations into the younger levels (see Trifonova 1992; Salaj et al. 1983, fig. 9). The occurrence of *Meandrospira deformata* within *Pilammina densa* Range-Zone was already confirmed by Trifonova (1993), meaning that this species is also present in the Bithynian and probably the Pelsonian of Bulgaria.

In the West Carpathians, the late Pelsonian and Illyrian age of the *Pilammina densa* Acme Zone is certain, whereas the *Meandrospira dinarica* Interval-Range Zone is restricted to the lower part of Pelsonian and *Meandrospira deformata* Interval-Range Zone is characteristic for the Aegean and Bithynian (Salaj et al. 1983). Independently of the ranges of their zones, both of these index species have occurrences in the entire Pelsonian (fig. 9, op. cit.).

All emphasized above, the application for the first time of the foraminiferal *Pilammina densa* Zone for the region of the Stara Planina Mts (Eastern Serbia) is fully justified. The association of *Pilammina densa* (in the sense of Urošević 1988) occurring together with rare *Meandrospira dinarica* (in the sense of Trifonova 1992) at the Spomen Dom locality could indicate a time span from the late Bithynian to Pelsonian. The Illyrian is excluded by the ammonoids of Pelsonian age in the overlying beds. However, the fact that the first acme of the distribution of *Pilammina densa* is limited to the Pelsonian (fig. 2 in Trifonova 1978) narrows the stratigraphic attribution of this part of the succession exclusively to the Middle Anisian. This completely affirms chronostratigraphic/biostratigraphic position of studied fossils and zones from the Spomen Dom section.

Regional correlation

The Triassic sediments of Bulgaria refer to two different types of development or provinces: Balkanide (Peri-Tethyan) and the typical Tethyan ("Alpine") (e.g., Budurov & Trifonova 1995; Zagorchev & Budurov 2009). The first, Balkanide development includes the larger part of Bulgarian territory, the regions of Western Bulgaria itself to the Serbian–Bulgarian State border namely to the Serbian part of Stara Planina Mts. This development differs from the Alpine one by clearly expressed Germanic type features of the rocks (i.e., with the braided fluvial systems of Buntsandstein type), formed after the Upper Permian continental deposits, in lower parts of the Lower Triassic. Other, younger sediments in the (?)Upper Smithian, Spathian (i.e., Olenekian) to Norian interval have the features of the deposits of the continental shallow marine domains composed of different types of carbonate ramps which correspond to the Alpine type of development. According to these characteristics it is very close to the development of the Triassic in the Jelovica–Visočka Ržana region and other, eastern parts of the Stara Planina Mts from Eastern Serbia.

The possibilities for correlations, especially with conodont and foraminifer zonation, were reported several times by Bulgarian authors (e.g., Budurov & Trifonova 1995; Zagorchev & Budurov 2009) but without real and appropriate response from the Serbian side.

Traditionally and even sometimes in recent papers, the Triassic of the Stara Planina Mts regions was regarded as the Germanic type of development. However, in relation to the paleobiogeography and paleo-environmental type of development of the Triassic on the Stara Planina Mts, M. Anđelković (1956, 1958 cited by Urošević 1971) was the first to document the Upper Triassic brachiopods in the Senokos area and designated their Alpine character.

Moreover, it is important to mention one of the very early attempts by Urošević (1971) to direct attention to the fact that the Triassic flora and fauna of the Stara Planina Mts have a Mediterranean character. This proves that the term "Germanic type of development" is inadequate for the Triassic sediments of this area. The same author also suggests that: "The most adequate term for the development of the Triassic sediments of Stara Planina Mt seems to be the Carpatho–Balkan type on account of the similarities which exist between the development of those sediments and those in other parts of the Carpatho–Balkan region" (op. cit., p. 104). These conclusions, although completely adequate, were too early to be made for that time. It was also an exaggeration to apply them to the whole East Serbian Carpatho–Balkanides. According to our recent opinions, based on the data obtained, this development must mainly be compared and correlated with the other regions of the East Serbian Carpatho–Balkanides which belong to the Kučaj Zone (Getic) Unit, since the areas of the Stara Planina Mts are a part of another unit, namely the Stara Planina–Poreč (Upper Danubian) Unit. Besides this, it is necessary and important to do the correlations with neighbouring regions with the same type of Triassic development in Bulgaria (e.g., with the Balkanide (Peri-Tethyan) Triassic) and in the Southern Carpathians of Romania.

Conodont investigations were not done this time in the Spomen Dom section. However, it is necessary to mention that in the nearby locality of Vrelo on the Stara Planina Mts (see Fig. 1C), several Anisian (Bithynian and Pelsonian) conodont zones were recognized (Urošević & Sudar 1991). In the same paper, the presence of the real Upper Anisian and Ladinian elements of the Balkanide conodonts province were reported (e.g., species of genera *Pridaella* Budurov & Sudar and *Sephardiella* March, Budurov, Hirsch & Marquez-Aliaga: Budurov & Trifonova 1995) in the northern regions of Eastern Serbia (Kučaj or Getic Zone). This, however, enabled the possibility of initial correlation between these two regions. Unfortunately, after these in any case satisfactory data, the investigations of Triassic conodonts in Eastern Serbia stop almost completely, which makes later necessary detailed correlations between Bulgarian and East Serbian Triassic regions impossible.

The *Pilammina densa* Range-Zone, together with other benthic foraminifer assemblages (Upper Smithian, Spathian (or Olenekian)-Norian in age) are present in both of the Bulgarian Triassic developments, namely in the Balkanide Triassic (Peri-Tethyan type) and in the Tethyan type of development (Budurov & Trifonova 1995). Without other microfaunistic and biostratigraphic evidence (e.g., conodonts), it is only possible to suppose the preliminary paleobiogeographic correlations and connection between our investigated region on the Stara Planina Mts (corresponding to the Stara Planina basin, Anđelković & Mitrović-Petrović 1996) with the Balkanide (Peri-Tethyan) type of Triassic development in Bulgaria.

Conclusions

The detailed paleontological and sedimentological investigations of strata from the newly described Spomen Dom section on the Stara Planina Mts (Carpatho–Balkanides, Eastern Serbia) exhibit various important features which can be summarized as follows:

- First discovery of an abundant ammonoid fauna in this region enabled the dating of the middle member of the Jelovica Limestone Formation to the Pelsonian substage. According to their biostratigraphic characteristics this ammonoid assemblage is assigned to the *Balatonites balatonicus* Zone. The ammonoids are accompanied by common macrofauna, collected from the same level, comprising brachiopods, nautiloids, bivalves and crinoids. Ammonoids assemblage shows clear Alpine affinities.
- The same deposits yielded a rich *Pilammina–Pilamminella* assemblage representing the foraminiferal *Pilammina densa* Zone, known also from other areas of the East Serbian Carpatho–Balkanides. Both established biostratigraphic units (i.e., Zones) represent very important novelties for this part of the Stara Planina Mts, as well as for all of Eastern Serbia.
- The presence of coeval assemblages of the Pelsonian age in the Stara Planina–Poreč Unit (Upper Danubian) of Eastern Serbian Carpatho–Balkanides, enables correlation with regions of Hungary (Balaton), Austria (Großreifling), Bulgaria (Western Balkanides), Slovakia (West Carpathians) and many others.
- The present study suggests that the Spomen Dom succession represents an important locality for the Middle Triassic interval and the results may contribute to improving the precision of the Tethys-wide and even worldwide correlations of the age events.

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