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The age of the brachiopod limestones from Guča, western Serbia

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Abstract. The asymmetric rhynchonellide brachiopod *Cyclothyris*? *globata* (Arnaud, 1877) has a large distribution in the Coniacian, Santonian and Campanian outcrops of the western Tethys. The species has also been identified in Guča, (Vardar Zone, western Serbia), where it occurs together with the capillate terebratuloid *"Terebratula"* sp. (gen. et sp. nov.). In addition to Serbia, this brachiopod association is found in many localities of northeastern Bulgaria (Shumen Formation). In older literature, in Romania and Bulgaria, *"Terebratula"* sp. (gen. et sp. nov.) was confused with the Late Maastrichtian *Terebratulina striata* (Wahlenberg, 1821). The present microfaunal study based on planktonic foraminifera showed that the age of the beds with *Cyclothyris*? *globata* and *"Terebratula"* sp. (gen. et sp. nov.) in Guča may be dated as Lowermost Campanian, *i.e*., the Santonian/Campanian boundary.

Key words: brachiopods, *Cyclothyris*? *globata*, *"Terebratula"* sp. (gen. et sp. nov.), foraminifera, stratigraphy, Lowermost Campanian, Guča, Vardar Zone, western Serbia.

Апстракт. Асиметрични ринхонелид *Cyclothyris*? *globata* (Arnaud, 1877) има велико распрострањење у конијак–кампанским изданцима западног Тетиса. Врста је такође позната и из Гуче (Вардарска зона, западна Србија) где се појављује заједно са капилатним теребратулидом *"Terebratula"* sp. (gen. et sp. nov.). Изван Србије, ова брахиоподска асоцијација је пронађена у многим локалитетима северозападне Бугарске (Шумен формација). У старијој литератури, у Румунији и Бугарској, *"Terebratula"* sp. (gen. et sp. nov.) је одређивана као горњомастрихтска *Terebratulina striata* (Wahlenberg, 1821). Садашња микрофаунистичка проучавања заснована на планктонским фораминиферима су показала да је старост слојева из Гуче са *Cyclothyris*? *globata* и *"Terebratula"* sp. (gen. et sp. nov.) одређена као најранији кампан, тј. граница сантон/кампан.

Кључне речи: брахиоподи, *Cyclothyris*? *globata*, *"Terebratula"* sp. (gen. et sp. nov.), фораминифери, стратиграфија, најранијн кампан, Гуча, Вардарска зона, западна Србија.

Introduction

A brachiopod assemblage of two species, *i.e.*, *Cyclothyris*? *globata* (Arnaud) and "*Terebratula*" sp. (gen. et sp. nov.), was found in the Upper Cretaceous succession at the Dupljaj Stream, near Guča, in the Bjelica Belt of the Vardar Zone (western Serbia) (Fig. 1). The occurrences in ex-Yugoslavia of *Cyclothyris*? *globata*, which is common in several Coniacian–Campanian outcrops along the northern and southern Tethyan margins and in central Tethyan domains, were described and dated as Campanian by Radulović & Motchurova-Dekova (2002). In several localities of the Vardar Zone (Guča, western Serbia) and the Balkans (the Shumen Formation, northern Bulgaria), *C.*? *globata* was found in assemblages with the capillate "*Terebratula*" sp. (gen. et sp. nov.), which previously was misidentified with the Late Maastrichtian *Terebratulina striata* (Wahlenberg). The age of the brachiopod association from Guča, based on the

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abundance of microfossils, is updated herein. It is documented by the evidence of a rich association of benthic and planktonic foraminifera. The sequence of deposits bearing brachiopods evolved from a shallow marine environment weakly influenced by open sea into true hemipelagic calcisphere–globotruncanid deposits of the lower ramp-transition to a shallow basinal environment.

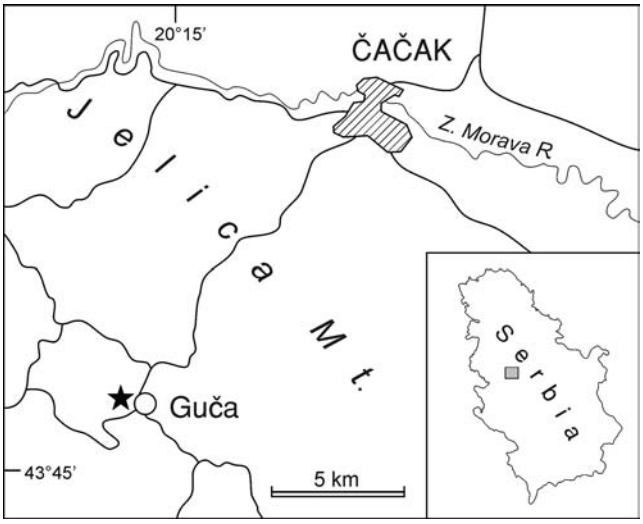

Fig. 1. Location map of the studied section (star).

Geological setting

The Cretaceous succession, according to ĆIRIĆ (1958), is formed of Senonian limestones and clastics transgressive and unconformable over different units of the Paleozoic complex. The author used abundant mollusks, mainly rudists, then corals and brachiopods, to document the Santonian, Campanian and Maastrichtian ages of the deposits; the latter also rich in large foraminifera – loftusiae and orbitoids.

Micropaleontological examinations and research of the rudist fauna during the geological mapping for the Sheet Čačak on the scale 1:100 000 documented the presence of the Coniacian and Turonian. Transgression in the present-day Dragačevo area started in the Albian, according to unpublished information (RR). Successive phases of the transgression evolved in the latest Cenomanian?–Early Turonian (following the Late Cenomanian event), in the Santonian and in Maastrichtian, when sea advanced over most of the area.

Albian deposits, precisely limestones bearing *Hemicyclammina sigali* MAYNC, are known only from the NE Kravarica Belt, under the Lower Cenomanian limestones with *Ovalveolina* sp, *Murgeina apula* (LUPERTO SINNI), *Pseudolituonella reicheli* MARIE, *Chrysalidina gradata* D'ORBIGNY, *Pseudorhipidionina casertana* (DE CASTRO) *etc*. A layer containing brachiopods, which is the subject of this note, was found in a minor exposure of the Bjelica Belt near Guča. The Cretaceous limestones and clastic preflysch succession of Bjelica were deposited during the Santonian, Campanian and Maastrichtian, whereas the age of the flysch (based on the nautilid *Hercoglossa* cf. *danica*) is Maastrichtian-Danian (ĆIRIĆ 1958). According to the authors of the geological map, massive marly limestones and partly marls in the Bjelica Belt are designated in the Middle Campanian only, while the flysch sedimentation in the belt, and in the entire Dragačevo expanse, excluding Jelica II, began (unsubstantiated!) much earlier, in the Late Campanian (BRKOVIĆ *et al*. 1978, Fig. 4). The presence of Maastrichtian limestones with rudists, loftusiae and orbitoids, well known from the publications on Dragačevo, has been unjustly and inexcusably neglected (first information on the Maastrichtian limestones was given by V. PETKOVIĆ 1909; in ĆIRIĆ 1958).

Observation on the Cretaceous of Jelica Mt. followed by an Explanatory Text for the Geological Map, Sheet Čačak on the Scale 1:100 000

The Cretaceous of Jelica Mt. is designated on the geological map in two belts of different developments: Jelica I (assigned to the Inner Dinarides) with a succession similar to the Bjelica Belt, and Jelica II (assigned to the Vardar Zone) with only a Middle Campanian Diabase-Chert Formation present (BRKOVIĆ *et al*. 1978, Fig. 4).

Why the (Jurassic) Diabase-Chert Formation was dated Campanian and what kind of deposits were developed there are the questions answered in the controversial text "Senonian of the Vardar Zone", as follows (translation from Serbian): "Senonian rocks in the Vardar Zone are represented by a particular Diabase-Chert Formation. They form a narrow, discontinuous belt along the Jelica Range, in a zone of intensive structural deformation, thereby in structural unconformity with adjacent units" "These rocks are rudistid in character (sic!) in a chaotic arrangement of units of ill-defined beds. The rock constituents are knots of different rocks chiefly in an arenite-silt matrix. Some areas in the breccioid mass differ in the composition and size of the knots and in the cementing material. The Jelica Range is built of breccia composed only of diabase fragments, with even the binder being fine-grained diabase breccia. The rocks in the western Jelica Range are sedimentary, subordinately mafite and ultramafite. In relation to the attitude of different units and their structures, these breccioids are likely an ophiolite mélange of olistostrome origin." (p. 36).

What the mapping researchers observed in the field was obviously tectonite, a chaotic unit or ophiolite mélange, by no means a Diabase-Chert Formation, which was only one component of a major tectonic

event during the Campanian. Lamentably, the authors of the map uncritically accepted then the prevailing interpretation of M. N. DIMITRIJEVIĆ & M. D. DIMITRIJEVIĆ (1973, pp. 228, 230) that the Diabase-Chert Formation was a "typical olistostrome mélange", given "Cretaceous age" on Jelica.

Jelica II is a part of the known tectonic Rujevac–Veliki Majdan Zone in western Serbia (ĆIRIĆ 1996; RADOIČIĆ 1997). Based on planktonic foraminifera from some minor masses and blocks of the Jelica II Belt, the newest sediment is dated Early Campanian, the same as the Rujevac–Veliki Majdan ending in Kosovo.

Not infrequently, differentiation is not made between tectonites *s.str.*, particularly those of higher order of magnitude and post-tectonic sedimentation processes (there are, of course, specific relationships). Concerning the ophiolite mélange – tectonite, it depends on the mechanical properties of the rocks, crushed and broken in strong tectonic events, which were sufficiently plastic to include more compact components. In the given terrains, it is mostly the Diabase-Chert Formation.

Microbiostratigraphy

Upper Cretaceous rocks of the Bjelica Belt in the Dupljaj Potok near Guča are known from the finds of brchiopods. Basal terrigenous deposits of the Bjelica Belt pass into carbonate rocks (sandstone-calcareous sandstone-sandy to silty limestone) unexposed in the Dupljaj Potok. Neither of the oldest carbonate rocks is uncovered sufficiently for observation of the stratification. For detailed stratigraphical dating of the brachiopods, six samples (VR 101 through VR 106) were collected for micropaleontological examination from 10–12 meters of the stratigraphic column, *viz*.:

– The lowermost 2 m of the observed calcareous sandstone (sample VR 101) contains an abundance of coarse agglutinated foraminifer *Hemicyclammina chalmasi* (SCHLUMBERGER), few other benthic foraminifers: *Pararotalia minimalis* HOFKER, *Nummofallotia cretacea* (SCHLUMBERGER), *Goupillaudina* sp., miliolids and a few planktonic microfossils – *Heterochelix* sp. and calcispheres. Sparse fragments of corallinacean algae and mollusks are also found. (Pl. 1, Figs. 1–5; Pl. 3, Fig. 9; Pl. 6, Figs. 1, 11).

– Sandy limestone with brachiopods (sample VR 102), 1.5 m thick, contains cm-size fragments of corals, calcisponges and mollusks. In addition to some algal grains, the limestone contains quite rich benthic, dominantly varied rotaliform foraminifera, and planktonic microfossils. The microfossils are: *Hemicyclammina chalmasi* (very rare), *Pararotalia minimalis*, *Pararotalia* cf. *minimalis*, *Pararotalia* sp. G3, *Pararotalia*? sp. G4, *Rotalia* cf. *R. saxorum* D'ORBIGNY, *Goupillaudina* sp., *Sulcoperculina*? sp., rotaliacean foraminifera species G1 and species G2, *Nummofallotia cretacea, Vidalina* sp., miliolids and some undetermined forms. The planktonic foraminifera and other planktonics found in this limestone are: *Globotruncana linneiana* (D'ORBIGNY), *Globotruncana lapparenti* BROTZEN, *Globotruncana hilli* PESSAGNO, *Globotruncana* sp., *Globotruncanita* cf. *G. elevata* (BROTZEN), *Heterohelix* sp., *Pithonella multicava* BORZA, *Stomiosphaera* sp. and other calcispheres. Sparse algal grains are of *Terquemella*, fertile ampullae of *Neomeris* and corallinacean fragments.(Benthic: Pl. 2, Figs. 1–6; pl. 3, Figs. 1–6, 11; Pl. 4, Figs. 1–6; Pl. 6, Figs. 5–10; planktonic: Pl. 4, Fig. 11; Pl. 5, Figs. 1–7; Pl. 6, Fig. 2).

Upward follow 2–2.5 meters of hemipelagic silty calcispherulid limestones (samples VR 103 and 104):

– The planktonic microfossils from sample VR 103 are: *Pithonella ovalis* KAUFMAN, *Pithonella multicava* BORZA, *Cercidina supracretacea* VOGLER, *Stomiosphaera* sp., other calcispheres, than *Dicarinella asymetrica* (SIGAL), *Marginotruncana coronata* (BOLLI), *Globotruncana linnneiana* (D'ORBIGNY), *G. lapparenti* BROTZEN, *G. mariei* BANNER & BLOW, and very rare benthic foraminifera – *Navarella joaquini* CITY & RAT and G*oupillaudina* sp. (Pl. 5, Figs. 8, 9–11).

– The limestone of sample VR 104 bears: *Globotruncana linneiana, G. lapparenti, Globotruncananita stuartiformis* (DALBIEZ*), Heterohelix* sp., genus? (aff. *Gublerina–Schackoina*), frequent calcispheres and benthic foraminifera *Tekkeina anatoliensis* FARINACCI & YENIAY, *Navarella joaquini* (both large agglutinated species known from hemipelagic–pelagic deposits) and *Lenticulina* sp. (Benthic: Pl. 4, Figs. 7–11; planktonic: Pl. 5, Figs. 13, 14, 16; Pl. 6, Fig. 3).

– The some six meters of silty limestones of samples VR 105 and 106 contain *Marssonella* sp., then calcispheres and very few glogotruncanids – *Globotruncanita elevata* (BROTZEN), a transitional form between *Globotruncana arca* and *Contusotruncana patelliformis*. (Pl. 5, Figs. 15, 17).

Brachiopods

The brachiopod assemblage from the sandy limestones (sample VR 102) at Guča consists of two species: the asymmetric rhynchonellide *Cyclothyris*? *globata* and the capillate terebratulide *"Terebratula"* sp. (gen. et sp. nov.).

***Cyclothyris*? *globata* (ARNAUD, 1877)** (Figs. 2.1–5) – This species was recently described by RADULOVIĆ & MOTCHUROVA-DEKOVA (2002) from Slovenia, Croatia, Serbia and Bulgaria. Here follows the description based on the specimens from Guča.

Shell of medium size (L_{min} 17.7 mm; L_{max}, 26.7 mm), generally with subtriangular outline, or transversely-oval, always with a twisted asymmetrical anterior commissure. The dorsal valve is usually more convex than the ventral valve. Greatest width at the anterior

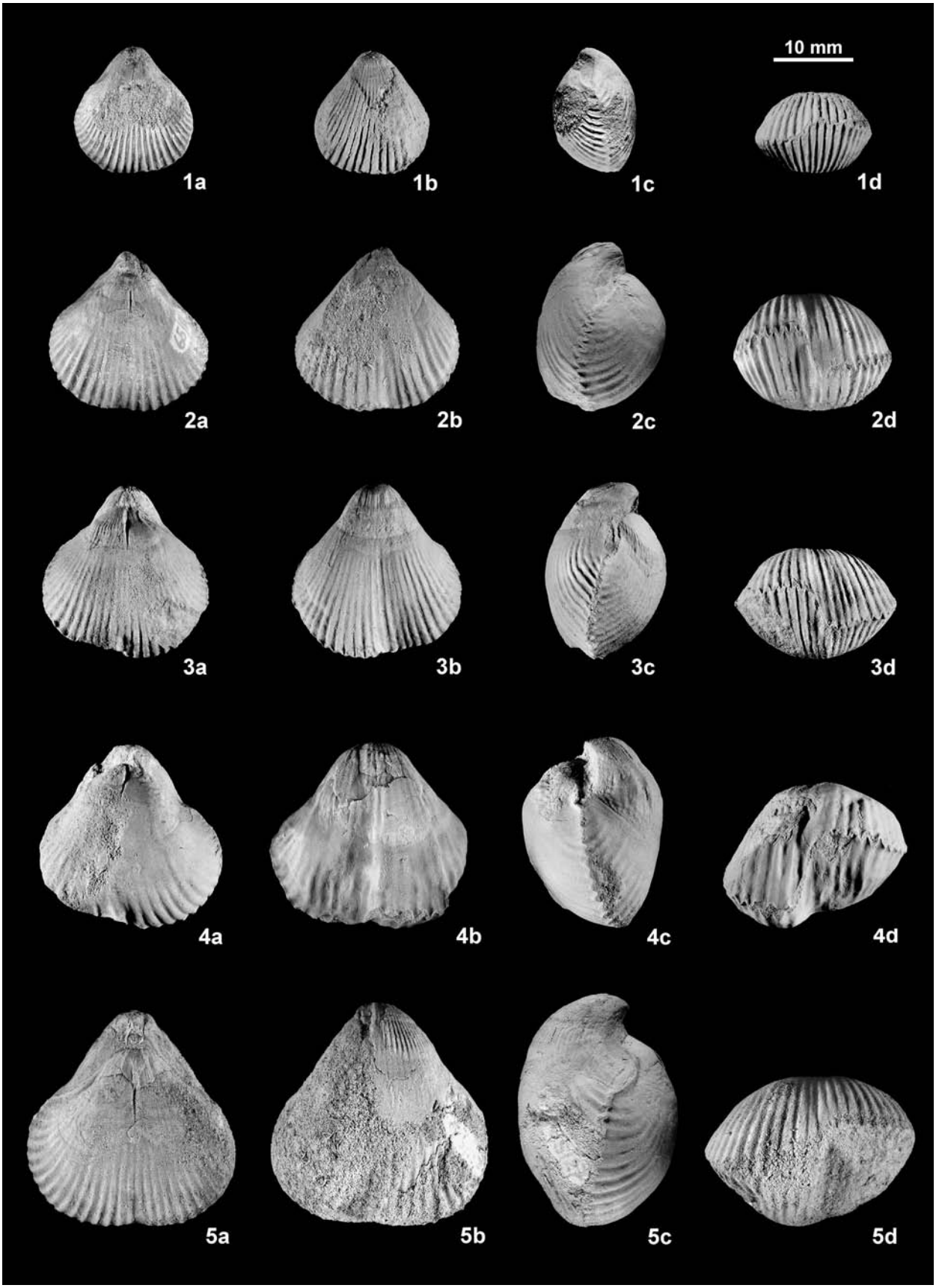

Fig. 2. *Cyclothyris*? *globata* (ARNAUD), Lowemost Campanian, Guča, western Serbia. **1** – RGF VR 62/4; **2** – RGF VR 65/14; **3** – RGF VR 62/6; **4 –** RGF VR 62/2; **5 –** RGF VR 65/27. The letters imply the view: **a**, dorsal; **b**, ventral; **c**, lateral; **d**, anterior.

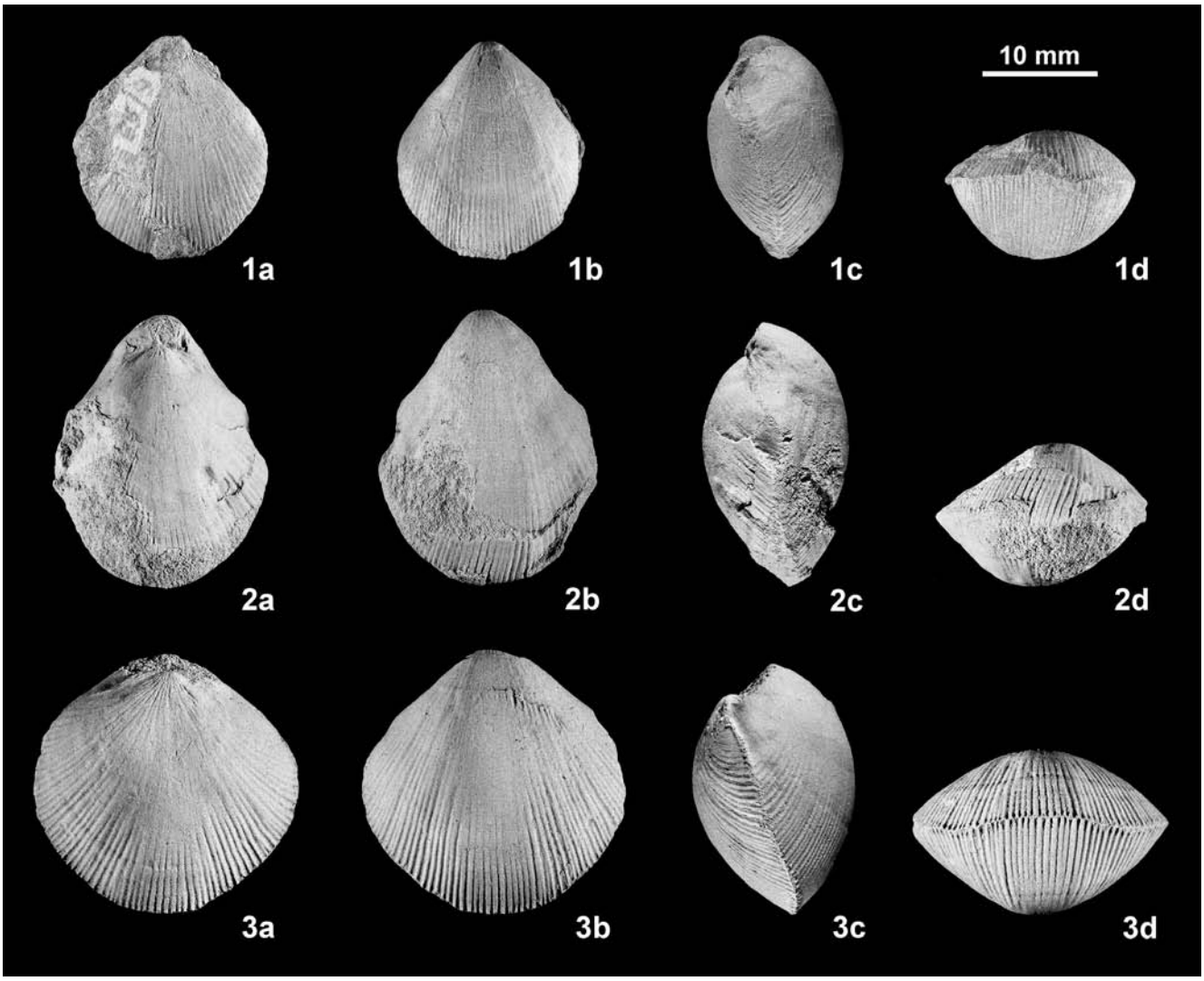

Fig. 3. "*Terebratula"* sp. (gen et sp. nov.), Lowermost Campanian, Guča, western Serbia. **1** – RGF VR 65/9; **2** – RGF VR 65/4; **3** – RGF VR 65/1. The letters imply the view: **a**, dorsal; **b**, ventral; **c**, lateral; **d**, anterior.

third, maximum thickness at midvalve. The lateral commissure straight. Beak massive, suberect to nearly straight with sharp and short beak ridges. Squama and glotta developed. The apical angle ranges between 72° and 96°. Foramen rounded, circular, relatively large, hypothyrid to submesothyrid, slightly labiate. The interarea small, concave. Each valve is ornamented with 24 to 36 simple ribs, which anteriorly become stronger and sharper.

Referring to the external features, such as asymmetric shell, the species is very similar to *Cyclothyris difformis* (Valenciennes *in* Lamarck) and *C. contorta* (d'Orbigny) known from the Cenomanian of Europe, with which it was very often confused. *C. globata* differs from both latter species in having fewer costae, a more triangular outline, smaller foramen and a permanently asymmetric shell ("obligate asymmetry"), whereas *C. difformis* and *C. contorta* can develop both asymmetric and symmetric shells ("facultative asymmetry" *sensu* Fürsich & Palmer, 1984). (See Radulović & Motchurova-Dekova 2002.)

The species frequently occurs in the Coniacian–Lower Campanian of the Pyrenees (Muñoz 1985, 1994), the Campanian of southwestern France (Arnaud 1877; Fage 1934; Gaspard 1983a, 1983b, 1991; Gaspard & Odin 2001), the Late Campanian of Slovenia (Pleničar 1960), the Santonian of Croatia (Pejović & Radoičić 1987), the Campanian of Serbia (Radulović & Motchurova-Dekova 2002), the Latermost Santonian of Bulgaria (Cankov 1930; Tzankov 1947; Zacharieva-Kovačeva 1947; Julkičev 1989; Motchurova-Dekova 1992a, 1992b, 1994, 1995, 1996b; Radulović & Motchurova-Dekova 2002) and the Coniacian–Santonian of the southern Caucasus (Aliev & Titova 1988).

***"Terebratula"* sp. (gen. et sp. nov.)** (Figs. 3.1–3) – Medium-size shell (L_{min} 19.5 mm; L_{max}, 26.7 mm), outline, independent of the size, can vary from ovally

elongated to nearly circular. The valves are moderately and nearly equally biconvex or slightly dorsibiconvex. Maximum width at about mid-length; maximum thickness in the posterior third. The anterior commissure rectimarginate, in one large specimen slightly and widely uniplicate; the lateral commissure slightly curved towards the dorsal valve. Beak suberect to erect, with mesothyrid foramen. Under beak, very short and thickened ridges developed. Beak ridges rounded, poorly developed. The surface is covered by fine radiating capillae, increasing in number both by bifurcation and intercalation (about 2–3 capillae per mm near the anterior margin).

Remarks. Specimens of supposedly the same species from Romania and Bulgaria (northern margin of Tethys) were confused with *Terebratulina striata* (WAHLENBERG, 1821), known from the Late Maastrichtian of Sweden (Epicontinental Sea). A preliminary research of the internal morphology of this new form by V. RADULOVIĆ and N. MOTCHUROVA-DEKOVA on Bulgarian specimens reveals a terebratuloid loop. This feature clearly distinguishes this taxon from *T. striata* that has a ring-like loop; this feature places them in two different families. The capillate ornamentation of the shell of the new form makes it similar to *Capillithyris capillata* (D'ARCHIAC 1847), known from the Albian and Cenomanian of western Europe (Belgium, England, Poland and the Ukraine). However, the Serbian terebratuloid differs in having straight capillae (in *C. capillata* the capillae are waving and intersected by concentric growth lines. Internally, it is distinguished from the latter in having much reduced hinge plates.

This new capillate terebratuloid brachiopod will be officially described elsewhere by a different coauthorship board. Its preliminary description is proposed here with the kind permission of the colleagues N. MOTCHUROVA-DEKOVA and E. SIMON.

The species is known from the Santonian-Campanian of Romania (southern Dobrudja, Remus Opreanu; NEAGU & BĂRBULESCU 1979; BĂRBULESCU *et al*. 1979; BĂRBULESCU & NEAGU, 1988), the Latemost Santonian of northeastern Bulgaria (CANKOV 1930, ZACHARIEVA-KOVAČEVA 1947; JOLKIČEV 1989; MOTCHUROVA-DEKOVA 1996a), the Campanian and Maastrichtian of the Crimea and the Caucasus (ASTAF'EVA 1959).

Discussion

Hemicylammina chalmasi, a large agglutinated foraminifer, is known from the Coniacian–Late Santonian of the Spanish Pyrenees (CORNELLA 1977; CAUS *et al*. 1981), from the Late Turonian or Early Campanian of the Northern Calcareous Alps (SCHLAGINTWEIT & WAGREICH 2004) and from the Campanian of the Vardar Zone in Serbia. The Campanian age of *Hemicyclammina chalmas*i is based on planktonic foraminifera in the limestone with planktonic and benthic foraminifera (POLAVDER 2003). The abundance of *Hemicyclammina chalmasi* in bed VR101 is the acme of this species or, more probably the paracme, because extreme scarcity of specimens in the limestone with brachiopods (VR102) can be interpreted as their last occurrence. Other benthic foraminifera in bed VR102 have a larger stratigraphic distribution – the Coniacian to the Campanian.

Prevailing planktonic foraminifera in sample VR102 are two keeled species distributed in both the *asymetrica* and *elevata* zones, some of them earlier, in the *concavata* Zone. Species of the genus *Dicarinella* were not found in the five thin sections, whereas, in the overlying hemipelagic-pelagic silty limestone, *Dicarinella asymetrica* and *Marginotruncana coronata* were present in the sample VR103. Both species totally disappeared in the Lowermost/Lower Campanian (PREMOLI-SILVA & VERGA 2004, p.45). This leads to the conclusion that the layer containing brachiopods was the basal bed of the Campanian that marked the Santonian/Campanian boundary.

A few benthic macroforaminiferal specimens of *Navarella joaquini* were found in the samples VR103 and 104. This species is described by CIRY & RAT (1951) from the Maastrichtian of the Spanish Pyrenees, then cited also from the Maastrichtian of the Suisse Alps, from Scaglia rossa of the Veronese in Italy, in the Pyrenees and France (SAMPÒ 1972). In the Western Aquitaine, the species was found in the Campanian (RIBIS 1965 *fide* SAMPÒ 1972). The hemipelagic limestone of the sample VR104, beside *Navarella*, bears another macroforaminifer *Tekkeina anatoliensis* FARINACCI & YENIAY, a species described from the Santonian of Susus Dag in the Western Pontides, Turkey. The Santonian age was confirmed by the planktonic foraminiferal association with *Dicarinella concavata* (BROTZEN). In the type locality, the species ends at an unconformable boundary (a gap between the Santonian and Late Campanian), and is absent in the Upper Campanian (FARINACCI & YENAIY 1994).

Takkeina anatoliensis was known only from the Campanian in the Mur exposure near Novi Pazar, the Vardar Zone; the Campanian age is confirmed by planktonic foraminifera and nanofossils (POLAVDER 2003). A *Tekkeina anatoliensis* from the hemipelagic Campanian limestones of the Dol Formation on the Brač island, Adriatic Carbonate Platform, was illustrated as "large coarsely agglutinate foraminifer, similar (or akin) to *Navarella joaquini*" (GUŠIĆ & JELASKA 1990, pl. 11, fig. 2).

It follows from the above that *Tekkeina anatoliensis* is distributed in Santonian and Lower Campanian hemipelagic–pelagic deposits.

Conclusions

The researched stratigraphic sequences of Dupljaj Potok, based on micropaleontological contains, is dated as Latest Santonian and Early Campanian. The bed with brachiopods marks the boundary between the Santonian and the Campanian and is included in the basal Campanian.

Cyclothyris? *globata* is a species of large geographical distribution, known from the Northern and Southern Tethyan margins and the Central Tethys. The species occurs in the stratigraphic interval from Coniacian to Campanian. In western Serbia, it is found at Guča (Bjelica Belt, the Vardar Zone) in association with the capillate *"Terebratula"* sp. (gen. et sp. nov.). The association is also known from the uppermost Santonian of northeastern Bulgaria (Shumen Formation).

According to the obtained data, a part of the Bjelica Cretaceous Belt, during the Latest Santonian and Early Campanian, evolved gradually from a shallow marine environment weakly influenced by open sea (few planktonic foraminifera in *Hemicyclammina chalmasi* carbonate sandstone) to hemipelagic with mixed benthic and planktonic foraminifers and brachiopods into true hemipelagic calcisphere-globotruncanid deposits on a lower ramp-transition to shallow basinal environment. Information on the development of facies (Ćirić 1958; Brković *et al*. 1978) indicates subsidence of the Cretaceous Dragačevo Unit in the Bjelica Belt, which continued to the Maastrichtian or even into the Danian.

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Резиме

Старост брахиоподских кречњака Гуче, западна Србија

Кредни седименти појаса Бјелице (Драгачево) у локалитету Дупљај поток код Гуче, познати су по наласку брахиопода (ĆIRIĆ 1958; RADULOVIĆ& MOTCHUROVA-DEKOVA 2002). Базални теригени седименти овог појаса поступно прелазе у карбонате (пјешчари–карбонатни пјешчари–пјесковити креч-

њаци–силтозни кречњаци). У Дупљај потоку базални теригени седименти нијесу откривени. Такође, најстарији дио карбонатне сукцесије Бјелице овдје није добро откривен, те стога стратификација није јасно видљива. У циљу прецизнијег датирања брахиоподске фауне узорковано је 10–12 m стратиграфког стуба за микропалеотолошке анализе са 6 узорака (VR101–VR106).

Најстарији откивени слој је карбонатни пјешчар (око 2 m, VR101) са аглутинентним фораминифером *Hemicyclammina chalmasi*, понеким другим бентоским и веома ријетким планктонским микрофосилима.

Слиједећи, пјесковити кречњак са брахиоподима (око 1.5 m, VR102) у којем се запажају фрагменти корала, калциспонгија и мекушаца, садржи бројне бентоске, претежно роталиформне фораминифере, али такође и планктонске микрофосиле: *Hemicyclammina chalmasi* (веома ријетка), *Pararotalia minimalis*, *Goupillaudina* sp., *Sulcopeculina* sp., *Nummofalotia cretacea*, *Globotruncana lapparenti*, *Globotruncana hilli*, *Globotruncanita* cf. *Gl. elevata*, и др. Брахиоподску заједницу из пјесковитог кречњака (узорак VR 102) чине двије врсте: ринхонелид *Cyclothyris*? *globata* и капилатни теребратулид *"Terebratula"* sp. (gen. et sp. nov.).

Навише слиједе хемипелашки кречњаци (2–2.5 m, VR103, VR104; 5–6 m, VR105, VR106):

– са ситним роталиформним облицима, калцисферама и глоботрунканидама: *Dicarinella asymetrica*, *Marginotruncana coronate*, *Globotruncana marie, Globotruncana linneiana*, *Globotruncana lapparent,* и др.

– са калцисферама и глоботрунканидама – *Globotruncanita stuartiformis*, *Globotruncana linneiana*, *Globotruncana lapparenti* и крупним аглутинентним фораминиферима који су познати из хемипелашких седимената: *Navarella joaquini* Ciry & Rat и *Tekkeina anatoliensis* Farinacci & Yeniay.

– са калцисферама и ријетким глоботрунканидама *Globotruncana elevata*, прелазна форма *Globotruncana arca–Contusotruncana patelliformis* и др.

На основу микропалеонтолошких података, кредни седименати Дупљај потока су сантон–кампанске старости. Полазећи од податка да глоботрунканска врста *Dicarinella asymetrica* (нађена изнад слоја са брахиоподима) ишчезава у најнижем кампану, слој са брахиоподима приписан је најнижем кампану. Он овдје обиљежава границу између сантона и кампана, док се карбонатни пјешчар са *Hemicyclammina chalmasi* сматра горњосантонским (акма или параакма врсте, док је њено посљедње појављивање у раном кампану, у слоју са брахиоподима).

Према добијеним подацима седименти овог дијела кредног појаса Бјелице, током касног сантона и раног кампана поступно су еволуирали од плитководне маринске средине са јаким теригеним приносом и веома слабим утицајем отвореног мора, преко хемипелашких кречњака са мјешовитом бентоском и планктонском фауном, до чисто хемипелашких-пелашких седимената депонованих у предјелу доња рампа – прелаз у домен релативно плитководне басенске средине. На основу фацијалних карактеристика млађих седимената (Ćirić 1958; Brković *et al*. 1978) закључује се да је тоњење у дијелу кредне јединице Драгачева настављено у току мастрихта, са претпоставком до у данијен.

Plate 1

Figs. 1–5. *Hemicyclammina chalmasi* (SCHLUMBERGER), sample VR101, thin sections VR101a and 101b.

Scale bar = 0.5 mm for all figures.

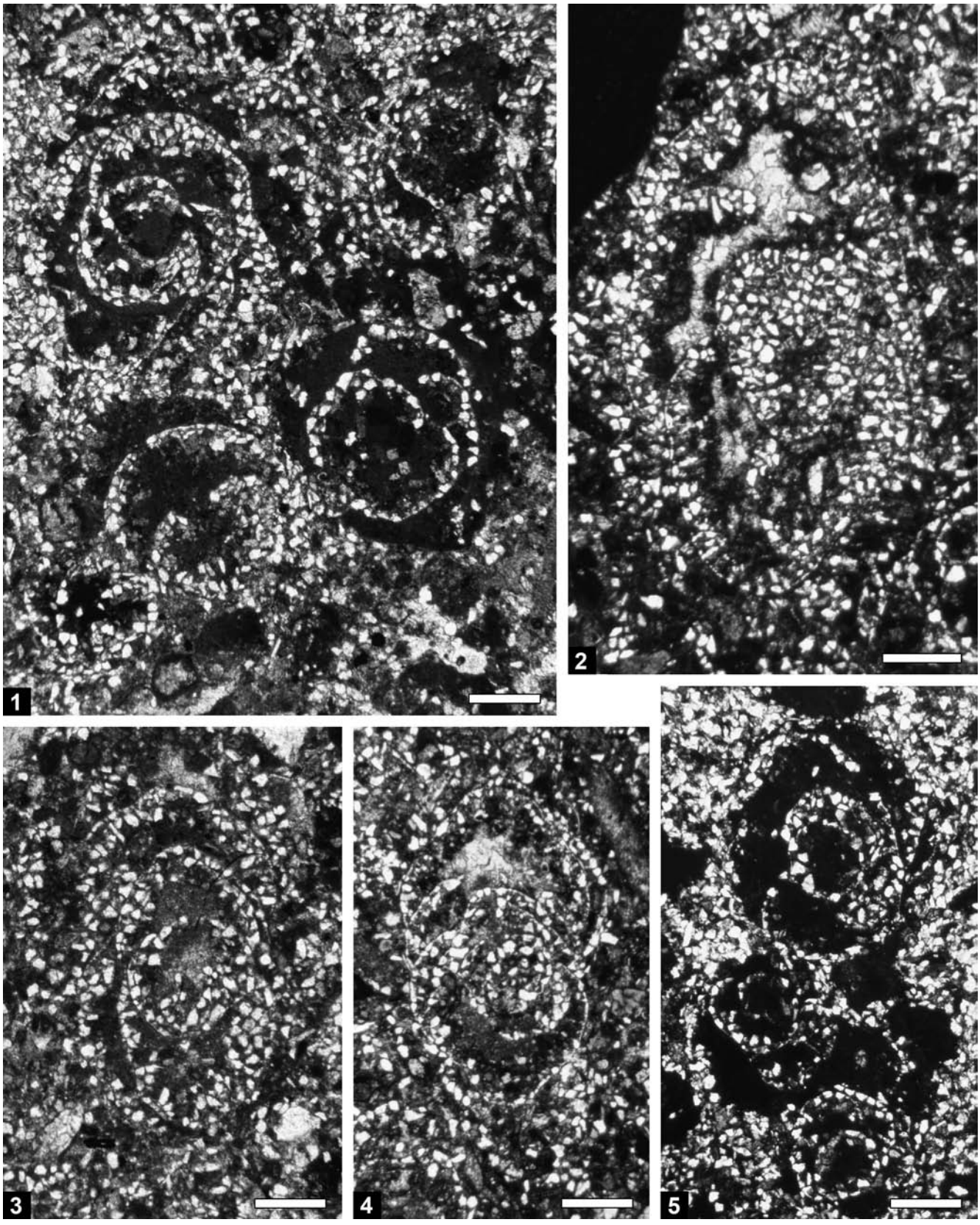
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Plate 2

Figs. 1–7. Rotaliform foraminifera from a bed with brachiopods, sample VR102.
1, 2. Rotalid – species G1, thin section VR102e, 102c.
3–6. Rotalid – species G2, thin section VR102c, 102d, 102d, 102.
7. Rotalid – species aff. G2, thin section VR102b.

Scale bar = 0.25 mm. for all figures.

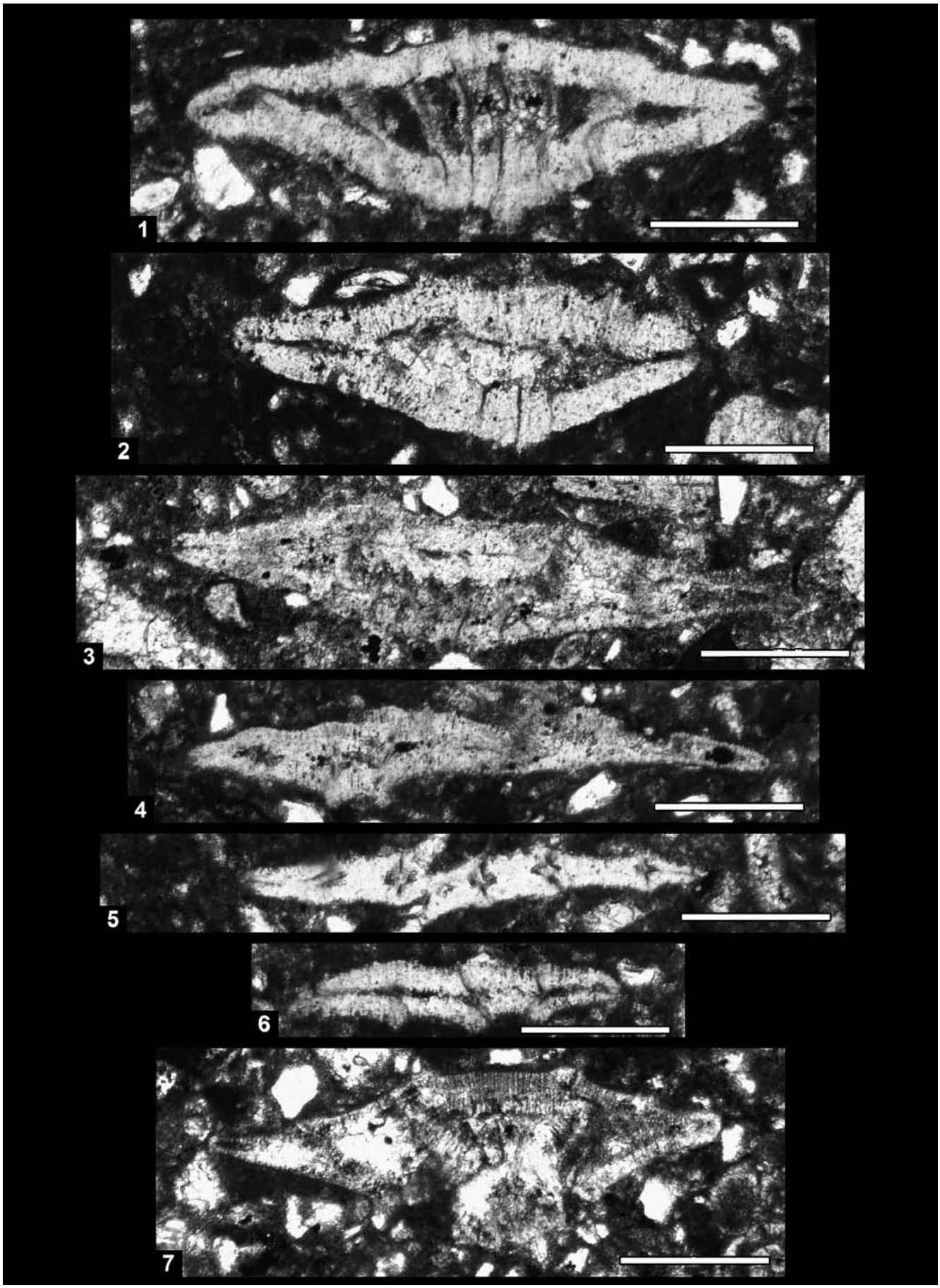
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Plate 3

Figs. 1–6, 11. Rotaliform foraminifera from a bed with brachiopods, sample VR102.
1–3. *Pararotalia* ? G3, thin sections VR102b, 102a, 102c.
4–6. *Sulcoperculina* sp., thin sections VR102, 102a, 102a, 102c.
11. *Rotalia* aff. *R. saxorum* D'ORBIGNY, thin section VR102e.

Figs. 7, 8. *Goupillaudina* sp., thin sections VR103a, 103b.

Fig. 9. *Goupillaudina* sp., thin section VR101a.

Fig. 10. Thin walled rotaliform foraminifera (aff. *Goupillaudina*), thin section VR103a

Scale bar = 0.2 mm for all figures.

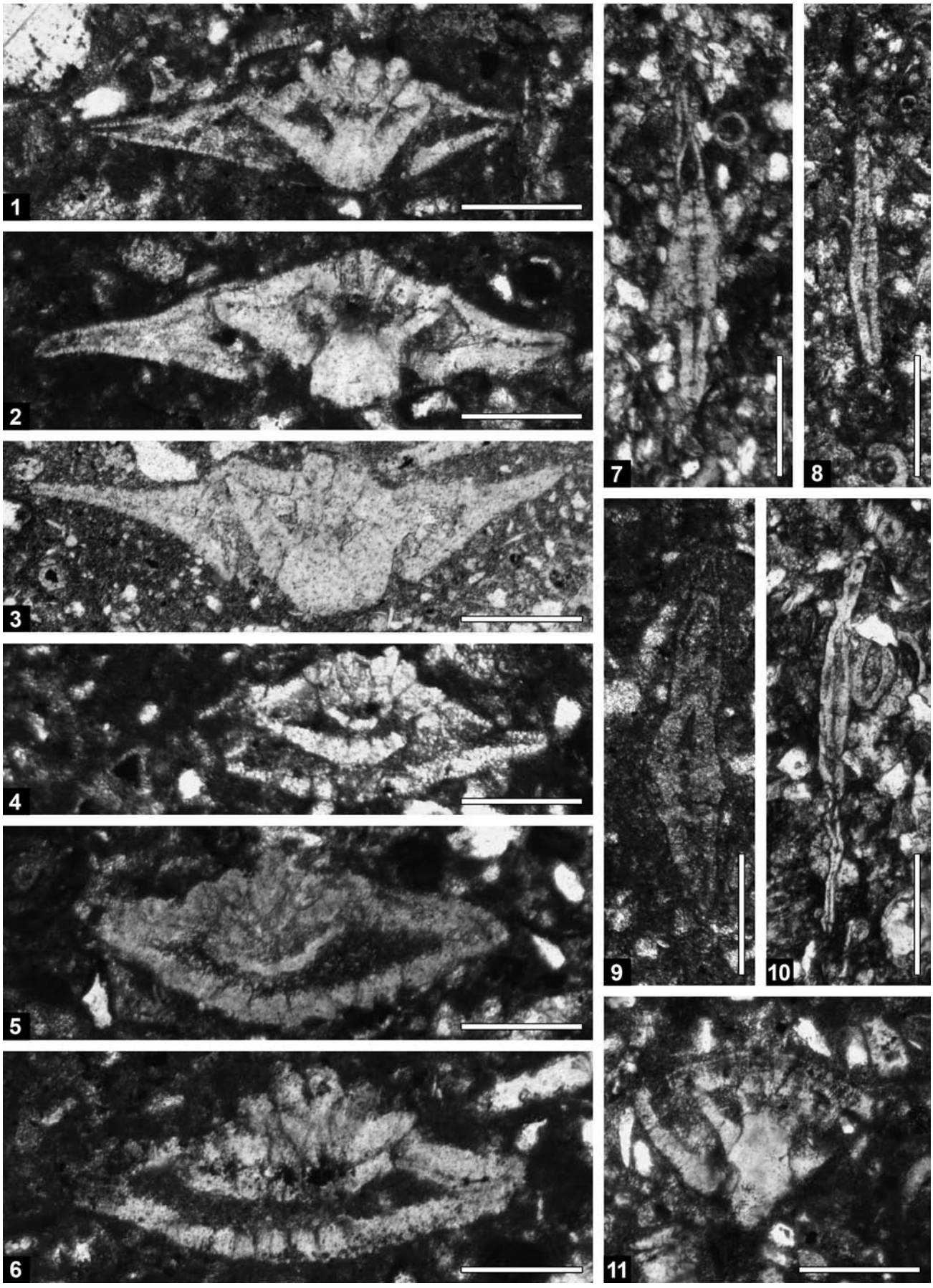
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Plate 4

Figs. 1–6. Benthic foraminifera from a bed with brachiopods, sample VR102.
1–4. *Nummofallotia creta*cea (SCHLUMBERGER), thin sections VR102c, 102c, 102b, 102b.
5. Lituolid, thin section VR102c
6. Rotaliform foraminifera and (upper) *Pithonella multicava* BORSA, thin section VR102c.

Scale bar = 0. 25 mm for all figures.

Figs. 7–11. Large *Lituolidae* from the hemipelagic limestone with planktonic microfossils, sample VR104.
7, 8. *Navarella joaquini* CIRY & RAT, thin section VR104a.
9–11. *Tekkeina anatoliensis* FARINACCI & YENIAY, thin section VR104b.

Scale bar = 0.5 mm for all figures.

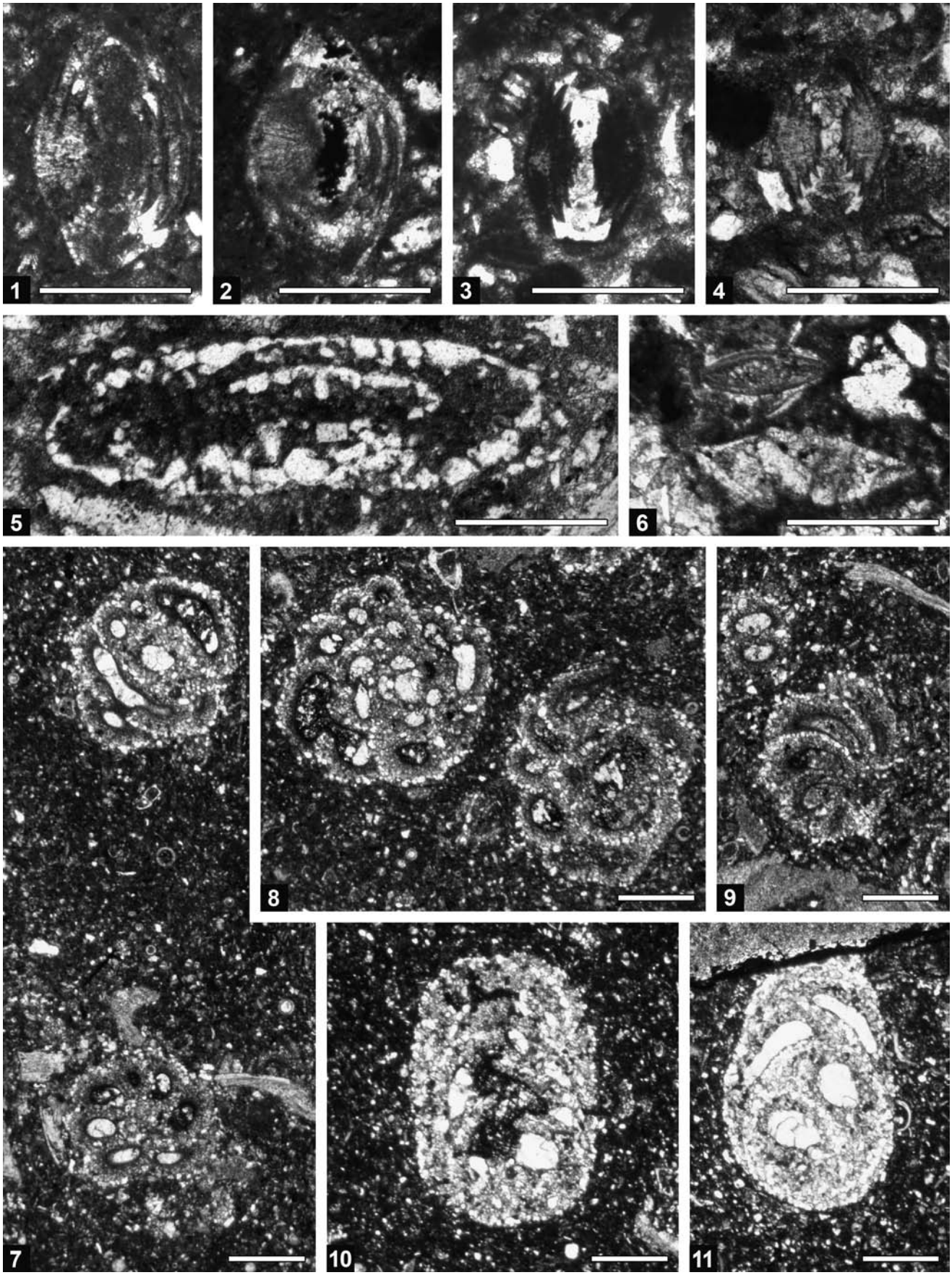
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Plate 5

Figs. 1–7. Planktonic foraminifera and *Pithonella* from a bed with brachiopods, sample VR102.
1–3. *Globotruncana linneiana*(D'ORBIGNY), thin section VR102a, D740 (= VR102), 102d
4. *Globotruncaanita* cf. *G. elevata* (BROTZEN), thin section D740.
5. ?*Muricohedbergella* sp., thin section VR102b.
6. *Globotrtuncana hilli* PESSAGNO, thin section VR102b.
7. *Pithonella multic*ava BORSA, thin section VR102b.

Figs. 8, 9. *Marginotruncana coronata* (BOLLI), thin section VR103b

Fig. 10. *Globotruncana lapparenti* BROTZEN, thin section, VR103a.

Fig. 11. *Dicarinella asymetrica* (SIGAL), thin section VR103b.

Fig. 12. *Globotruncana hilli* PESSAGNO, thin section VR103b.

Fig. 13. *Globotruncana linneana* (D'ORBIGNY), thin section VR104b.

Fig. 14. Genus? (the form aff. *Gublerina–Schackina*), thin section VR104a.

Fig. 15. The form between *Globotruncana arca* and *Contusotruncana patelliformis*, thin section VR106.

Fig. 16. *Globotruncanita stuartiformis* (DALBIEZ), thin section VR104b.

Fig. 17. *Globotruncanita elevata* (BROTZEN), thin section VR105.

Scale bar = 0.2 mm for all figures.

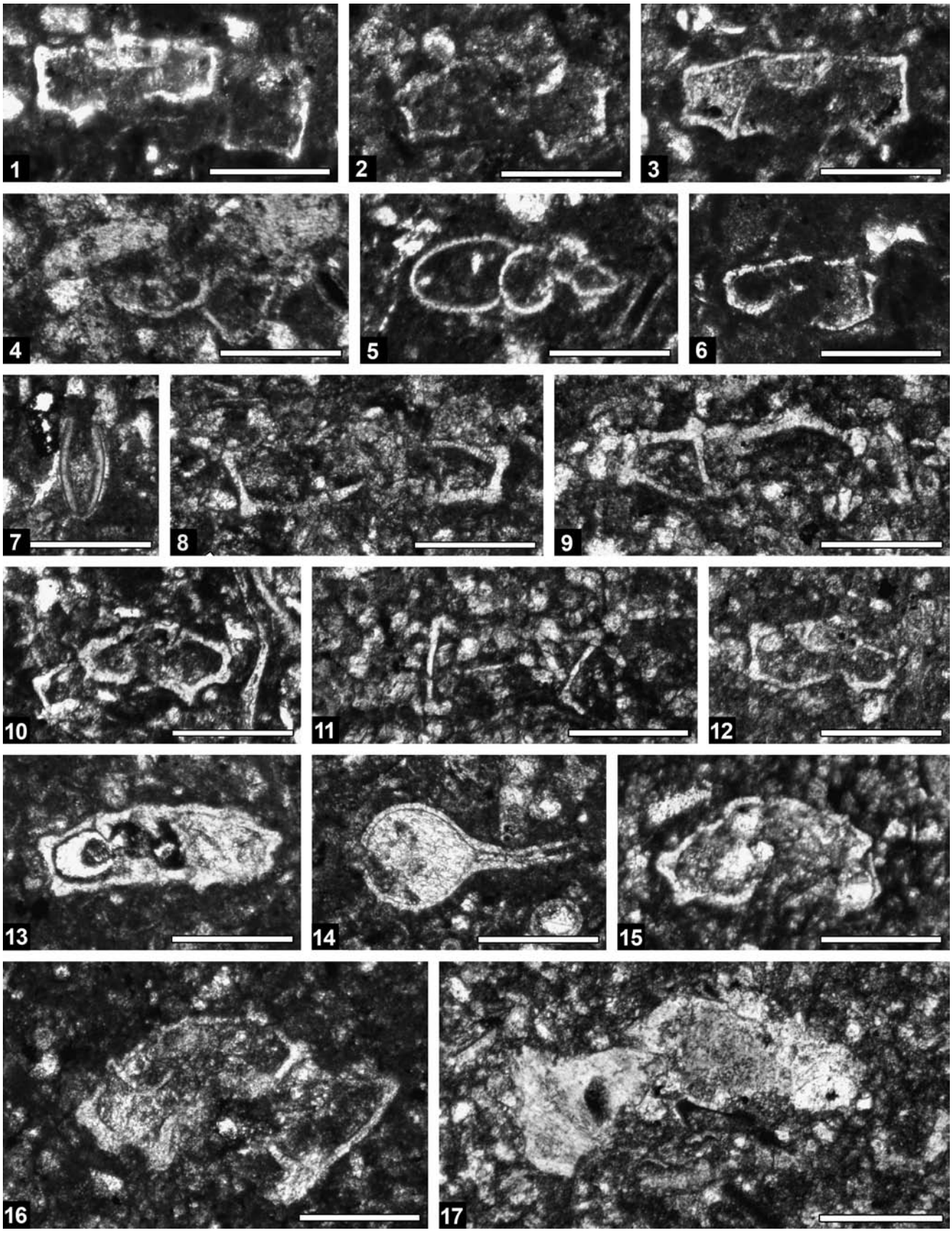
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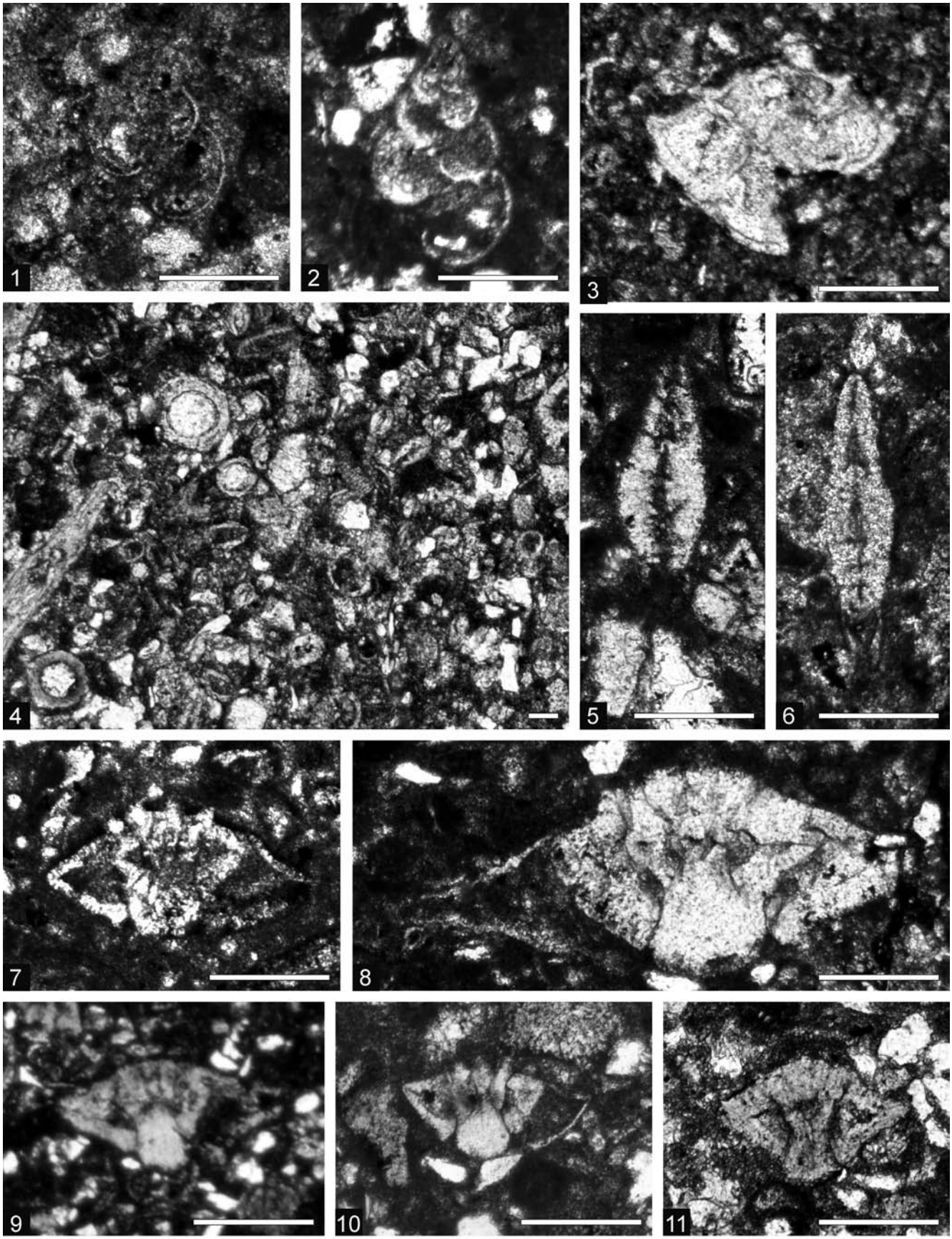
Plate 6

Fig. 1. *Heterohelix* sp., thin section VR101a.
Fig. 2. *Heterohelix* sp., thin section VR102a.
Fig. 3. *Globotruncanita stuartiformis* (DALBIEZ), thin section VR104c.
Fig. 4. *Pithonella ovalis* (KAUFMANN), *Stomiosphaera*, other calcispheres, thin section, VR103b.
Fig. 5. *Goupillaudina* sp. and *Pararotalia minimalis* HOFKER, thin section VR102a.
Fig. 6. *Goupillaudina* sp., thin section D740 (= VR102).
Figs. 7, 9, 10. *Pararotalia* cf. *P. minimalis* HOFKER, thin sections VR102c, 101a, 102e.
Fig. 8. *Pararotalia* sp. G4, thin section VR102c.
Fig. 11. *Pararotalia minimalis* HOFKER, thin sction VR102a.

Scale for = 0.2 mm for all figures.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