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Salpingoporella nicolacarrasi spec. nov., a dasycladalean alga from Santonian of southwestern Serbia (Novi Pazar, Mirdita Zone)

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Abstract. A dasycladalean alga, *Salpingoporella nicolacarrasi* spec. nov., is described from Santonian limestones of the Mur Formation outcropping in Novi Pazar, Mirdita Zone belt, SW Serbia. The alga, the main axis of which bears tightly packed whorls of numerous laterals, resembles the Triassic *Salpingoporella sturi*. Calcareous sparry calcite skeleton, likely first aragonitic, is more or less heavily destroyed by a special process of bio-erosion, described under the name of Mur1.

Key words: Dasycladales, new taxon, bio-erosion, diagenesis, Upper Cretaceous, Santonian, SW Serbia, Mirdita Zone.

Абстракт. Нова врста *Salpingoporrlla nicolacarrasi* описана је из сантонских кречњака Бајевица формације у локалитету Мур, јужно од Новог Пазара.

Кључне ријечи: Dasycladales, зелене алге, нова врста, биоерозија, горња креда, сантон, ЈЗ Србија, Мирдита зона.

Introduction

Salpingoporella nicolacarrasi spec. nov., was first informally described and illustrated by Radoičić (1984) under the name of *Dasycladacea* gen. ind., in a paper primarily introducing *Drimella*, a subgenus of *Neomeris*. As mentioned at that time (*ibid.* p. 24), the skeleton of this alga is compact around the primary laterals, and the possible presence of secondary laterals is dimly suggested by one specimen only (ibid., pl. 5, fig. 1), *Dasycladacea* gen. ind., consequently and tentatively corresponding to the internal part of a *Drimella* type skeleton. *Salpingoporella nicolacarrasi* spec. nov. was found in the Novi Pazar area, in an outcrop of Late Cretaceous limestones belonging to the NW Rogozna–Novi Pazar–S Golija Mt. belt (in short Novi Pazar belt, Mirdita Zone, Fig. 1), also called the western belt of the Vardar Zone by some authors.

Geological setting

Sample location is in the Novi Pazar–Golija Mt., Mirdita Zone belt, also called the western belt of the Vardar Zone, i.e. Dinarides by some authors. In this area, the Late Cretaceous succession transgressively rests on the Paleozoic, showing a transition from shallow-water to basinal environments. As shown by Polavder (2002), in the south Novi Pazar suburb, two formations are visible on outcrop: (1) the Bajevica Formation (Santonian to lowermost Campanian), with a basal, transgressive member of quartzite and sandstone, and a shallow water carbonate upper member, and (2) the Mur Formation (Campanian to lowermost Maastrichtian), with a lower member of hemipelagic-bioclastic deposits and an upper hemipelagic-pelagic member. The lower member of the Mur Formation consists of silty-marly deposits containing limestone blocks and clasts originating from a fractured, perireefal area. This episode ended with thick-bedded limestones corresponding to the influx of finer bioclastic debris. Limestone blocks are present as a lateral development of the upper Bajevica, nearly in situ in slope deposits. Some blocks bear numerous, large *Vaccinites* and *Hippurites*, smaller forms of *Radiolitidae*, rudist fragments, debris of colonial corals, calcisponges and more or less frequent foraminifera with an association comprising *Idalina antiqua* (Polavder 2002, p. 82, figs. 3–5 p.p.). Our new *Salpingoporella* originates from one of these blocks.

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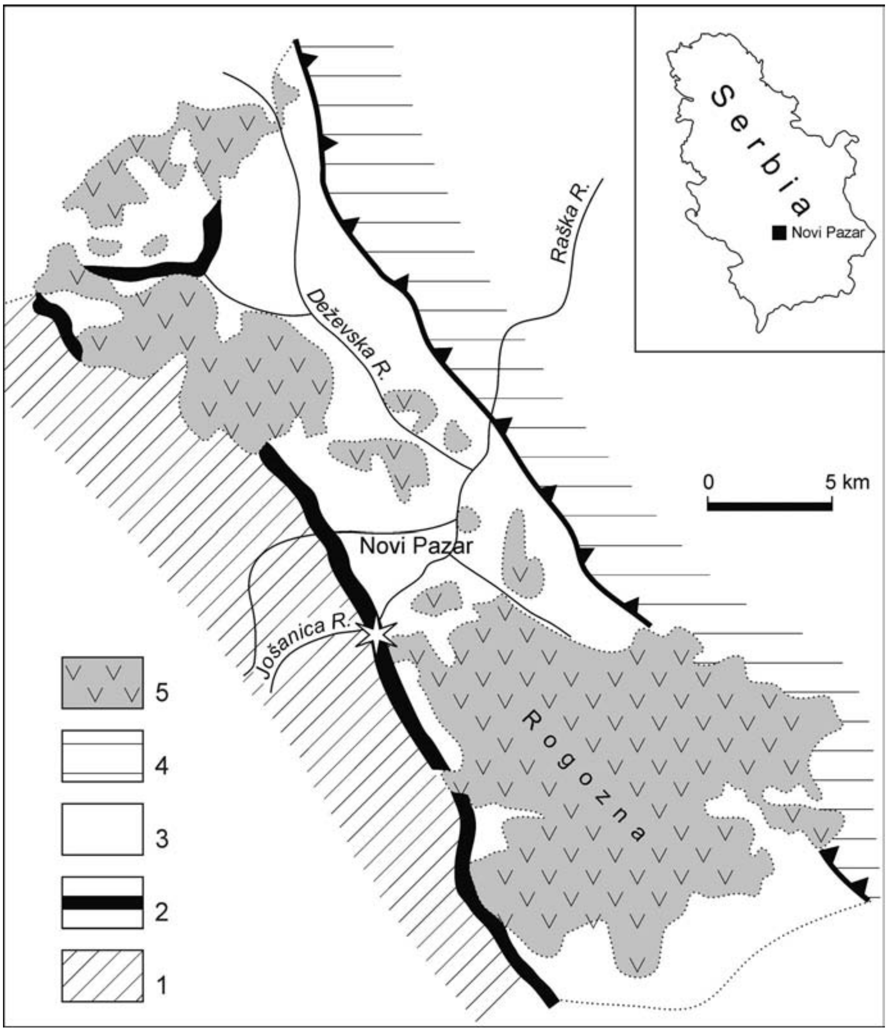

Fig. 1. Geological sketch map of the Novi Pazar area, redrawn after MILOVANOVIĆ & ĆIRIĆ (1968) and UROŠEVIĆ *et al.* (1970), simplified. Legend: **1,** Paleozoic; **2,** Basal terrigenous deposits, lower member of the Bajevica Formation; **3,** Shallow-water, hemipelagic and bioclastic carbonates (upper member of the Bajevica and Mur Formation); **4,** Senonian flysch; **5,** Ophiolites; **6,** Quartz latites. Based on calcareous nannoplankton, the part of ''Senonian flysch'' exposed north of Mur along the road in the Novi Pazar city, is Eocene (DE CAPOA *et al.* 1998).

Systematic taxonomy

Order *Dasycladales* PASCHER, 1931
Family *Triploporellaceae* (PIA, 1920) BERGER & KAEVER, 1992
Tribus *Salpingoporellaceae* BASSOULLET *et al.*, 1979
Subtribus *Salpingoporellinae* BASSOULLET *et al.*, 1979
Genus *Salpingoporella* PIA in TRAUTH, 1918

Salpingoporella nicolacarrasi spec. nov.
Figs. 2, 3; Pls. 1–3

1984 *Dasycladacea* gen. ind. – RADOIČIĆ, pl. 5, figs. 1–5., locality Mur, Novi Pazar, Santonian.

Origin of name. The specie is dedicated to our friend Dr. NICOLAOS CARRAS (IGME, Athens), as a tribute to our long friendship, collaboration and fruitful contribution to the knowledge of the Jurassic and Cretaceous calcareous algae.

Holotype. The transverse section illustrated in Fig. 2 and Pl. 1, Fig. 1, with 35 laterals per whorl. Thin section RR2299, R. RADOIČIĆ collection housed in the Geological Institute of Serbia, Beograd.

Isotypes. Numerous specimens, some of which are illustrated in Pls. 1–3, cut in different sections, contained in 18 thin sections labeled RR2293 to RR2310 (hand sample 013614).

Type locality and age. Mur, at the southern periphery of Novi Pazar, immediately south of the bridge on the Jošanica river, in a block of bioclastic limestone, part of the upper member of the Bajevica Formation. Latest Santonian to Early Campanian. Coordinates: x 7458000, y 4773450.

Diagnosis. Large, elongated cylindrical thallus with a large main stem (d/D of skeleton 47–57 %, occasionally 52–55 %) and tightly packed whorls of numerous (25–35) horizontal, occasionally slightly tilted laterals forming quincunxes. Laterals phloiophorous, first very narrow with a short proximal tapering, then funnel-like, slightly widening out except at tip, where rapidly expanding, forming a bulge corresponding to the uncalcified cortex typical of *Salpingoporella*. Calcareous skeleton made of sparry calcite.

Measurements. *Salpingoporella nicolacarrasi* is among the largest species of the genus. Only the Triassic *Salpingoporella sturi* has equivalent values for the thallus width. The skeleton of our new species varies in size, with an external diameter (excluding two small forms) ranging from 1.58 to 2.74 mm, and the main stem from 0.840 to 1.55 mm. Thickness of skeleton (length of laterals) from 0.37 to 0.59 mm. The longest observed specimen is 9.2 mm. The space between two contiguous whorls varies from 0.148 to 0.197 mm, and the width of the laterals at periphery of the skeleton may reach 0.247 mm.

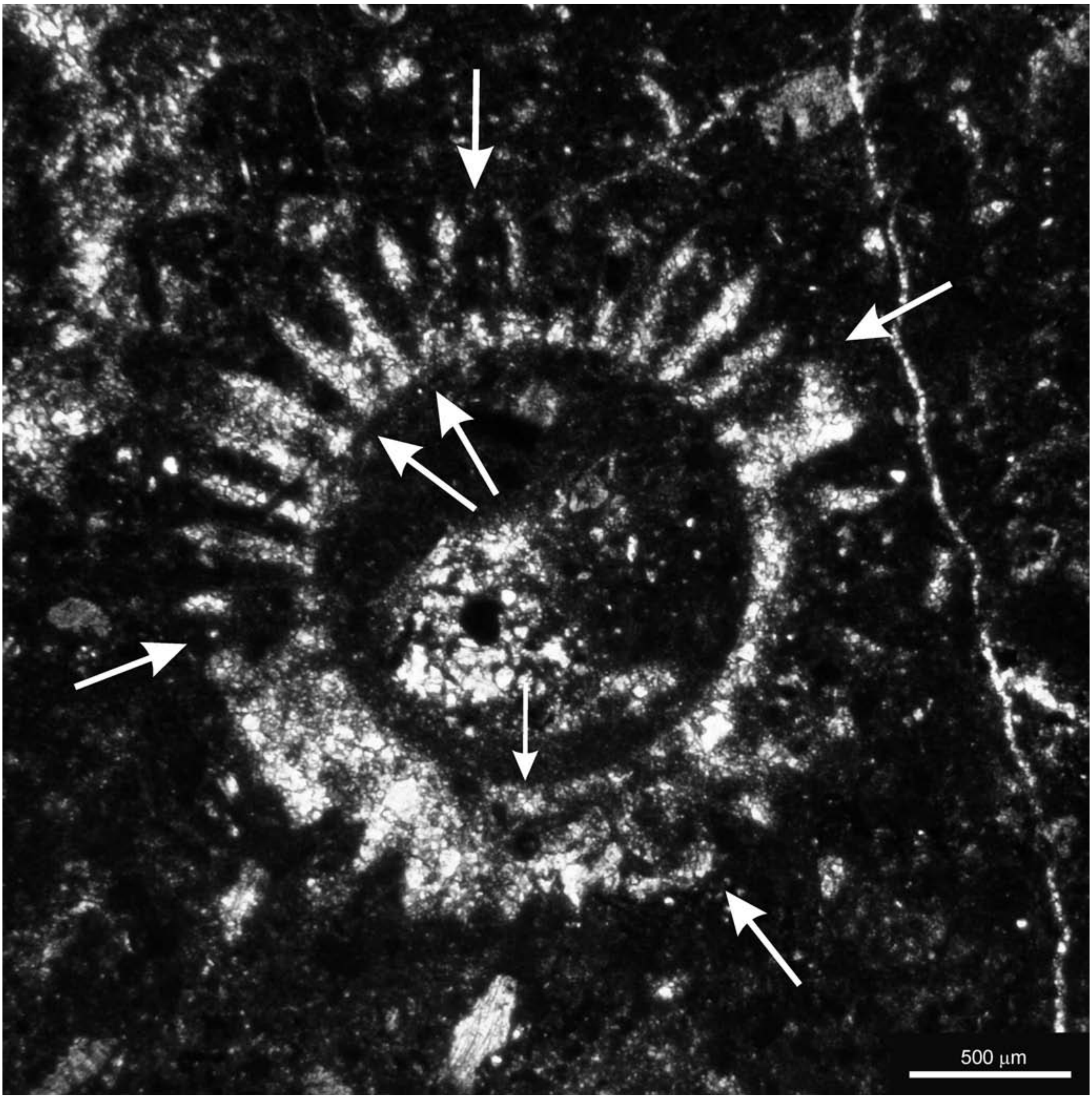

Fig. 2. *Salpingoporella nicolacarrasi* spec. nov., the holotype, transverse section, thin section RR2299 (= Pl. 1, Fig. 1). In the upper half of the section, pores corresponding to the laterals are relatively well preserved. Some of them (two arrows) indicate the characteristic "palisade"-like structure of the skeleton. In lower half of the section, various stages of preservation of the skeleton are visible, ranging from simply recrystallized pores (lower-left) to different grades of alteration. Thin arrow: a small, circular Mur1 cavity. Other arrows: some Mur1 cavities located in the pores (laterals), and also in the partly altered skeleton. To the right, a more advanced process of disintegration is visible; on the right, only the proximal part of the skeleton being preserved.

Calcification and preservation. When relatively unaltered, the final product of calcification forms a sleeve enclosing the slender proximal part of the laterals and the proximal portion of the distal bulge (Fig. 1; Pl. 1, Fig. 1). Distally, the laterals are still uncompressed, circular or subcircular in section, but because of their alternating setting among contiguous whorls, the surface of sleeve typically forms a hexagonal pattern (Pl. 3, Figs. 4, 5). The well preserved, smooth inner skeleton surface was the more resistant area, lingering disintegration processes and corresponding to the past presence of a membrane coating the cyto-

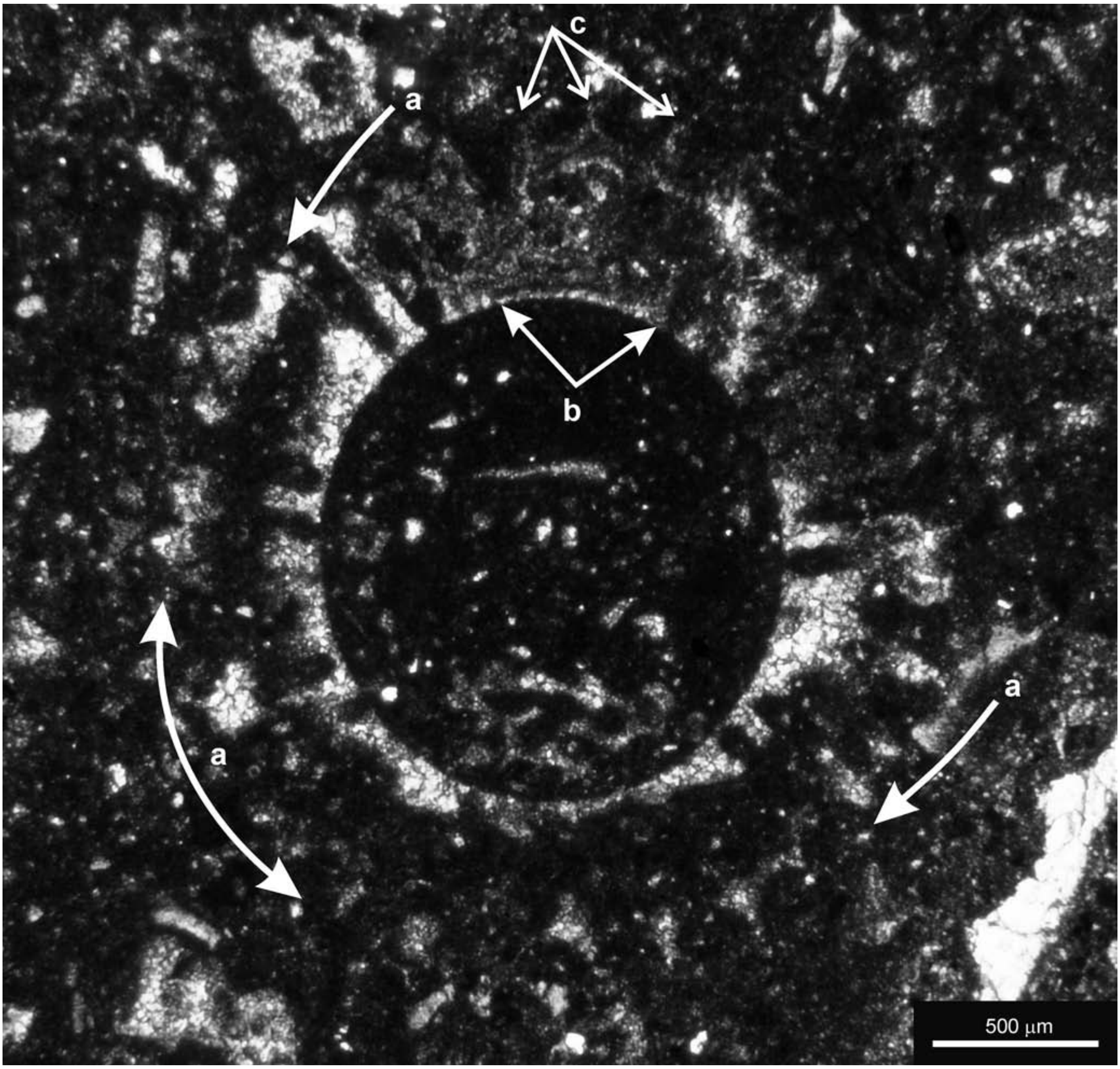

Fig. 3. *Salpingoporella nicolacarrasi* spec. nov., thin section RR2295 (= Pl. 1, Fig. 6). Transverse section of the skeleton largely affected by the microbial cryptoendolith Mur1, in addition to a slightly ochraceous, pervasive, diffuse Mur2 (?biological, ?chemical), alteration-disintegration. The late, but not latest phase, Mur1 bioerosional activity results in the disintegration of the middle part of the skeleton wall, half way from the proximal and distal parts of the laterals. Arrows **a** (from the upper left to the lower-right in the figure) indicate the remnants of the skeleton surface network. Arrows **b**: several Mur1 circular cavities are assembled in the part of the skeleton altered by Mur2, leaving a very thin calcite line corresponding to the innermost remainder of the calcified main stem membrane. Arrows **c**: Altered thin surface network of the skeleton.

plasm (Pl. 2, Fig. 5). In several cases, a very thin calcite line occurs corresponding to the innermost remainder of the membrane (Pl. 1, Figs. 6, 8, 9; Pl. 3, Fig. 1).

In most specimens the skeleton is affected by a peculiar biological process of boring here informally called Mur1, and another process of pervasive, diffuse Mur2 (?biological, ?chemical), alteration-disintegration. Mur1 chiefly develops in the middle part of the pores (laterals), half way from the proximal attachment and the skeleton surface (Pl. 1, Figs. 1, 3, 4, 5; Pl. 2, Fig. 8). In its incipient stage of development, it consists of well delineated, sub-circular holes, isolated or in groups of two-three, initially of small size (Pl. 1, Fig. 8). Then, these holes expand, producing in some cases large circular cavities (Pl.1, Figs. 9, 10), or coalescing to produce, as final result, some sort of undulated tubular strings (Pl. 1, Figs. 3, 6). Tentatively, the Mur1 feature was carried out by seemingly microbial cryptoendoliths. It is especially visible in transverse sections (Pl. 1, Figs. 1, 3–8) showing the various stages of the process.

Relationships. At first glance, *Salpingoporella nicolacarrasi* bears a resemblance to the Triassic *Salpingoporella sturi* (BYSTRICKY) (see CARRAS *et al*. 2006 for a review). In our new species however, in the distal part of the laterals, the distance between two adjacent laterals of the same whorl is clearly smaller than the distance between two adjacent whorls, while in *S. sturi* it is clearly the opposite. Consequently, in both species the pattern of the laterals in tangential section forms polygons which are equilateral in *S. nicolacarrasi* and horizontally elongated in *S. sturi*.

Accompanying biota. Rotalids are prevailing in the foraminiferal association with numerous *Pararotalia minimalis* HOFKER and similar small forms; *Idalina antiqua* MUNIER-CHALMAS, *Hemicyclammina chalmasi* (SCHLUMBERGER), *Moncharmontia apenninica* (DE CASTRO) and *Rotalia reicheli* HOTTINGER, are uncommon. Other biota includes radiolitids, corals, calcispongia fragments and fine metazoan debris.

Acknoweledgements

The authors are grateful to the reviewers I. BUCUR (Babes-Bolyai University, Cluj-Napoca), B. GRANIER (University of Brest) and TONĆI GRGASOVIĆ (Croatian Geological Survey, Zagreb).

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Резиме

Salpingoporella nicolacarassi spec. nov., дазикладалеанска алга из сантона југозападне Србије (Нови Пазар, Мирдита зона)

Нова врста *Salpingoporrlla nicolacarrasi* описана је ин сантонских кречњака Бајевица формације у локалитету Мур, јужно од Новог Пазара.

Salpingoporella nicolacarrasi spec. nov
Figs. 2, 3, Pls. 1–3

1984 *Dasycladacea* gen. ind. - RADOIČIĆ, Таб. 5, сл. 1–5, локалитет Мур, Нови Пазар, сантон.

Дијагноза. Крупан издужен цилиндрични талус са пространом главном осом и густо сложеним пршљеновима са бројним огранцима (25–35), наизмјенично распоређеним у сусједним пршљеновима. Огранци су љевкастог облика са дужим благо проширеним проксималним и нагло проширеним дисталним дијелом који на површини талуса одговара некалцифицираном кортексу типичном за салпингопореле. Кречњачки омотач спари-калцитски.

Опис. Кречњачки омотач обухвата већи дио огранака укључујући доњи дио дисталног проширења дајући мрежасту хексагоналну слику површини омотача. Карактеристично је да је унутрашња површина омотача глатка и веома отпорна на процес разарања. У неким случајевима као посљедњи остатак разореног омотача очувана је танка калцитска линија, у ствари посљедњи остатак првобитно отпорније мембране главне осе.

У већини кречњачких омотача ове врсте уочава се дјеловање особеног биоерозионог процеса који је неформално именован Мур1, и другог, Мур2 процеса (?биолошког, ?хемијског) који се огледа у смеђе измијењеном и мање или више разореном омотачу. Мур1 развија се у средњем дијелу пора, односно кречњачког зида, остављајући кружне шупљине, у почетку ситнијих димензија, изоловане или у групама (веома лијепо видљиве особито у попречним пресјецима на табли 1). У даљем дјеловању обим ових шупљина се повећава (табла 1; сл. 9, 10) или повезује стварајући цјеловиту шупљину неравног обриса кроз средњи дио зида као на сл. 3 и 6, на табли 1.

Salpingoporella nicolacarrasi спада у накрупније салпингопореле, а на први поглед подсјећа на тријаску врсту *Salpingoporella sturi* (BYSTRIICKY).

PLATE 1

Salpingoporella nicolacarrasi spec. nov., transverse and quasi transverse sections showing different kinds of conservation of the skeleton. Magnifications: see Fig. 1.

Fig. 1. The holotype (see also Fig. 1 in the text). Thin section RR2299.
Fig. 2. Lower part: the smallest specimen. To a certain extent the skeleton is dissolved, with the exception of the calcified membrane corresponding to the stem and part of the laterals. Thin section RR2310.
Fig. 3. The middle part of the skeleton wall is largely destroyed by the cryptoendolith Mur1. Arrow: a circular cavity is visible at the end of the coalescing holes. Thin section RR2301.
Fig. 4. Rather ill-preserved skeleton. Arrow: group of Mur1 cavities. Thin section RR2305.
Fig. 5. Fragment, recrystallized and affected by Mur1. Arrow: distal opening of a pore and, in mid-part of the skeleton, circular cavity of Mur1. Thin section RR2305.
Fig. 6. The skeleton is largely destroyed by the Mur1 activity and partly altered, or destroyed by another secondary process. (See also Fig. 3 in the text). Thin section RR2295.
Fig. 7. The skeleton is quite recrystallized and Mur1 coalescing cavities are visible. Thin section RR2308.
Fig. 8. Most of the skeleton is altered by Mur1 (the relatively small holes between the arrows) and other destructive processes. Thin section RR2294.
Fig. 9. The left part is affected by an advanced stage of Mur1, leaving a very thin line of calcite corresponding to the main stem membrane. Thin section RR2294.
Fig. 10. The skeleton is largely disintegrated by an advanced stage of Mur1. Some better preserved laterals are visible in the upper part of the section. Thin section RR2295.

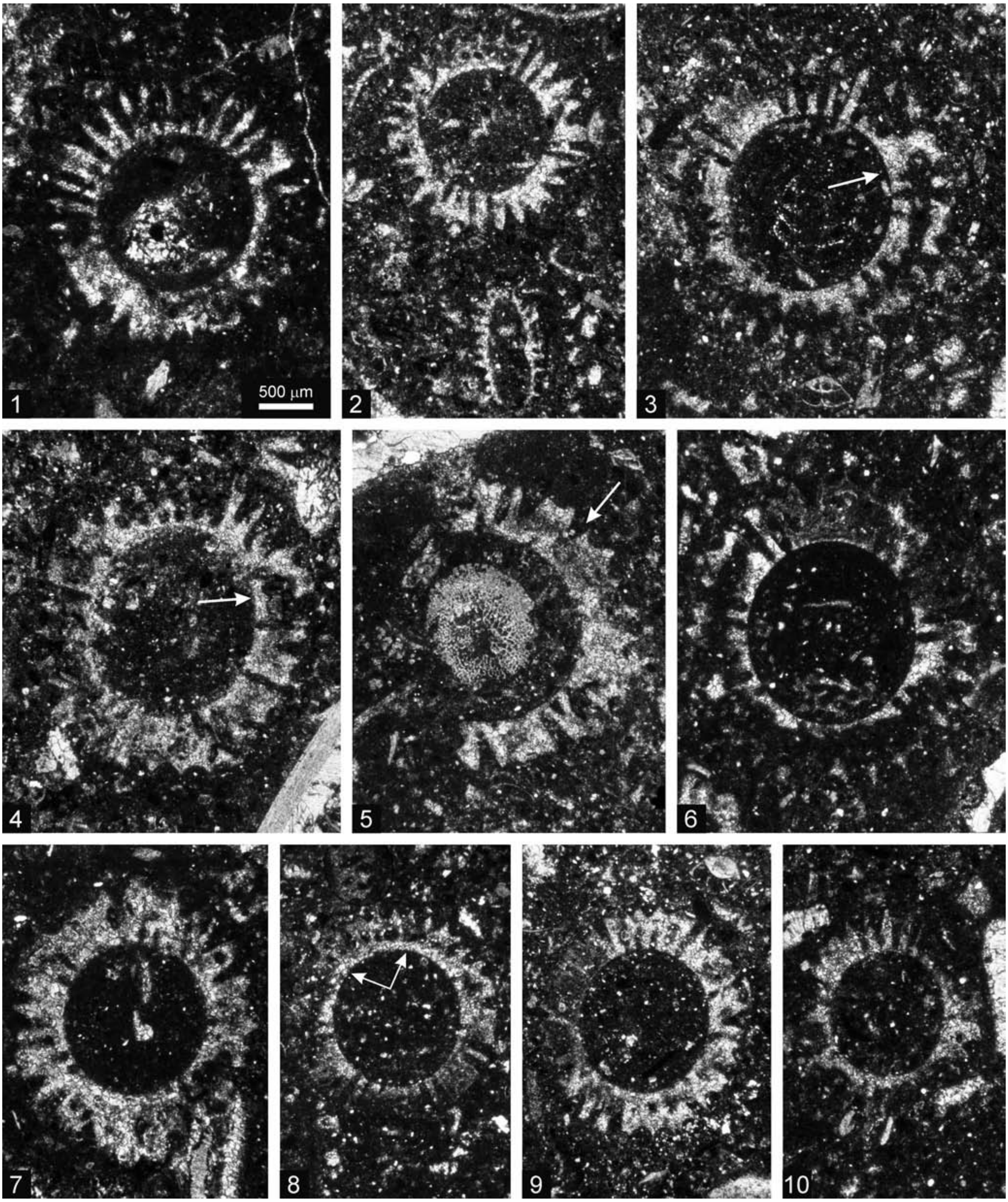
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PLATE 2

Salpingoporella nicolacarrasi spec. nov., oblique, oblique-longitudinal and tangential sections.
Magnifications: see Fig. 1.

Fig. 1. Sections of large, middle and small-sized skeletons with about 25 laterals per whorl. The specimen in the upper left is more disintegrated. The skeleton of the large section is affected by the very small irregular tubular euendolith (not clearly visible). Thin section RR2300.

Figs. 2,3. Sections of medium-sized skeletons. Thin sections RR2299 and RR2307.

Fig. 4. Partly disintegrated skeleton. In the lower right part of the section, the skeleton is partly disintegrated, probably by both Mur1 and Mur 2 activity. Thin section RR2308.

Fig. 5. Most of the skeleton is dissolved, leaving the well preserved, calcified membrane of the main stem, and part of the membrane coating the laterals. Thin section RR2305.

Fig. 6. Only the proximal-middle part of the skeleton is preserved. Thin section RR2301

Fig. 7. Tangential-longitudinal section, of a slightly deformed specimen. Thin section RR2296.

Fig. 8. Rather well preserved skeleton showing laterals alternating in the successive whorls. *Mur1* activity is visible on the left side, producing coalescing cavities in the middle part of the wall. Thin section RR 2293.

Fig. 9. Tangential-longitudinal section.The piece of skeleton is strongly altered, except in the axis area. Thin section RR2296.

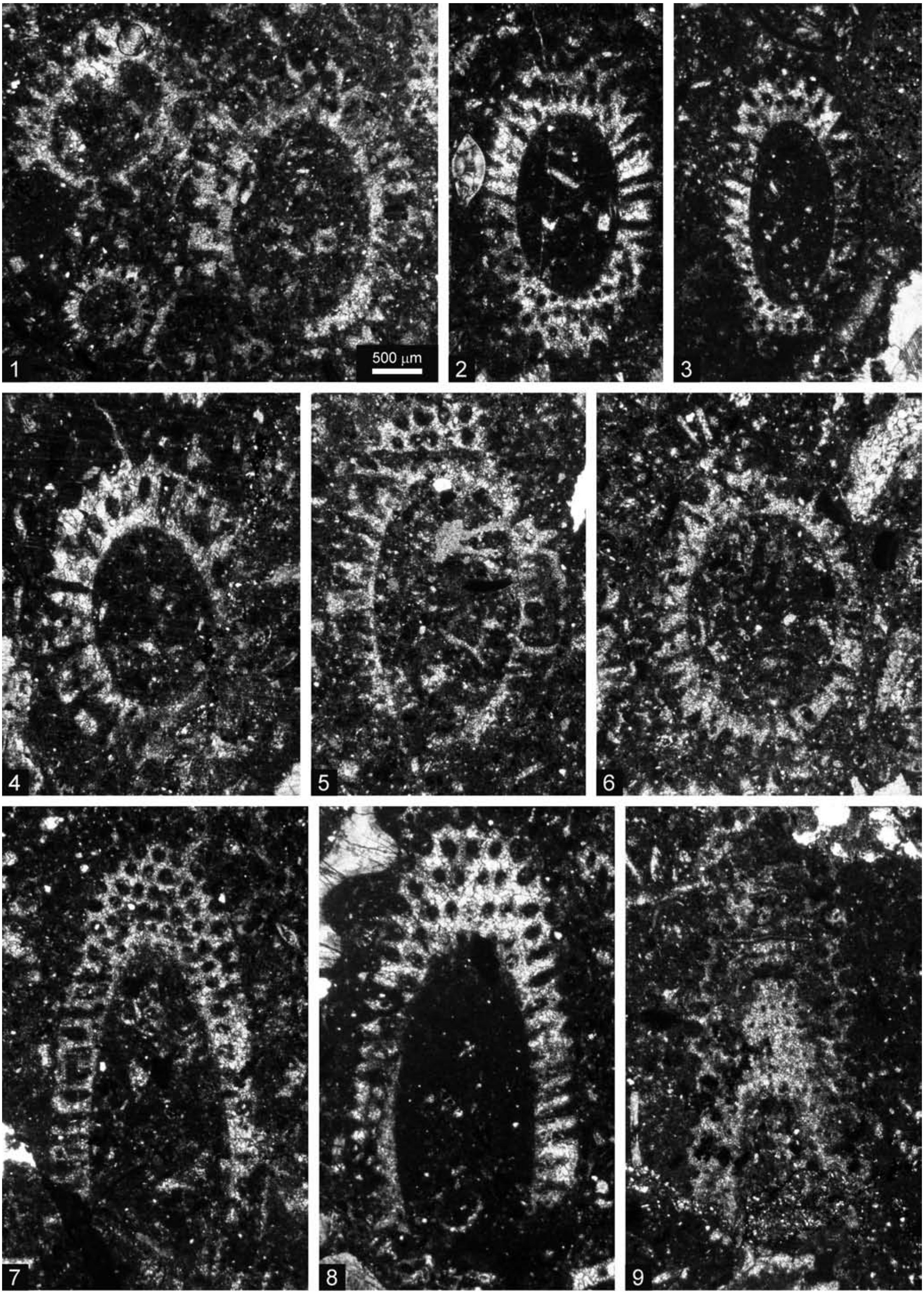
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PLATE 3

Salpingoporella nicolacarrasi spec. nov. Magnifications: see Fig. 1, except Fig. 5.

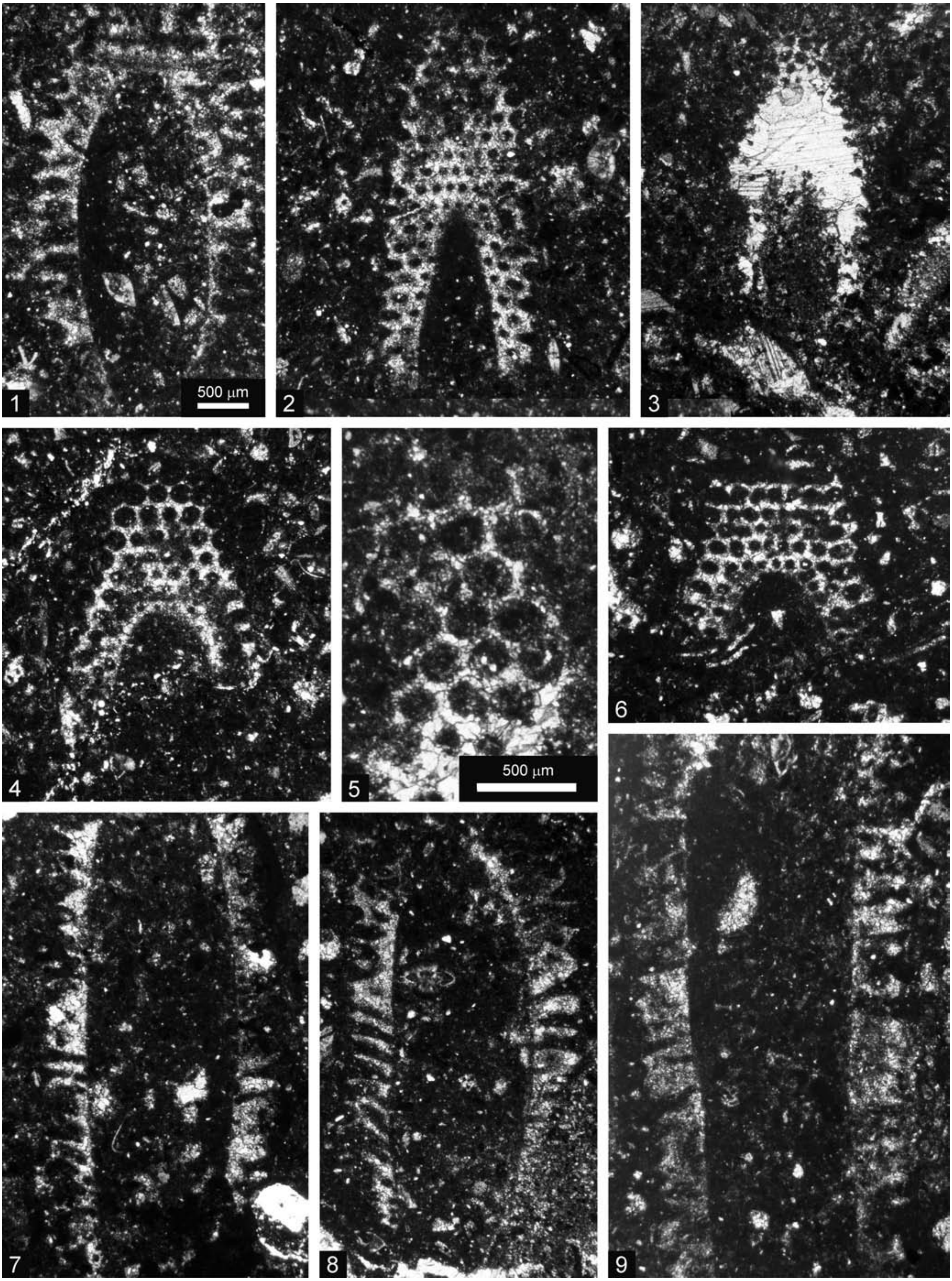
Fig. 1. Oblique section,showing the disintegrating Mur1 activity. Note the clear-cut calcification of the axial membrane. Thin section RR2305.

Fig. 2. Tangential-oblique section showing laterals regularly alternating in consecutive whorls. Upper part in the section: borings due to the Mur1 process are characteristically located in the middle part of the wall. Thin section RR2307.

Fig. 3. Tangential-oblique section.In this case, most of the skeleton is replaced by late calcite cement. Thin section RR2300.

Figs. 4–6. Tangential sections showing the hexagonal network at surface of the skeleton. Note in Fig. 4 the coalescing Mur1 cavities in middle part of the wall. Thin sections RR2297, 2306, 2297.

Figs. 7–9. Longitudinal and quasi-longitudinal sections of slightly deformed specimens. Fig. 9 shows part of a 9.2 mm-long section. Thin sections RR2300, 2299, 2299.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