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Clypeina teakolarae sp. nov., a dasycladalean alga from Lower Eocene of Rakitovec (Čičarija, Slovenia)

Clypeina teakolarae sp. nov., spodnjeeocenska dazikladacejska alga iz Rakitovca (Čičarija, Slovenija)

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Ključne besede: Dasycladales (zelene alge), *Clypeina teakolarae* sp. nov., spodnji eocen, Alveolinsko-numulitni apnenec, Čičarija, Slovenija

Abstract

A new species, *Clypeina teakolarae,* is described from the Lower Eocene of Čičarija, in Slovenia. The pattern of calcification, known so far only from the Upper Jurassic and the Lower Cretaceous, is structurally equal to that of the *Clypeina jurassica* group of species, having an intracellular, radial-fibrous calcite infilling and a micritic cell wall. Contrary to other species of the *C. jurassica* group, the main stem of the new taxon consists of spaced out twin-whorls bearing numerous, commonly irregularly arranged laterals.

Izvleček

Iz spodnjeeocenskih plasti Čičarije v Sloveniji je opisana nova vrsta dazikladaceje *Clypeina teakolarae*. Kalcifikacija vrste je strukturno enaka kot pri algah grupe *Clypeina jurassica* po tem, da ima intracelularno fibrozno-radialno kalcifikacijo in kalcitno-mikritno celično steno. Od vrst te grupe se razlikuje po steljki (talusu), na kateri si v presledkih sledita po dve skupaj ležeči vretenci (dvojčka) s številnimi, pretežno nepravilno postavljenimi vejicami.

Introduction

Fossiliferous samples containing the algal genus *Clypeina* were collected near the Rakitovec village (Čičarija, Slovenia). Based on some characteristic differences with species of the *Clypeina jurassica* group, a new taxon, *Clypeina teakolarae*, is introduced. Due to the markedly imbricated tectonic structure in the Čičarija area, it is not possible to present a corresponding, continuous stratigraphic succession. Only part of carbonate strata occurring in the northern part of the Adriatic-Dinaric Carbonate in the Platform is found in the Čičarija area, forming slices. The Rakitovec limestone containing *Clypeina teakolarae* indicates a particular, local episode, part of the more general depositional environment of the Alveolinid-nummulitid limestone formation.

Geological setting

The Eocene strata with *Clypeina*, presented in this paper, are part of the Alveolinid-nummulitid Limestone found in the Čičarija region. The entire area, tectonically very complicated (Fig. 1), represents part of a wide subthrusted belt constituted of several thrusting zones in the hinterland of Istria and Trieste Bay. Knowledge on geologic structure of this belt in the last decades was much supplemented parallel to regionaly oriented geological researches for the Basic Geological Map SFRY 1 : 100.000. There appear different names for this structure, i.e. Thrusted Structure of Čičarija (Sheet Trst – Trieste; Pleničar et al., 1973), Cretaceous-Paleogene Structure of Čičarija (Sheet Ilirska Bistrica; Šikić & Pleničar, 1975), but on Sheet Labin only geographic name Čičarija was

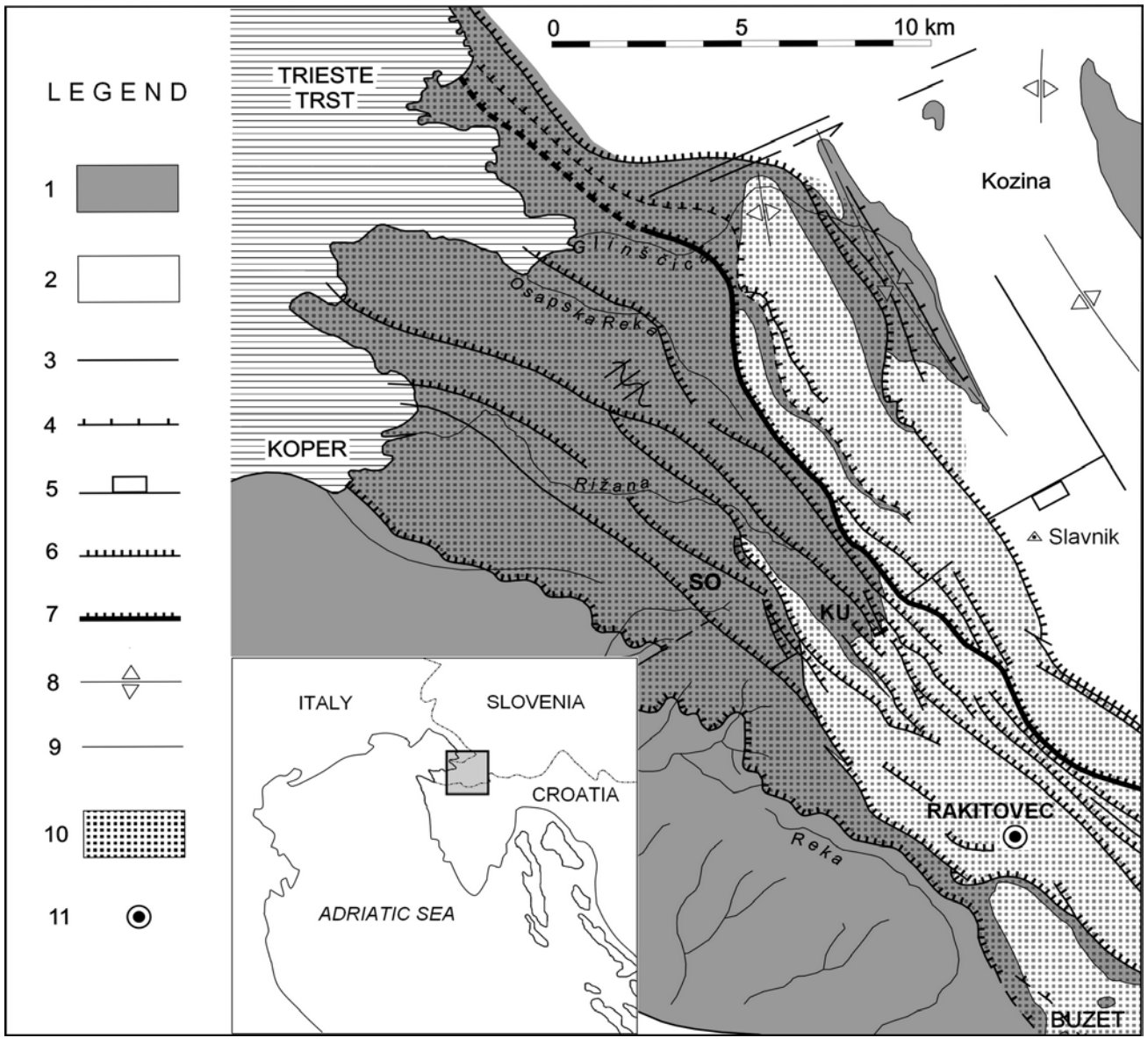

Fig. 1. Sketch map of the subthrusting belt between Trieste and Buzet, showing the Rakitovec locality (modified after Placer 2007, 2010). 1. Flysch; 2. Platform carbonates; 3. Fault; 4. Reverse fault; 5. Normal fault; 6. Thrust fault, thrust fault zone: SO – Sočerga thrust zone, KU – Kubed thrust zone; 7. Črni Kal thrust fault (Palmanova thrust zone, Palmanova line); 8. Fold; 9. Geological boundary; 10. Subthrusting belt; 11. *Clypeina teakolarae* sp. nov. locality.

used (Šikić & Polšak, 1973). The tectonic structure of the NW Dinarides and of Istria was studied in detail by Placer (2005, 2007, 2008, 2010), who termes this area the Čičarija Imbricated Structure that is in a wider sense included in the Istria – Friuli Underthrust Zone**.** The latter was formed due to subduction of the northern part of Adriatic – Apulian foreland, Istria and Friuli under the External Dinarides (Karst and Čičarija).

Due to marked imbricated structure of this area it is not possible to present a continuous stratigraphic succession, as there are in slices preserved only some segments of carbonate strata characteristic for the northern part of the Adriatic-Dinaric Carbonate Platform (Jurkovšek et al., 1996, 1997; Jurkovšek, 2010). They are mainly represented by the Kras group (Košir, 2003) that was, after break of sedimentation between the Late Santonian and Upper Maastrichtian, deposited on the Late Cretaceous rudist limestone (Fig. 2). The presence of softer Flysch sediments that are frequently in tectonic contact with limestone resulted in forming of the typical geomorphologic steps (Placer, 2007).

Strata of the Kras Group (Liburnia Formation, Trstelj Formation and Alveolinid-nummulitid Limestone) together with pelagic and hemipelagic carbonate-clastic rocks (Transitional Beds) and Flysch in its top part form characteristic succession of early developement of foreland basins in the NW part of the Dinarides (Košir, 2003; Otoničar, 2007). All three units appear diachronous (Drobne, 1979) as a result of dynamic of rise and subsidence of the area in front of orogene and connection with migration of platforms and basins. The Kras Group is clearly confined with the regional discordance in the lowermost part, but the group is overlain by basinal clastites which representing the final magasequence of the Adriatic-Dinaric Carbonate Platform.

In the oldest part of the Kras Group the Liburnia Formation was deposited above a distinct carstic relief during the Upper Maastrichtian and

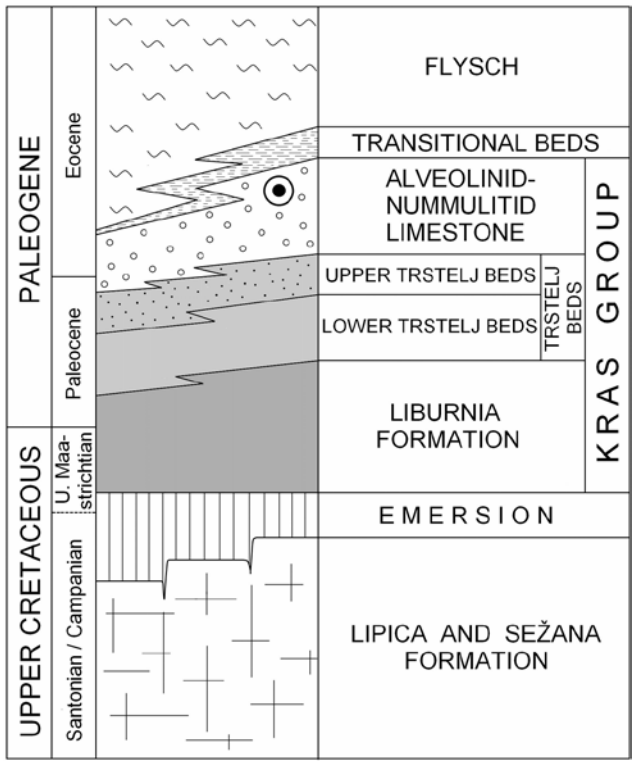

Fig. 2. Simplified stratigraphic column of the Kras (Karst) region, SW Slovenia, with the stratigraphic position of the level with *Clypeina teakolarae* sp. nov. (modified after Jurkovšek, 2010; Košir, 2003).

Paleocene. The shallow marine, brakish and freshwater environments of this formation were recognized already by Stache (1889). The carbonates of the Liburnia Formation are followed by Trstelj Beds in which bioclastic limestone with prevailing miliolids. They were deposited in very shallow near-shore environment of the innermost ramp with periodic emersions and shallows (Zamagni et al., 2008) as indicated also by layers with *Microcodium* (Jurkovšek et al., 1996; Košir, 2004). The Lower Thanetian age is based on benthic association of the SBZ 3 (Shallow Benthic Zones; Serra-Kiel et al., 1998). Major part of the Upper Trstelj Beds is characterized by bioclastic limestone with numerous large foraminiferal genera, mainly *Assilina*, *Lacazina* and *Pseudolacazina* that inhabited mid ramp (Zamagni et al., 2008). Based on foraminifer association this unit of the Trieste-Komen Plateau is defined as SBZ 4 of the Late Thanetian (Ogorelec et al., 2001). Above the Trstelj Beds lies the Alveolinid-nummulitid Limestone with larger benthic foraminifera like alveolinas, nummulitids, orbitoids and discocyclinids. The lower boundary is marked by very frequent appearance of alveolinas, and the upper boundary is gradual or sharp. Alveolinid-nummulitid Limestone was deposited mainly in inner ramp setting that is in the Trieste-Komen Plateau ranged into SBZ 5 to 8, thus in Illerdian (Jurkovšek et al., 1996; Ogorelec et al., 2001; Zamagni et al., 2008), however in Istria it may range up to the Lower Lutetian (Drobne, 1979). Thickness of Alveolinid-nummulitid Limestone is variable and in the thickest parts it exceeds 300 m. During the Eocene the carbonate platform finaly drowned and was covered by advancing hemipelagic marls, marly limestones and redeposited carbonates (Transitional Beds) and deep water clastites (Flysch).

The location Rakitovec with clypeinas in the Alveolinid-nummulitid Limestone is situated in the border area between the Kubed and Sočerga Thrust Faults with Dinaric direction (NW–SE) toward Rijeka Gulf, i.e. at the road and railway junction 1.5 km SW from the Rakitovec village (45° 27' 38'' N, 13° 57' 14'' E). The bed dip in NE direction (35°/15°–30°) is slightly tectonized (Fig. 3). Next to clypeinas localy appear mollusk shells, predominated by gastropods and miliolids. The rock is very similar to Paleocene limestone of the Lower Trstelj Beds. Due to tectonics and vegetation the strata can not be followed in a wider area of the type locality, but the same level can be recognized also 500 m to the north, near the Rakitovec railway station in which Drobne (1977) determined *Alveolina cremae* Cherchia-Rispoli proving the Middle Cuisian (SBZ 11). Next to alveolinas, miliolids and spirolins she mentioned also alga *Clypeina* sp. In continuation of the succession from the Rakitovec railway station towards Movraž village (Drobne, 1977), there are lighter, thick bedded to massive limestone with *A.* aff. *frumentiformis* Schwager and above them follows limestone with *A. callosa* Hottinger and *A. boscii* (Defrance & Bronn) characterizing the Lower Lutetian and these beds rest very close to the Transitional Beds and Flysch. The *Clypeina* described in this paper appears in 70 to 80 cm thick succession of grayish to dusky brown and bituminous limestone in direct vicinity of road and railway junction 500 m

Fig. 3. A 80 cm-thick limestone bed with *Clypeina teakolarae* sp. nov.

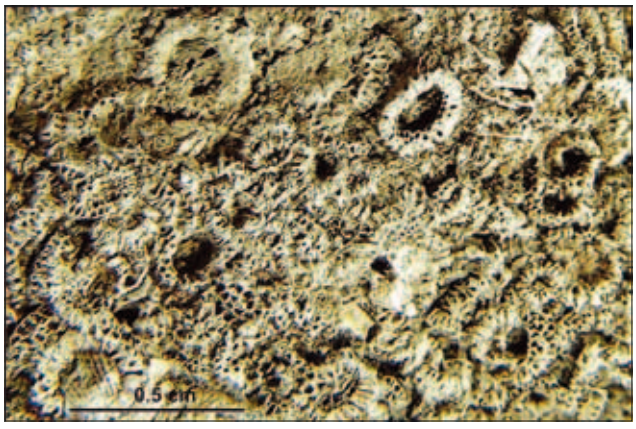

Fig. 4. Weathered limestone surface with accumulated *Clypeina* skeletons.

south from the Rakitovec railway station. The whorls mainly lie parallel to the bedding and they are rarely connected together. The clypeinas are visible in accumulations on surfaces (Fig. 4). The limestone laterally contains considerably less clypeinas, that are badly preserved and also deformed.

Systematic paleontology

Order *Dasycladale*s Pascher, 1931
Genus *Clypeina* (Michelin, 1845) Bassoullet et al. 1978
Clypeina teakolarae sp. nov.
Text Figs. 4, 5, Pls. I–VI

Origin of name. The species is dedicated to our friend and colleague Tea Kolar-Jurkovšek for her contribution in paleontology, especially in conodont stratigraphy.

Holotype. The oblique longitudinal (subaxial-tangential) section with five (four on the figure) twin-whorls contained in a micritic clast, depicted in Pl. I, Fig. 2. Thin section BJ2796-27, Bogdan Jurkovšek collection housed in the Geological Survey of Slovenia, Ljubljana.

Isotypes. Numerous specimens contained in 39 thin sections from sample BJ2796, some of which illustrated in Pls. I–VI.

Type locality. 1.5 km southwest of the Rakitovec village, 500 m south of the railway station, at the road and railway intersect (45° 27' 38'' N, 13° 57' 14'' E; Čičarija, Slovenia, Figs. 1 and 3).

Type level. A 70–80 cm-thick litho-bioclastic bituminous limestone with abounding *Clypeina* skeletons, visible also on the limestone surface (Figs. 3 and 4).

Age. The limestones outcrop in the Rakitovec area is dated middle Cuisian (SBZ 11) by Drobne (1977), based on the presence of *Alveolina cremae* Chechia-Rispoli. Because *Clypeina teakolarae* sp. nov. is resedimented, the species is contemporaneous or older than middle Cuisian. Thin sections with *Clypeina teakolarae* contain mollusk fragments, debris of problematic affinity (?algal) and extremely rare foraminifera. In the BJ2796-27 thin section, two sections of *Clypeina* sp. are present. Few resedimented, altered alveolinids, questionable miliolinids, fragments of problematic affinity and scarce, disintegrated *Clypeina* occur in the thin clayey bituminous limestone wedge.

Diagnosis. Thallus cylindrical. The main stem bears 0.75-3.5 mm-spaced, two by two closely arranged, funnel-like fertile whorls (twin-whorls). The whorls usually consist of numerous (11–35 or even more) long tubular to spindle-like primary laterals containing one ovoid ampulla, upward tilted 45°–75° to the main stem; they are fused through half or 2/3 of their length, except when the whorls bear loosely compounded laterals. In whorls with a large number of laterals, the laterals may be more or less compressed and irregularly arranged. Calcification is structurally equal to that of the *Clypeina jurassica* group of species.

Except at the distal end, the main stem wall and the wall of a laterals are well preserved due to environmental conditions (impregnation by bituminous-?ferruginous or extraneous substance).

The diameter of the external skeleton varies from 1 to 4 mm and main axis diameter is 0.25–1.25 mm. The diameter of the laterals is about 0.125 mm in the proximal part, and 0.325 mm in the largest part. The calcified lenght of the laterals is up to 1.05 mm long, while the ampulla diameter is around 0.125mm.

Description. A characteristic feature of *Clypeina teakolarae* is the presence of twin-whorls of laterals whose arrangement varies as follows. (A) the two contiguous whorls may have the same number of laterals (Pl. II, ?Fig. 2; Pl. IV, ?Fig. 5) or the lower whorl may have twice as much or even more laterals than the corresponding, contiguous upper whorl (Pl. IV, Figs. 2, 4, 9). (B) the arrangement of the laterals can be quite regular (showing minor displacement; Pl. IV, Figs. 9, 11) or more or less irregular (Pl. III, Fig. 1; Pl. IV, Figs. 1–4). (C) in either of the twin-whorls, or both, the laterals may have many densely set, more or less com-

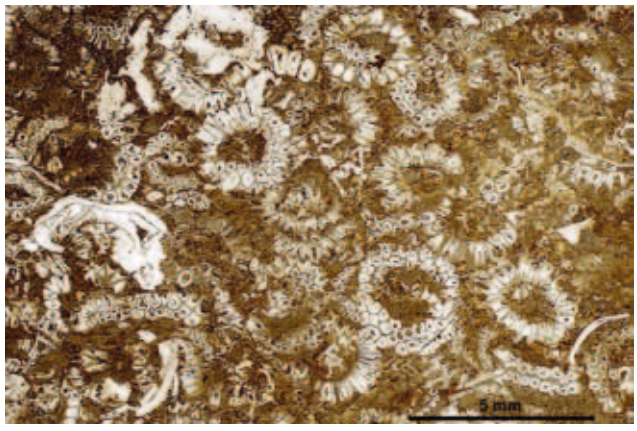

Fig. 5. Different sections of *Clypeina teakolarae* sp. nov., thin section BJ2796-30.

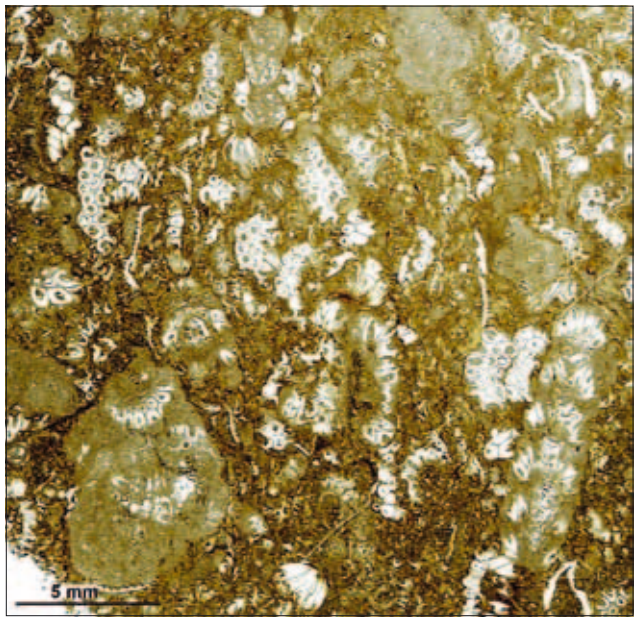

Fig. 6. Micritic clasts with *Clypeina teakolarae* sp. nov. embedded in the matrix of an heterogeneous bituminous-ferruginous, clayey micritic limestone. Thin section BJ2796-27.

pressed laterals (Pl. II, Figs. 3, 6); elsewhere the laterals are slightly touching each other, or loosely arranged (Pl. IV, Figs. 9, 11 = Pl. VI, Fig. 3, Pl. V, Figs. 3, 6), or also, differently compounded in two successive twin-whorls (Pl. I, Fig. 1). (D) when in tangential section, both of the twin-whorls show a number of densely and irregularly set laterals, is is not possible to distinguish a boundary between them (Pl. II, Fig. 6, Pl. V, Fig.1).

Calcification. The primary biogenous calcification of *Clypeina teakolarae* sp. nov. is similar, or at least looks identical to that of the *Clypeina jurassica* group of species comprising *Cl. jurassica* (Lower Kimmeridgian to Upper Berriasian), *Cl. inopinata* (Berriasian) and *Cl. isabellae* (Middle – Upper Berriasian) with radial-fibrous, intracellular colorless calcite deposited around the ovoid ampulla, and primary calcite-micritic calcification of the cell wall, on both the main stem and the laterals. Only the distal part of laterals is missing.

Preservation. The Rakitovec limestone contains numerous, scattered and resedimented fragments and twin-whorls of *Clypeina*. Pieces of skeleton comprising several, up to five or more consecutive twin-whorls are relatively rare (Pl. II, Figs. 1–6; Pl. I, Figs. 1, 2). The micrite in which *Clypeina teakolarae* had been originally deposited was slightly consolidated. Consequently, disintegration increased in the new depositional environment. Clasts containing *Clypeina* and small micritic grains were embedded in a matrix of heterogeneous, bituminous-ferruginous clayey micritic limestone holding calcite grains and some ?organic detritus (Fig. 6). The primary (original) micritic sediment bearing *Clypeina* is usually preserved in the proximal portion of twin-whorls with rather loosely set laterals (Pl. II, Fig. 7 left; Pl. IV, Fig. 9; Pl. V, Figs. 3, 6, 8).

Preservation of the skeleton varies, even in some thin limestone laminae (L_1–L_4) of the same sample (L_1: Fig. 5; L_2: Pl. IV, Fig. 8 = Fig. 7 in Pl. VI; L_3: Pl. IV, Fig. 10; L_4: Pl. IV, Fig. 12). Here, different effects of diagenetic changes are the result of some environmental particularity, too. The well preserved impregnated calcite-micritic cell wall is found in numerous fragments and twin whorls. Examples are given in the Pl. VI: Figure 1 shows perfectly preserved impregnated calcite-micritic cell wall – thickness of the walls of the main stem and the laterals, is about the same. In this slightly oblique section, the walls are either separate (arrows 1, 4), in slight contact (arrow 2) or amalgamated (arrow 3). A radial-fibrous structure of the primary intracellular calcification is barely discernible in some of laterals, around weakly deformed ampullae filled with sparite. The section on the Pl. VI, Fig. 2 is important. It shows part of a transversal, slightly oblique section cutting the lower whorl and a small basal part of the corresponding upper whorl: part of main stem wall is visible, with incisions of two laterals (arrows). It is the sole section in which the basal incisions of laterals may be observed. The section in Pl.VI, Fig. 3, magnifies a detail shown in Pl. IV, Fig. 11: the wall of the main stem is hardly discernable, being almost disintegrated. In part of the section, as frequently observed, some slightly or loosely compounded laterals keep their own wall individually (arrow 1), some have slightly amalgamated walls (arrow 2), while part the individual walls are lost due to compression, reduced to a thin line (arrow 3, which also is a characteristic of *Clypeina jurassica*).

The biogenic, intracellular radial-fibrous colorless calcification is secondarily altered, more or less recrystallized. Ampullae are filled by sparite or, sometime, sediment. Where the recrystallization is strong, the ovoid ampulla is lost (Pl. VI, some laterals on the Fig. 2). In a number of laterals, the primary radial-fibrous structure is not completely lost, as shown on Pl. V, Fig. 12, and on Pl. VI, Figs. 4–6. In these sections, the calcite is slightly pigmented (bituminous matter?); in some sections also the thin calcified membrane of the ampulla is preserved (arrows); on the Pl. VI, Fig. 6 the ampulla membrane is clearly pigmented. A contrary example is shown in Pl. VI, Fig. 7: both the intracellular calcification and the ampulla membrane (arrow) are strongly pigmented, whereas the ampullae infilling consists of pure sparite; this is the only specimen where the micritic wall of the laterals is altered, being replaced by sparite.

Relationships. *Clypeina teakolarae* belongs, or at least is closely related to the *Clypeina jurassica* group of species having intracellular radial-fibrous calcification and preserved calcite-micritic cell wall. It differs from the species of this group by the presence of twin-whorls bearing numerous, prevailingly irregularly arranged laterals. Rare sections may be erroneously assigned to *Clypeina jurassica*. Some transversal and oblique tangen-

tial sections look very similar to corresponding sections of *Praturlonella salernitana* (Barattolo, 1978, Pls. IV and VI). In the latter species, the pattern of calcification is however different, denoting an originally aragonitic skeleton inverted to calcite. Besides the *Clypeina jurassica* group, somewhat different, although possibly related patterns of calcification are found in several species including *Halumusella durandelgai* (Berriasian), *Likanella campanensis* (Berriasian-Lower Valanginian), *Macroporella*? *praturloni* (Tithonian? – Lower Valanginian), *Pseudoclypeina cirici* (Upper Kimmeridgian) and *Pseudoclypeina distomensis* (Lower Oxfordian – Lower Kimmeridgian). Noteworthy, with *Clypeina teakolarae*, the *Clypeina jurassica* pattern of calcification is reported for the first time in deposits younger than Valanginian.

Environments. *Clypeina teakolarae* populated a sheltered shallow marine environment (algal marine meadows). The micritic deposits with *Clypeina teakolarae* were slightly reworked as semiconsolidated sediment. All of the re-deposited, bituminous-ferruginous limestone found at Rakitovec, originate from a single ecological environment. The Rakitovec limestone containing *Clypeina teakolarae* indicates a particular episode, likely of limited regional extent, part of the more general Alveolinid-nummulitid depositional environment. The authors consider that future, detailed investigations should be carried out on these deposits using ad hoc technique such as geochemical analysis and electron scanning microscope.

Acknowledgment

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PLATE I

Figs. 1–3 *Clypeina teakolarae* sp. nov.

1 Tangential oblique section of the large size skeleton with seven twin-whorls, third from the base more irregularly arranged. Notice, on the left, the section of the small size skeleton. Thin section BJ2796-1.

2 Holotype, subaxial to tangential section of successive 5 twin-whorls (4 in figure) in micritic clast. Thin section BJ2796-27.

3 Different transverse and other sections. Notice on the right in partially preserved sparite main stem wall. Thin section BJ2796-28.

PLATE I

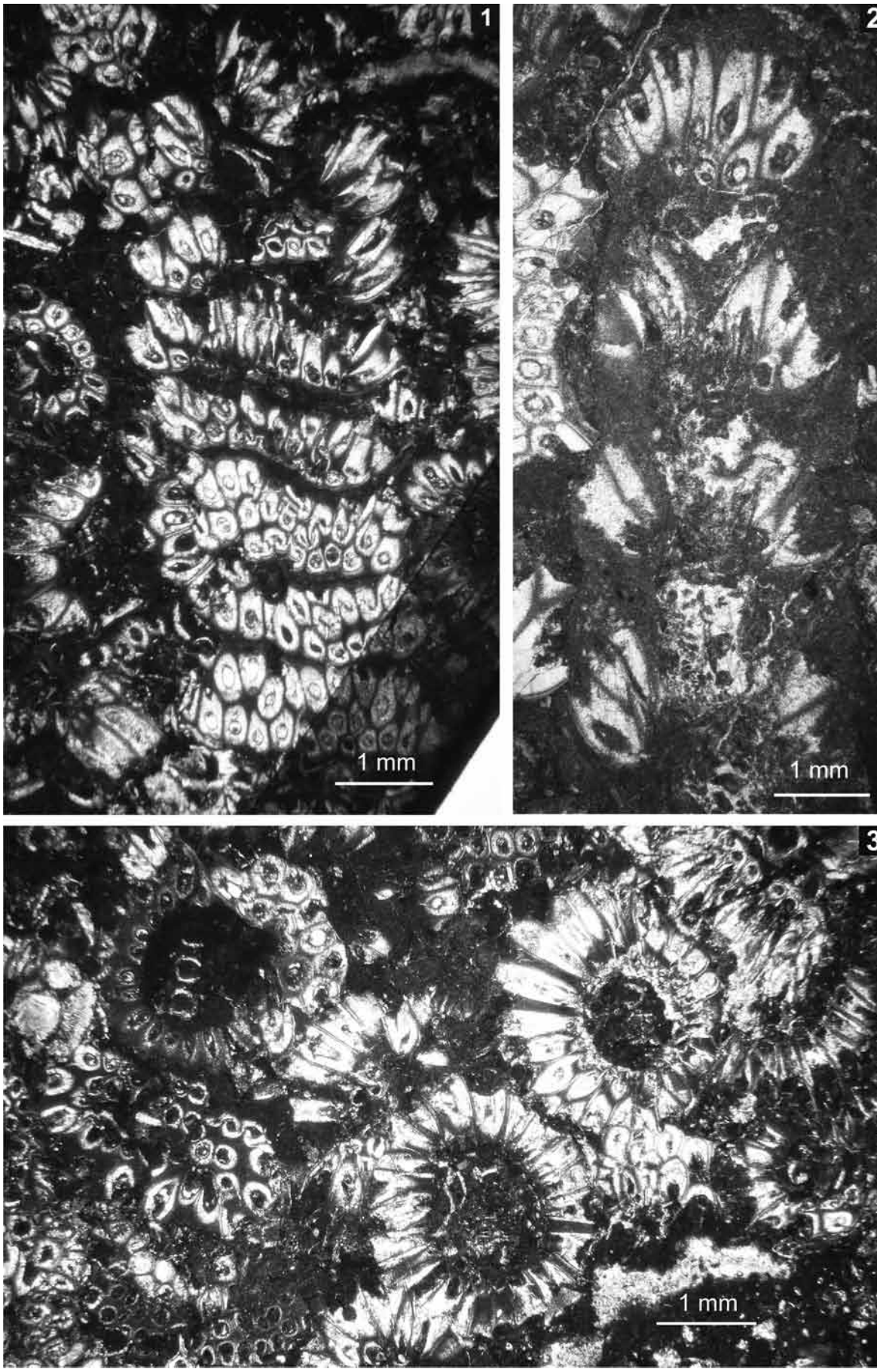

PLATE II

Figs. 1–9 *Clypeina teakolarae* sp. nov.

1 Tangential section of slightly irregularly arranged three successive twin-whorls. Thin section BJ2796-16.

2 Tangential section of relatively large size skeleton, two upper of three twin-whorls are regularly composed. Thin section BJ2796-9.

3 Tangential section of three successive twin-whorls with numerous irregularly arranged and very compressed. Thin section BJ2796-34.

4 Oblique-tangential section of the two successive twin-whorls irregularly arranged. Thin section BJ2796-32.

5 Oblique to tangential section of the medium size skeleton. Thin section BJ2796-9.

6 Tangential section of the large size skeleton, twin whorls with numerous irregularly arranged slightly compressed laterals. Thin section BJ2796-33.

7 Tangential and oblique sections of recrystallized skeleton. Thin section BJ2796-8.

8, 9 Oblique sections of twin-whorls with loosely arranged laterals. Thin sections BJ2796-27 and BJ2796-3.

PLATE II

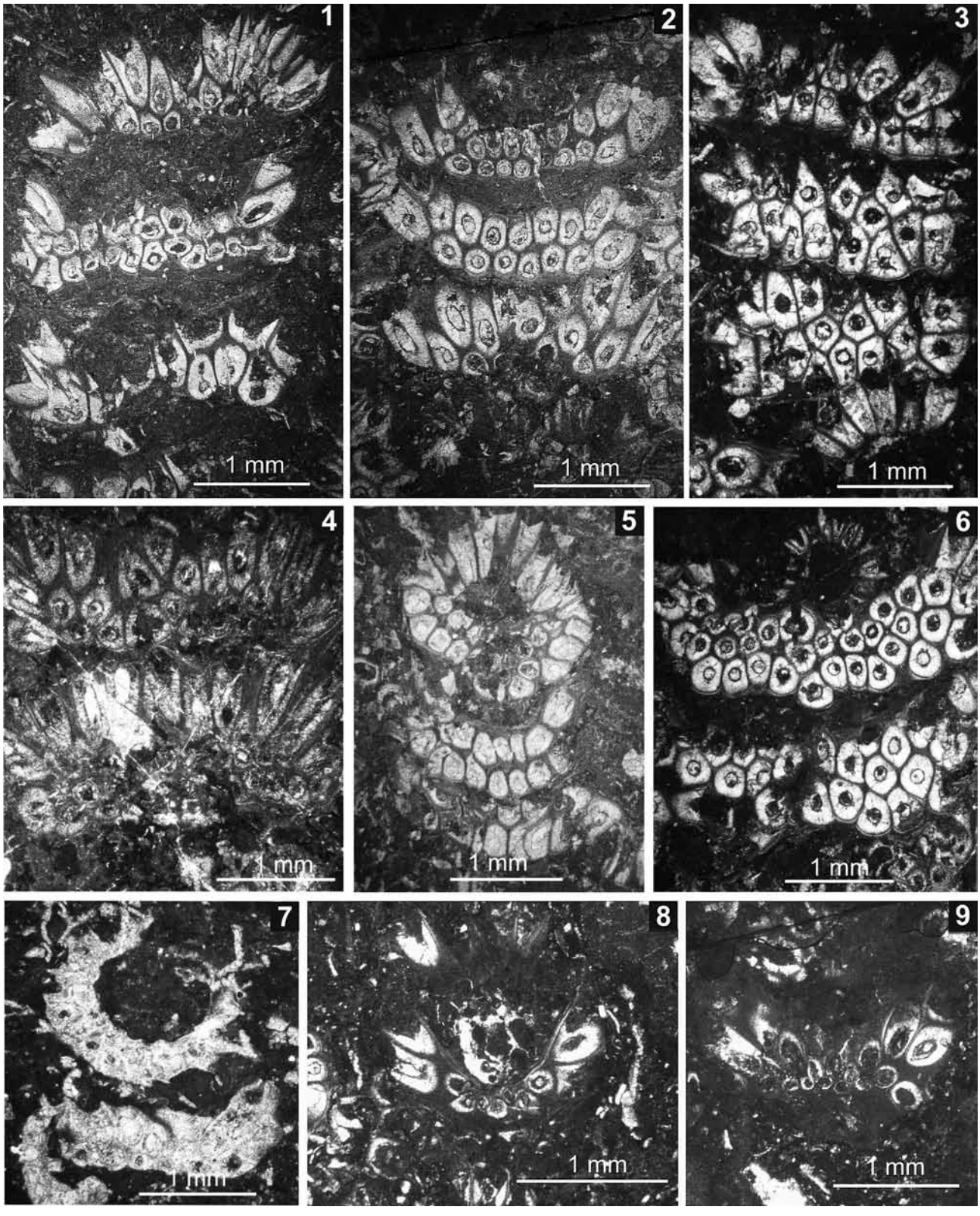

PLATE III

Figs. 1–8 *Clypeina teakolarae* sp. nov.

1 Oblique sections of two twin whorls. Notice in the large specimen poorly preserved with remnant of the upper whorl. Thin section BJ2796-19.

2 Deformed recrystallized large size skeleton. Thin section BJ2796-10.

3 Transverse section of the flattened skeleton. Thin section BJ2796-11.

4 Transverse section of twin-whorls, notice section through proximal part of upper whorl. Thin section BJ2796-20.

5 Transverse sligtly oblique section of recrystallized twin whorls. Thin section BJ2796-42.

6 Fragment, transverse section of the lower whorl. Thin section BJ2796-34.

7 Oblique section of two twin whorls. Notice the difference between them, left specimen has loosely arranged laterals and, between them, preserved primary micrite, section at right has prevailing recrystallized and densely set laterals with ampullae filled by sparite or sediment. Thin section BJ2796-12.

8 Oblique section, laterals loosely compounded. Thin section BJ2796-2.

PLATE III

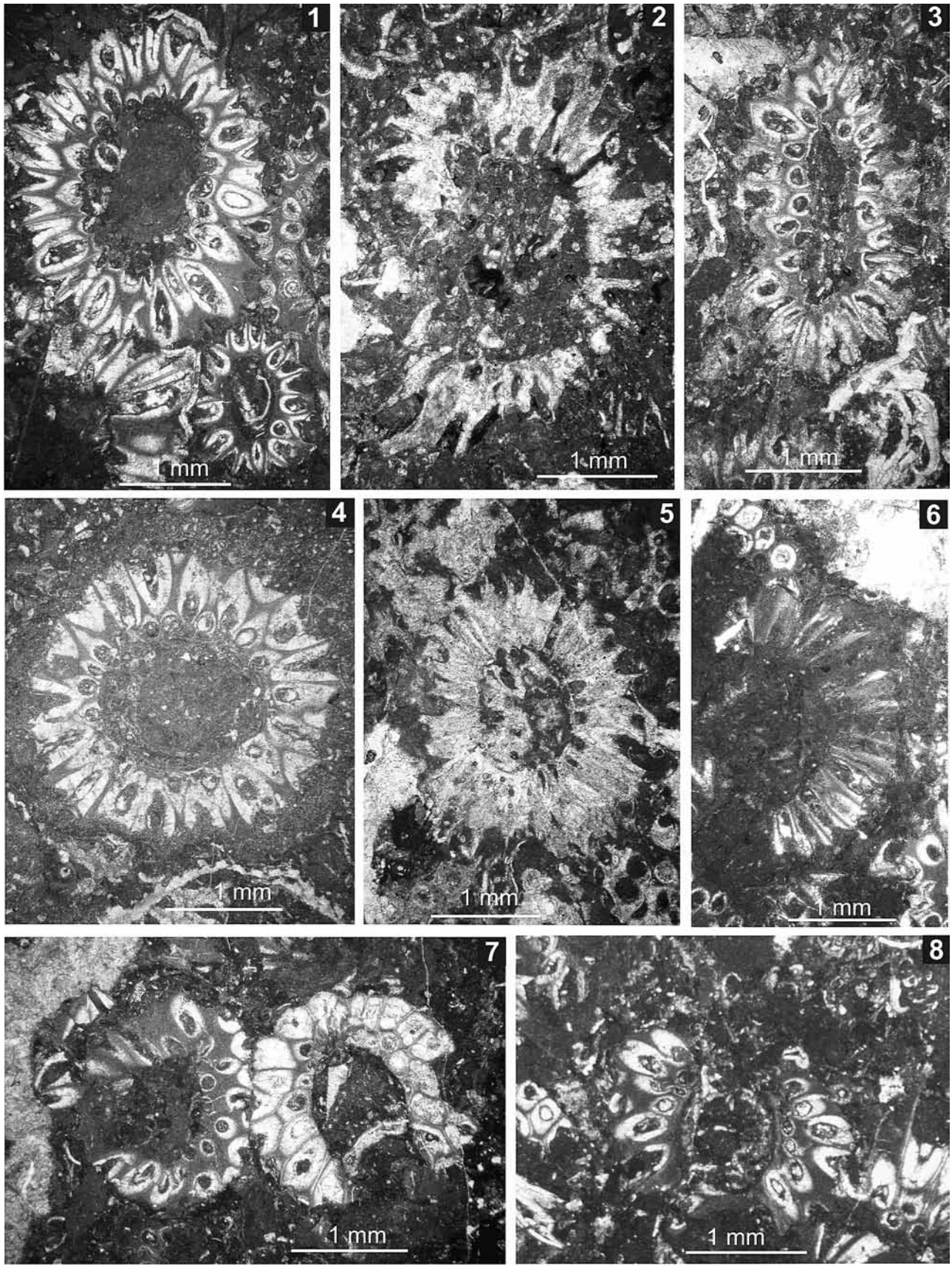

PLATE IV

Figs. 1–13 *Clypeina teakolarae* sp. nov.

1, 2 Two transverse oblique sections of differently and irregularly arranged laterals of twin whorls. Thin sections BJ 2796-20, BJ2796-23.

3 Transverse oblique section, recrystallized irregularly set laterals of upper twin whorl and a remnant of lower whorl. Thin section BJ2796-20.

4 Slightly oblique transverse section of the twin-whorls with very well preserved impregnated wall of laterals and part of main stem wall. Thin section BJ2796-11.

5, 6 Two similar twin whorls in transverse section with well preserved upper whorls and only remnants of lower whorls. Thin sections BJ2796-19 and BJ2796-5.

7 Transverse slightly oblique section of the small size skeleton of upper whorl and fragment of transverse section of lower whorl. Thin section BJ2796-25.

8 Flattened oblique transverse section of twin-whorls pigmented by bituminous matter (detail in Pl. VI, Fig. 7). Thin section BJ2796-42.

9 Twin-whorls of regularly arranged laterals in slightly oblique transverse section. In the part of section well preserved impregnated wall of laterals and main stem. Thin section BJ2796-6.

10 Recrystallized slightly colored skeleton and transverse section. Notice ampullae are not colored. Thin section BJ2796-8.

11 Transverse oblique section of small size skeleton (detail in Pl. VI, Fig. 3). Thin section BJ2796-30.

12 Recrystallized brocken skeletons. Thin section BJ2796-17.

13 Slightly oblique section of upper whorl with main axis wall preserved. Thin section BJ2796-20.

PLATE IV

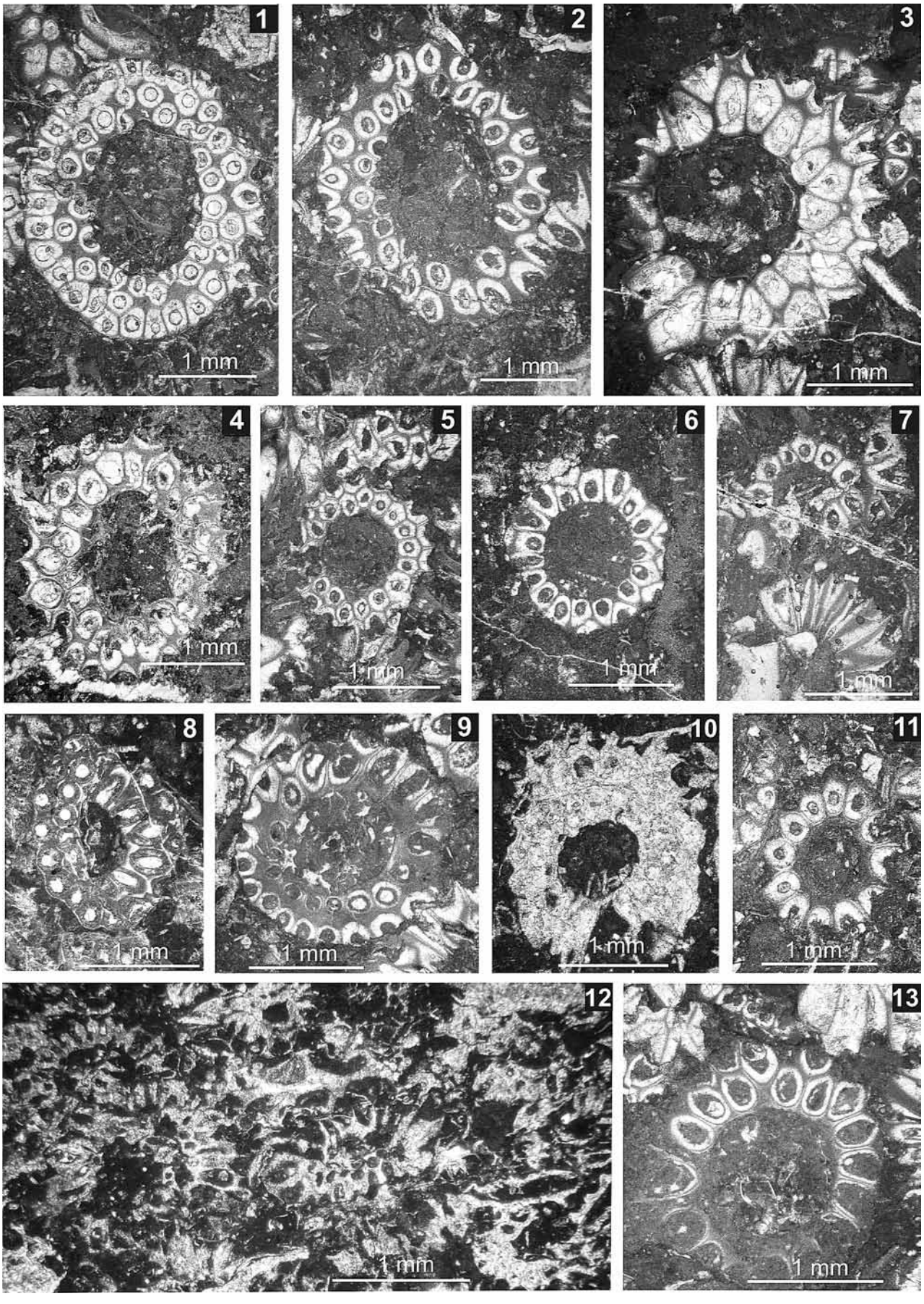
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PLATE V

Figs. 1–12 *Clypeina teakolarae* sp. nov.

Figs. 1–6 Different tangential sections of twin-whorls;

1 Laterals densely set, in part compressed. Thin section BJ2796-20.

2, 4 Slightly irregular (thin sections BJ2796-21, BJ2796-27) and 3, 5 relativelly regular arranged laterals (thin sections BJ2796-18, BJ2796-26).

6 Irregular arrangement of loose laterals. Thin section BJ2796-15.

7–10 Transverse slightly oblique sections of differently preserved twin-whorls. Notice in fig. 8 remnants of lower whorl and preserved primary sediment. Thin sections BJ2796-20, BJ2796-29, BJ2796-8 and BJ2796-24.

11 Twin-whorls in transverse oblique section. Notice six basal sections (between white points) of upper whorl in slight contact and some parts of sparite main stem wall. Thin section BJ2796-28.

12 Transverse oblique section of recrystallized laterals in which radial-fibrous structure of primary intracellular calcification is not lost. Notice calcified ampulla membrane and membrane structure of external surfaces of laterals (arrows). Thin section BJ2796-12.

PLATE V

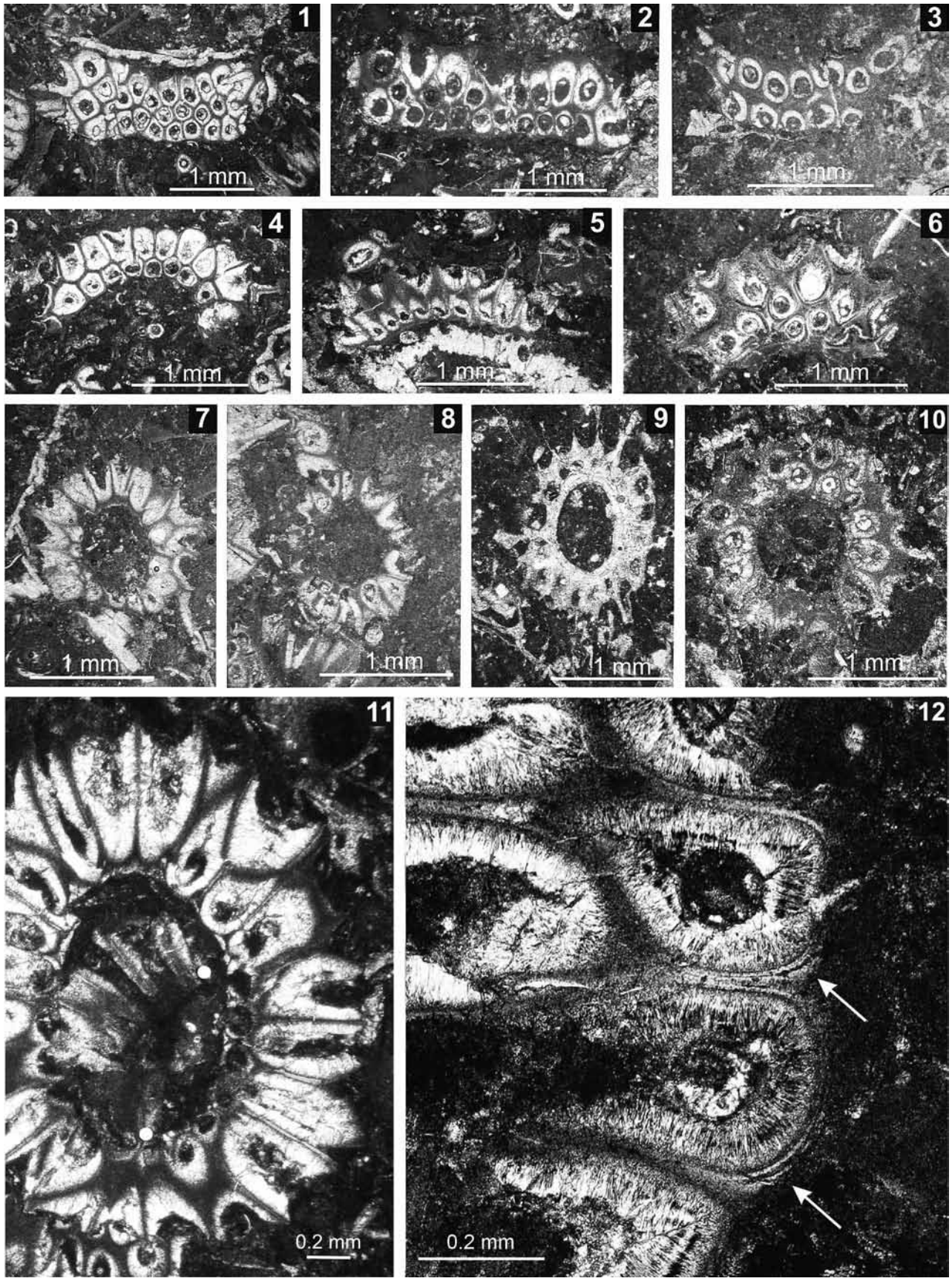
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PLATE VI

Figs. 1–7 *Clypeina teakolarae* sp. nov.

1 Detail of the transverse section with perfectly preserved impregnated calcite-micritic cell wall – of the main stem and of laterals. Main stem wall is separated from lateral's wall, also wall between laterals is separated (arrows 1–4), in part slightly fused, no losing individuality (arrow 2) or amalgamated (arrow 3). Thin section BJ2796-20.

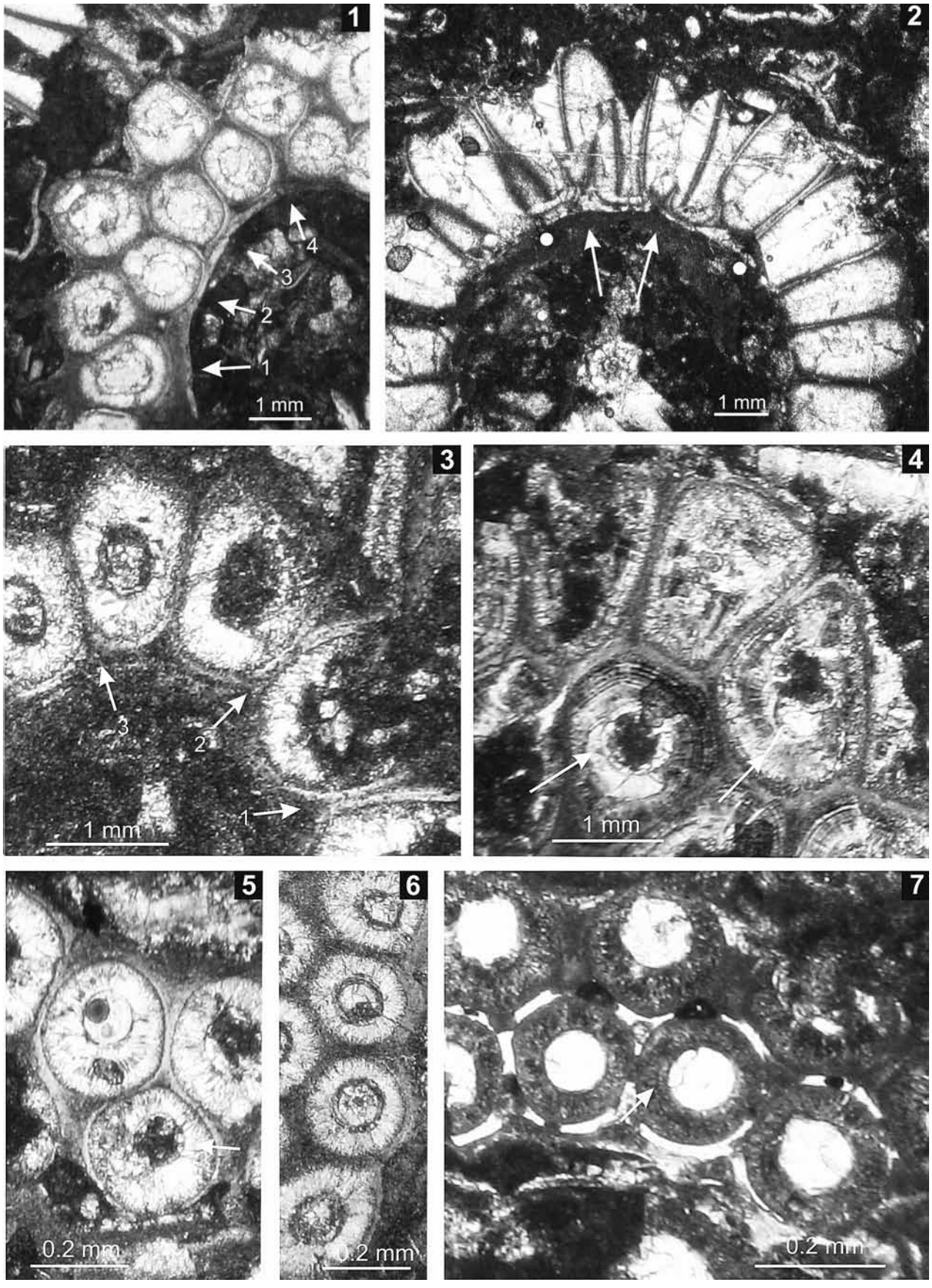
2 Transverse section cutting the lower whorl and a small basal part of the upper whorl (between the white dots). Part of main stem wall is visible, with incisions of two laterals (arrows). Notice a small foraminifer. Thin section BJ2796-34.

3 Detail of Fig. 11, Pl. IV, main stem wall faire discernible, wall of laterals individualized (arrow 1), more or less slightly fused (arrow 2) or reduced thin line (arrow 3). Thin section BJ2796-30.

4–6 Laterals in transverse section in which primary fibrous-micritic calcification is not entirely lost. Some of them are slightly or more pigmented, in some laterals calcite membrane of ampulla is preserved (arrows), in Fig. 6 calcite membrane of ampulla is pigmented. Notice well preserved impregnated wall of laterals. Thin sections BJ2796-10 and BJ2796-9.

7 Recrystallized intracellular calcification of this specimen, contrary to these in figs. 5 and 6 is more pigmented, also membrane of ampulla (barely discerned, arrow). Primary micritic, the wall of laterals are partially altered. Thin section BJ2796-42.

PLATE VI



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