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Acicularia tavnae sp. nov. and other Acetabulariaceae from the Palaeocene of eastern Majevica (NE Bosnia, Dinarides)

Acicularia tavnae sp. nov. i druge Acetabulariaceae iz paleocena istočne Majevice (SI Bosna, Dinaridi)

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Abstract

A rich assemblage of calcareous algae (Dasycladaceae, Acetabulariaceae) from Kamenjak limestone belt of the Majevica mountain gives the Palaeocene age of the sediments maintained so far for the Middle Eocene. Following the introduction of a new acicularian species – *Acicularia tavnae*, representatives of the family Acetabulariaceae are presented form the Kamenjak algal assemblage. The foraminiferal fauna also confirms the Palaeocene age of the Kamenjak limestones.

Kratak izvod

Bogata skupina krečnjačkih algi (Dasycladaceae, Acetabulariaceae) iz krečnjačkog pojasa Kamenjaka, istočna Majevica, daje paleocensku starost sedimentima koji su do sada smatrani za srednji eocen. Povodom uvodjenja nove acikularijske vrste – *Acicularia tavnae*, ovom prilikom se iz algalne skupine Kamenjaka prikazuju samo predstavnici familije Acetabulariaceae. Foraminiferska fauna takodje potvrdjuje paleocensku starost ovih sedimenata.

Introduction

Information on the Palaeocene in northern Bosnia was registered within a short time by Blanchet and Neumann (1967) and Stojčić (1968), and somewhat later by Jelaska et al. (1976). Palaeocene sediments of northern Majevica mountain, NE Bosnia, were documented by Hottinger and Drobne (1980) and Drobne (1984). In references (Čičić, 1968, 1877) and the Geological map of Yugoslavia (1970), Palaeogene sediments of eastern Majevica were included in the Eocene, although Čičić (1977) allowed that the lowermost part of »the First Eocene horizon« (= sandstone and marls of the Lower-Middle Eocene age; earlier: Middle Eocene) might be Palaeocene. The Middle Eocene age of Kamenjak limestone belt on eastern Majevica has not been questioned. But it was in this limestones that rich foraminiferal-algal assemblage of Palaeocene age (probably Thanetian) was found.

This note on the introduction of a new *Acicularia, A. tavnae* sp. nov., also gives information on other Acetabulariaceae from limestones of Kamenjak: *Clypeina elliotti* Beckmann & Beckmann, *Clypeina* aff. *haglani* Radoičić, *Clypeina* spp. and *Orioporella malaviae* Pia. Sampled limestones (from sequence of alternating limestones and sandstones about 20 metres thick) contained an abundance of dasycladaceae, *Cymopolia* in particular, and species of genera *Broeckella, Digitella, Dissocladella, Jodotella, Neomeris, Sarosiella, Trinocladus, Uteria* and other. The rich assemblage of dasycladaceae and geological data on the Kamenjak area will be considered in a separate paper.

Limestones of Kamenjak also bore a diverse foraminiferal fauna (Pl. 6, Figs. 1–7). Associated with neumerous miliolids and rotalids were the species *Mississippina binkhorsti* (Reuss) (sensu Samuel et al. 1972, Pl. 36, Figs. 1–4) and *Anatoliella ozalpiensis* Sirel, species recently described from the Middle Palaeocene of Turkey (Sirel, 1988), and found also in Palaeocene limestone of the Western Iraqi Desert subsurface (Radoičić, 1990).

Systematic descriptions

Family Acetabulariaceae (Endlicher) Häuck, 1885
Tribus Acetabularieae Decaisne, 1842
Genus *Acicularia* d'Archiac, 1843
Acicularia tavnae sp. nov.
Pl. 1, Figs. 1–7

Holotype: Specimen figured in Pl. 1, Fig. 1, transverse section through four ampullae, thin section RR-3449 (sample 021420), author's collection.

Isotypes: Sections shown in Pl. 1, Figs. 2–7, thin section RR-3449, RR-3440, RR-3452 and RR-3453.

Derivation of name: After river Tavna.

Age and type locality: Middle Palaeocene of Kamenjak area between villages Uzunovići and Presjeka, eastern Majevica mountain.

Diagnosis: Large reproduction disc. Elongated fertile ampullae laterally united with a thin lamella. Fertile ampullae circular in cross section. Consequently, lateral sides of the intermediate lamella are concave. Ampulla distally tapering, subconical. Interior of ampulla is filled with large sphaerical cysts, arranged in irregular rows, leaving very little room in the axial part of the ampulla. In transverse section through middle-distal part of ampulla, four cysts are showing, indicating an arrangement of cysts in four rows. The number of rows is increased to five, or even six, in the distal end of each ampulla. The relationship of cysts in rows is irregular.

Dimensions:

Diameter of the fertile ampulla (through middle-distal part) 0.360 – 0.440 mm

Diametr of the cysts 0.160 mm

Thickness of the intermediate lamella in the middle part 0.020 mm, at the disc surface 0.090 mm

Description: Available thin sections contained only fragments of a reproduction disc consisting of 3–4 ampullae at the most (Fig. 1). Transverse sections through these fragments were typically moniliform (Pl. 1, Figs. 1 and 2). The interior, between and around sphaerical cavities corresponding to cysts, was completely calcified.

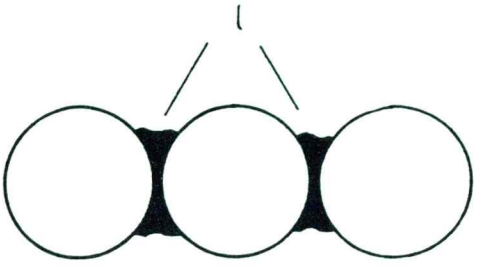

Fig. 1. *Acicularia tavnae* sp. nov. Moniliform aspect of the cross section through fused ampullae showing (black) intermediate lamella; after section figured in Pl. 1, Fig. 2

Contours of the ampulla lateral side, as well as intermediate lamella contours (Pl. 1, Figs. 1, 4, 6 and 7), and sometimes cyst contours (Pl. 1. Figs. 2 and 6) were lost due to recrystallization. Contour of lamella was only rarely discernible, like that in the section shown in Pl. 1. Fig. 2. Cysts obviously were sphaerical in shape: regular sphaerical cavities were commonly preserved with, in places, calcified thin cyst membrana (Pl. 1, Figs. 1, 2, 3 and 5). Various by sized cavities are showing in thin sections because some of them are cut on the diameter. Most of transverse ampulla sections showed four cysts each.

Relationship: Species of the genus *Acicularia* were distinguished primarily by the general shape of fertile ampullae and the shape of their distal ends (Génot, 1987, p. 127). Random sections in the thin sections were rarely informative of the shape of the ampulla distal end. *Acicularia tavnae* sp. nov. was compared with acicularies of similarly circular or oval ampulla cross section:

Acicularia pavantina d'Archiac (Génot, 1987, Pl. 19, Figs. 1–13) in contrast to *Acicularia tavnae,* has dominantly oval or, in t he proximal part, subcircular sections of ampullae, which are also elongated but thinner. Moreover, in the transverse section, it has more much smaller cysts arranged in the marginal part of the ampulla. Reproduction disc of *Acicularia tavnae* reached or even exceeded the size of *Acicularia pavantina* disc.

Palaeocene *Acicularia valeti* Segonzac (Segonzac, 1971, pl. II. Figs. 13, 14 and 17) had similar but smaller ampullae, only with numerous cysts alternately arranged in regular rows all over the ampulla periphery.

Highly similar with *Acicularia tavnae* cross section was the section of a proximal ampulla part of *Acicularia acuminata* Morellet with four much smaller cysts which filled up this part of the ampulla interior (Génot, 1987, Pl. 20, Fig. 13). Distally, the cysts were arranged only on the periphery increasing in number to twelve (Génot, 1987, Pl. 20, Figs. 11 and 12). Moreover, ampullae of *Acicularia tavnae* were much larger.

Ampulla of the Sarmatian species *Acicularia persica* Morellet had a circular shape in transverse section, only this ampullae were larger, cysts relatively smaller, more numerous and marginally located (Segonzac, 1967, Pl. 31, Fig. 5).

Acicularia tavnae sp. nov., which had a small number of cysts in the cross ampulla section, different much from acicullariae also in a small number of cysts in transverse ampulla section, such as *Acicularia archiaci* Morellet (4–7), *Acicularia herberti* Morellet (3–6), *Acicularia modesta* Génot (4–6) and *Acicularia munieri* Morellet (4–7) (Génot, 1987, Pls. 23, 17, 21 and 18).

Genus *Orioporella* Munier-Chalmas, 1877

Orioporella malaviae Pia

Pl. 2, Figs. 1–4, Pl. 3, Fig. 1

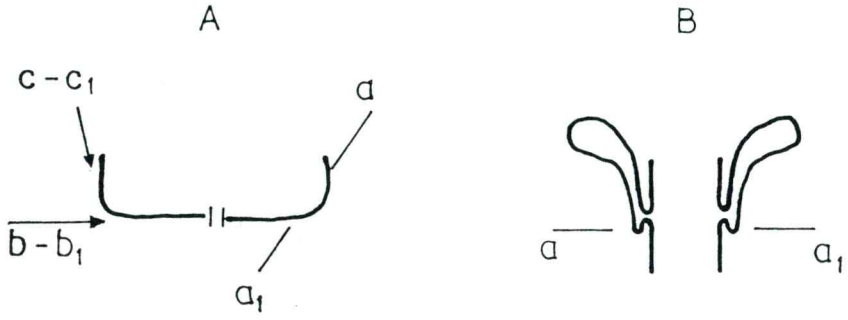

Fig. 2. A) Contour of the bowl-shaped *Orioporela* reproduction disc indicating the orientation of sections figured in Pl. 3, Fig. 1 (= $a - a_1$), Pl. 3, Fig. 1 (= $b - b_1$) and in Pl. 2, Fig. 3 (= $c - c_1$)

B) Vertical section of the *Clypeina elliotti* verticil: schematic appearance of the transverse cut through lower verticil part corresponding to section figured in Pl. 4, Fig. 12

A most interesting, among a dozen of *Orioporella* sections, was a tangential section of the reproduction disc shown in Pl. 2, Fig. 1. This and a tangential section through the disc proximal surface (Fig. 2; Pl. 3, Fig. 1) suggest a flat-bottom bowl-shaped reproduction disc composed of about sixty fertile ampullae (cf. upper disc in Pia's reconstruction of *Orioporella malaviae;* Pia, 1936, Fig. 43). It was a disc of about 10 mm or more in diameter; others were different sections of 5–10 ampullae which, in transverse sections through most of the ampulla length, had a variable rectangular shape (or oval in the distal part).

In his description of *Orioporella malaviae,* Pia showed an subaxial vertical section through two successive disc (1936, Fig. 33; Pl. 2, Fig. 4) and inferred "This may indicate, that a single plant bore more than one disc." Pia's reconstruction (1936, Fig. 43) of this species seems plausible: a plant did not bear only one disc, and the upper one/s could be bowl-shaped, while the lower one/s were much shallower or nearly flat. As to the number of fertile ampullae in a disc of *Orioporella malaviae,* this species seems to have no more than 64 ampullae. This reduced the differences between *O. malaviae* and *O. villattae* Segonzac: it is quite likely that this latter is a junior synonym of the *Orioporella malaviae* (perforations in septae of *O. malaviae,* mentioned by *Pia,* are a secondary feature connected with dissolution).

The same section of the bowl-shaped disc from Danian of the Western Aquitaine (France), as this shown in Pl. 2, Fig. 1, was attributed by Deloffre (1980, Pl. 3, Fig. 7) to foraminifer *Miniacina multiformis* Scheibner.

Tribus Clypeineae (Elliott, 1978) Bassoullet et al., 1979
Genus *Clypeina* (Michelin, 1845) Bassoullet et al., 1979
Clypeina elliotti Beckmann & Beckmann
Pl. 4, Figs. 1–14

Sections of *Clypeina* with distally enlarged lilyform verticils were not uncommon in thin sections of the examined limestones. The verticils consisted of elongated, distally gently widening branches, which were laterally fused forming the lilyform

verticil. Its distal ends of free branches were wide open. Various sections some of which are given in Pl. 4, Figs. 1–14, show how variable could be the size of verticil: the smallest to the largest size ratio was up to 1:2.4 or more. The number of branches to a verticil was rather constant, commonly 12–15. Verticil calcification was solid, in the lower calix in particular. The vertibils were found mostly isolated, or occasionally two successive verticils.

Beckmann & Beckmann (1966) described, from the Palaeocene of Cuba, the new species *Clypeina elliotti* with bowl-like verticils of 9–11 branches. These were sections of calcified verticils (up to 8 in a row), much recrystallized to offer sufficient data on the morphology in general, or basal part of branches in particular.

Clypeina elliotti was recognized in Thanetian limestones of the Pyrenees by Segonzac (1971, Pl. 2, Fig. 8; Pl. 3, Fig. 11), who mentioned more branches (12–20) per a verticil than readily seen in the illustrated sections.

Of similar morphology and size, but much better preserved than the Cuban *Clypeina elliotti*, was an alga from Palaeocene of Iraq introduced by Elliott (even having noted similarity with *C. elliotti*) as a new genus and species *Hamulusella sedalanensis* (Elliott, 1978, Pl. 3, Figs. 1–4). The species, and consequently the genus was suggested correctly, by Deloffre and Génot (1982, pp. 97–98), an association with Clypeinae. The hook-like basal part of a branch and its conection with the main axis were clearly visible in this Iraqi alga. Although this datum was not available for *Clypeina elliotti*, it is not unlikely for *Clypeina elliotti* to have had similar branches (which is typical of many Clypeinae). Neither the assumption that *Hamulusella sedalanensis* might be its younger synonym should be rejected. For this reason I think it opportune to ascribe these fossils to the *Clypeina elliotti*.

Clypeina elliotti from the Palaeocene of Majevica was better preserved than Cuban fossils. Sections clearly showing shapes of the basal parts of branches were missing also, though the hook-like form of branches was discerned in some sections (Pl. 4, Figs, 3, 5 and 12).

Among Clypeinae with lilyform verticils, *Clypeina croatica* (Gušić) resembled the most *Clypeina elliotti* (the resemblance of some oblique vertical and tangential sections: Gušić, 1967, Pl. 4, Figs. 3, 9 and 10). Vertical sections of recrystallized *Clypeina elliotti* verticils also resembled those of the Upper Triassic *Clypeina besici* Pantić which was different in other feature (Pantić, 1965, Pl. 1, Figs. 2 and 4).

Clypeina elliotti was not frequently mentioned, but seems to had been a species of large geographic distribution: It was presented from Palaeocene of China also (Mu Xinan, 1982, Pl. 12, Fig. 5: *C.* cf. *elliotti*, and Fig. 7: *Clypeina* sp.).

Clypeina aff. *C. haglani* Radoičić
Pl. 5, Figs. 1–5

Several different sections of a clypeina show its disc-like verticils with 18 branches very gently inclinated. Branches are tubular, circular in cross sections and laterally fused to half the length (where the widest). Calcified parts of branches do not seem to exceed 2/3 of the lengths.

In general form and size of verticil (Pl. 5, Figs. 1 and 2), this *Clypeina* shows the similarity with *Clypeina haglani*, a recently described species from the Palaeocene of Iraq (Radoičić, 1990), but also some differences. *Clypeina haglani* verticil is smaller in diameter and bears more thinner branches. The *Clypeina* from Majevica has closer-set verticils.

Clypeina spp.
Pl. 3, Figs. 2–4

Clypeinae are relatively rare fossils in dasyclad-rich limestone of Kamenjak. Besides the two mentioned species, only three more sections in the available thin sections belong to this genus, viz.:

– A vertical section of large clypeina (*Clypeina* sp. 1 – Pl. 3, Fig. 2). By asymetrical branches (in the vertical section) this probably new species is reminding of the much smaller Palaeocene *Clypeina liburnica* Radoičić (though some Cretaceous Clypeinae have a similar shape of branches);

– The section shown in Pl. 3, Fig. 3 (*Clypeina* sp. 2) also belong to an unidentified species that occurs in some Palaeocene limestones of the Outer Dinarides: on Kras and in the Adriatic littoral of Dubrovnik (Buser & Radoičić, 1987, Pl. 6, Fig. 1 – "*Clypeina* nov. sp."; Drobne et al., 1989, Pl. 2, Figs. 3 and 4), and

– A cross-section of a small verticil with six oval branches (*Clypeina* sp. 3, Pl. 3, Fig. 4) which either belongs to a minute clypeina or is the uppermost verticil of a somewhat large species.

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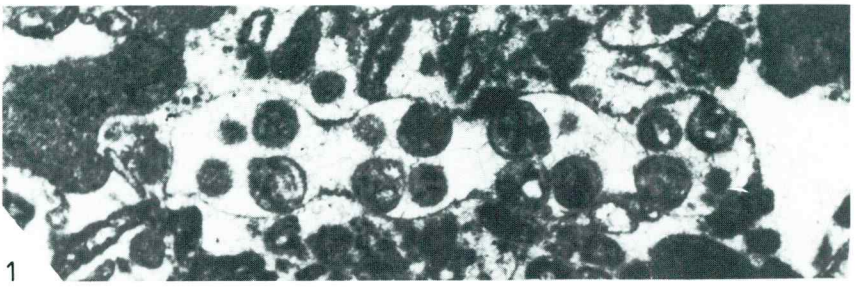
Plate 1

1–7 *Acicularia tavnae* sp. nov. (× 47.5)
Fig. *1* Holotype, cross section through four fertile ampullae, thin section RR-3449;
Figs. *2–7* Isotypes; Cross and cross-oblique sections – Figs. *2*, *4*, and *6*; oblique-longitudinal sections of ampulla – Figs. *3* and *5*; and Fig. *7* tangential-oblique section of the fragment with three ampullae; thin sections RR-3440, RR-3452, RR-3453, RR-3460 and RR-3462a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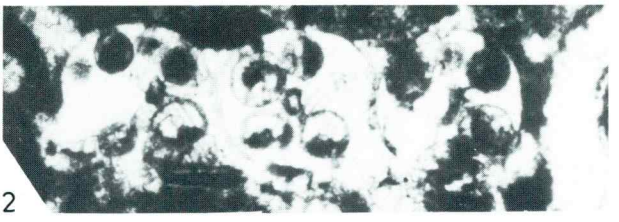
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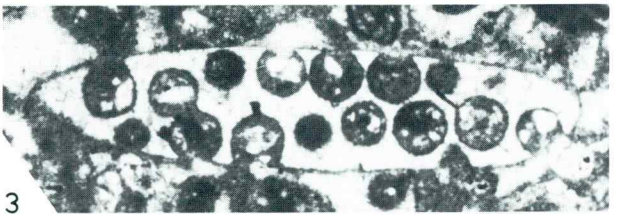
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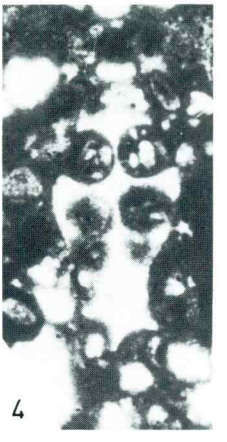
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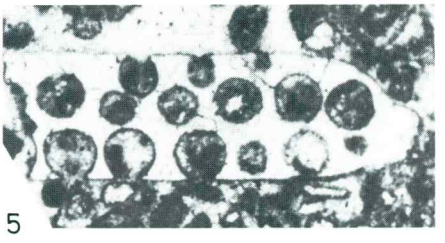
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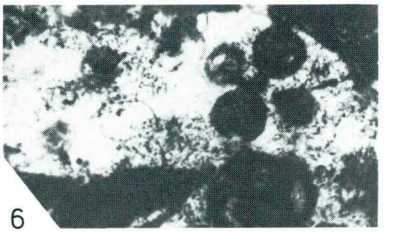
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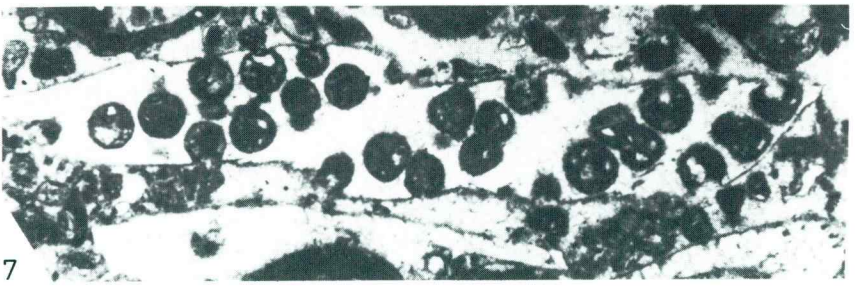
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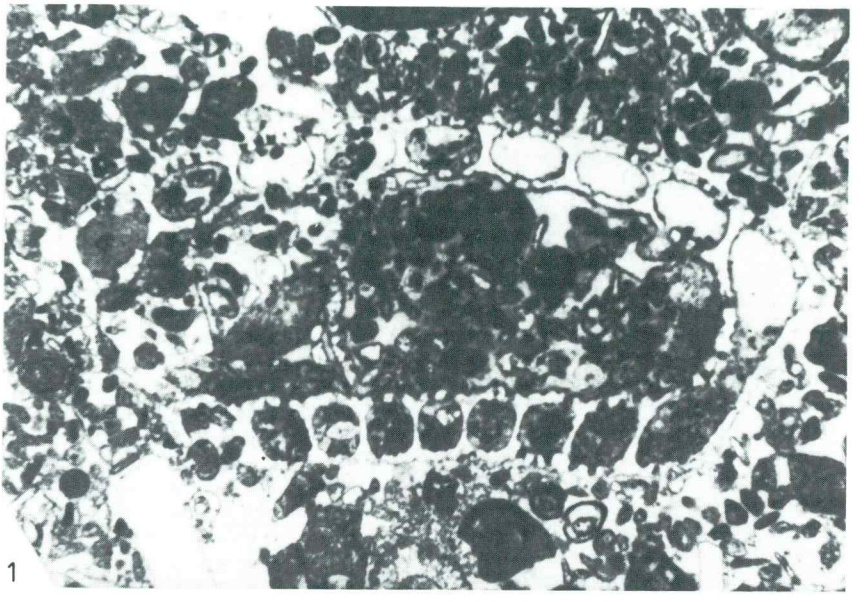
Plate 2

1–4 Orioporella malaviae Pia
Fig. *1* (× 25) tangential section corresponding to cut a – a_1 in the Fig. *2A*, thin section RR-3453
Fig. *2* (× 25) oblique tangential section, thin section RR-3450
Fig. *3* (× 30) tangential section corresponding to cut c – c_1 in the Fig. *2A*
Fig. *4* (× 45) cross section of the proximal disc part and *Terquemella* sp., thin section RR-3473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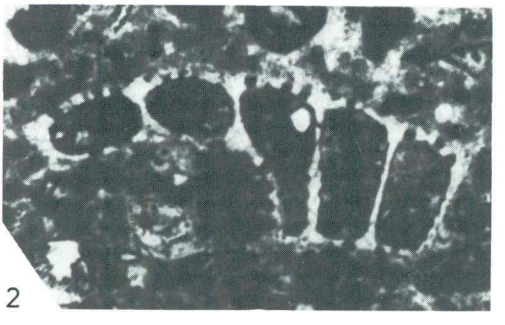
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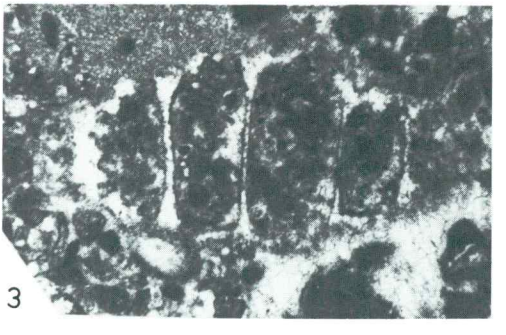
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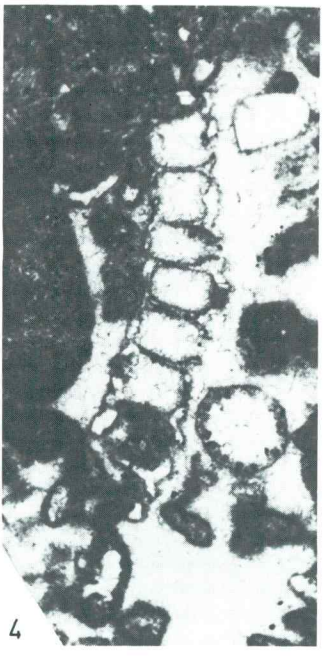
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Plate 3

1 *Orioporella malaviae* Pia (× 25), tangential section through the disc proximal surface corresponding to cut b – b_1 in the Fig. 2*A*, thin section RR-3462
2 *Clypeina* sp. 1, (× 25), vertical section, thin section RR-3450
3 *Clypeina* sp. 2, (× 25), oblique-longitudinal section, thin section RR-3453a
4 *Clypeina* sp. 3, (× 60), transverse section, thin section RR-3453a
5 ?*Clypeinina* (?*Actinoporella*) (× 47,5), tangential-oblique section of the verticil, thin section RR-3462a

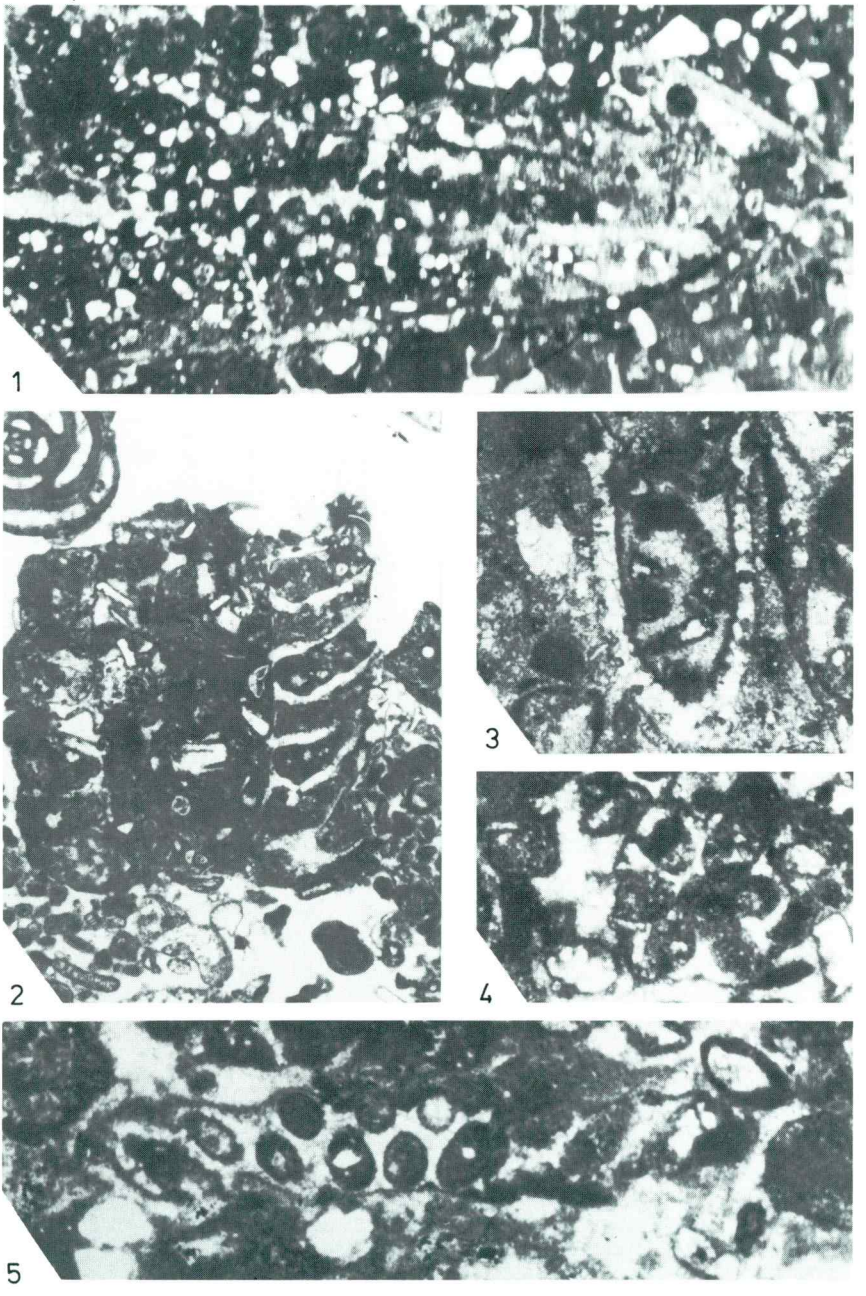
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Plate 4

1–13 *Clypeina elliotti* Beckmann & Beckmann (× 47.5: Figs. *1–2, 7–10* and *12*; × 50: Figs. *3, 5, 6, 12* and *13*); different sections; arrow in the Fig. *3* and Fig. *5* indicate hook-like basal part of branch; Fig. *11*: transverse section through basal hook-like part of branches corresponds to cut a – a_1 in the Fig. *2B*


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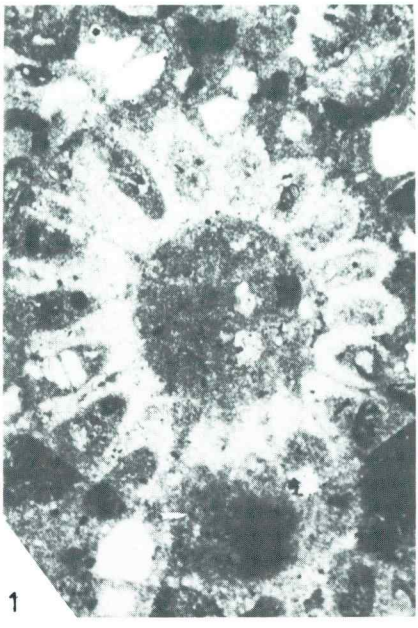
Plate 5

1–5 *Clypeina* aff. *Cl. haglani* Radoičić
(× 47.5: Figs. *1–2* and *4*, × 45: Figs. *3* and *5*), different sections, thin section RR-3460, RR-3452a, RR-3441a, RR-3438 and RR-3473a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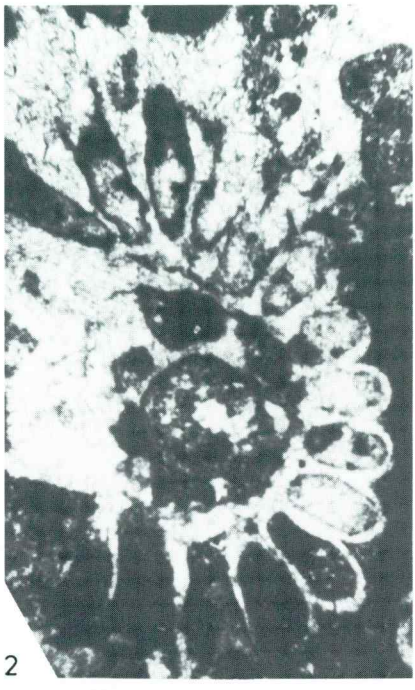
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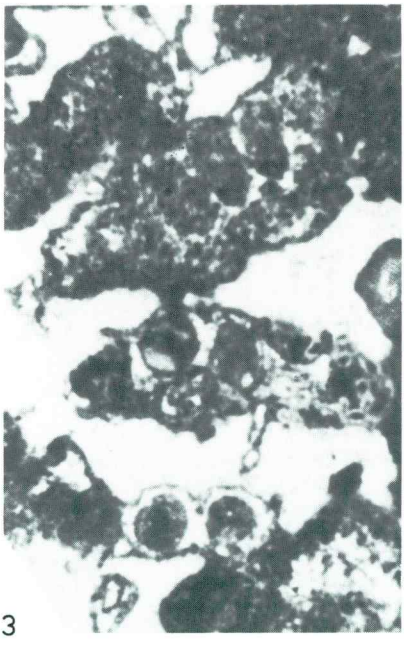
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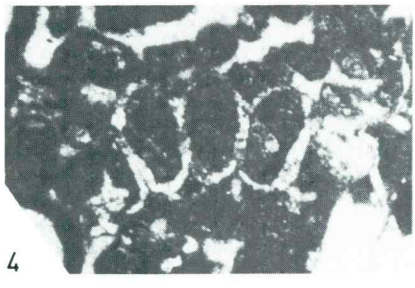
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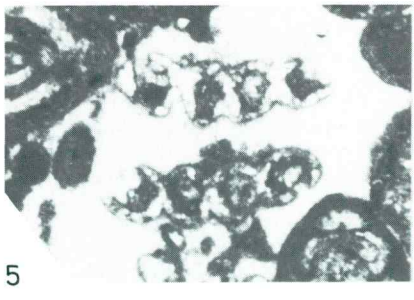
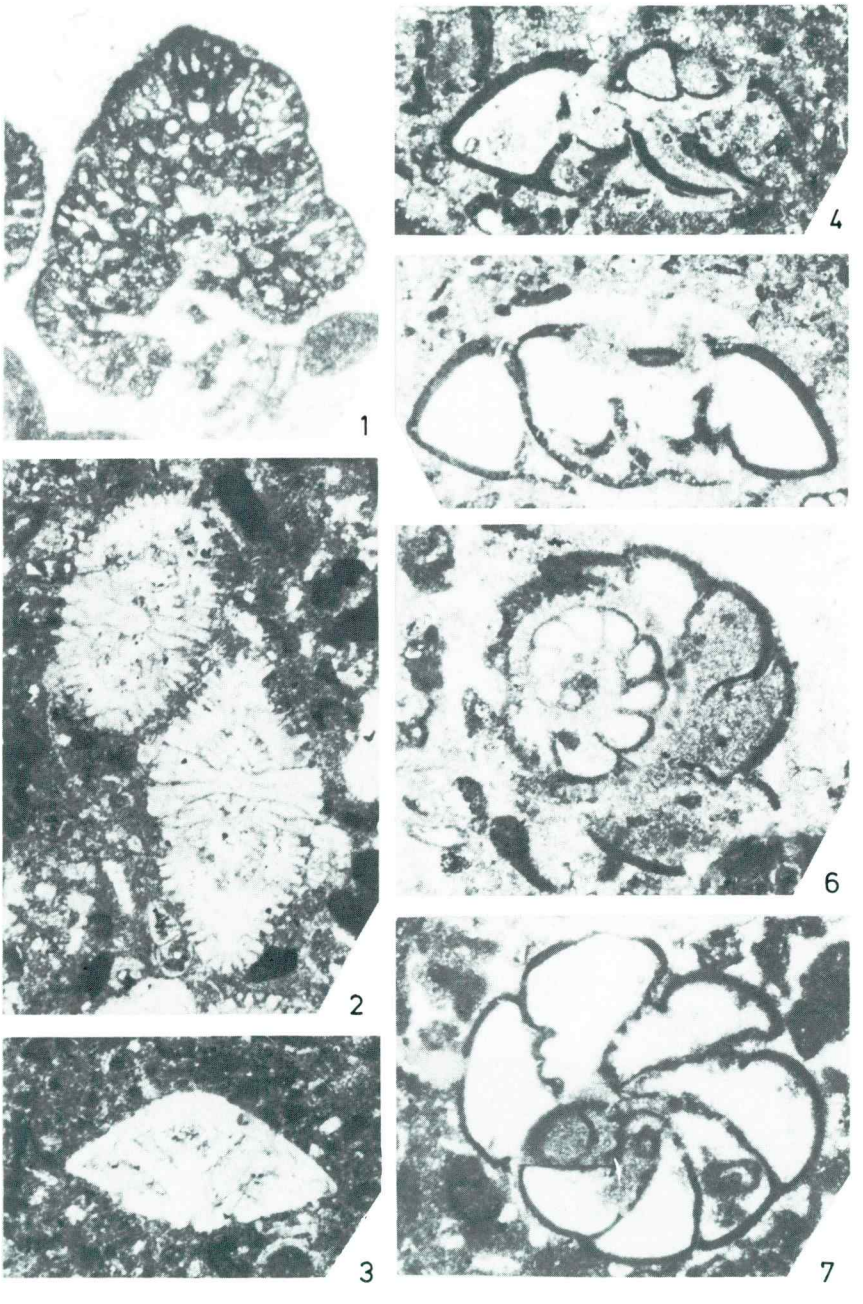

5

Plate 6

1–7 Foraminifera in the Palaeocene Kamenjak limestones (× 47.5)
Fig. *1 Anatoliella ozalpiensis* Sirel, thin section RR-3474a;
Fig. *2 Miscellanea* sp., thin section RR-3448;
Fig. *3 Rotalia perovalis* (Terquem), thin section RR-3431;
Figs. *4–7 Mississippina binkhorsti* (Reuss), thin sections RR-3453, RR-3431, RR-3448 and RR-3471a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