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New Dasycladales and microbiota from the lowermost Valanginian of the Mirdita Zone

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Abstract. A rich diversified algal microbiota is described from the lowermost Valanginian limestone reworked in the Upper Cretaceous clastics of the Metohija Cretaceous Unit (Mirdita Zone). Two new dasycladalean taxa are introduced: *Zujovicella* nov. gen. (type species *Suppiluliumaella gocanini* RADOIČIĆ, 1972) and *Furcoporella vasilijesimici* nov. sp.

Microbiota of this bioclastic limestone (containing dominantly corals and other metazoan fragments) consists of algae, microbial epiliths, microproblematica, foraminifera, calcispongie and a few calpionellids of the *Calpionellopsis* Zone – *Calpionellopsis oblonga* (CADISCH), *Remaniella cadischiana* (COLOM), *Tinntinopsella carpathica* (MURGEANU & FILIPESCU). Besides the new taxa dasycladales also associated are: *Salpingoporella pygmaea* (GÜMBEL), *Salpingoporella* sp., *Gyroporella lukicae* SOKAČ & VELIĆ, *Neomerinae* and several indetermined taxa. *Lithocodium aggregatum* (ELLIOTT), other encrusting *Lithocodioidea* and different microbial epiliths are an important component of this microbiota association.

Foraminiferal assemblage consists of: *Coscinophragma* cf. *C. cribrosum* (REUSS), *Mohlerina basiliensis* (MOHLER), *Nautiloculina bronnimanni* ARNAUD-VANNEAU & PEYBERNÈS, *Neotrocholina valdensis* REICHEL, *Neotrocholina* sp. *Placopsilina* sp., *Protopeneroplis trochangulata* SEPTFONTAINE, *Trocholina alpina* (LEUPOLD), *Trocholina delphinensis* ARNAUD-VANNEAU, BOISSEAU & DARSAC, *Trocholina* sp., lituolids, miliolids and other small benthic taxa.

The analyzed lowermost Valanginian limestone originated from the topmost sequence of the Tithonian–Neocomian cycle which ended as a consequence of the Main Cimmerian Events, which occerred, as in the Vardar zone, after the lowermost Valanginian. Cretaceous cycle (Mirdita Crtaceous Unit) begins in the Hauterivian.

Key words: *Dasycladales*, new genus, new species, *Udoteaceae*, *Codiaceae*, microproblematica, microbial epiliths, lowermost Valanginian, Late Cimmerian Events, Mirdita Zone.

Апстракт. Описана су два нова таксона дазикладалеса: *Zujovicella* nov. gen. (type species *Suppiluliumaella gocanini* RADOIČIĆ, 1972) и *Furcoporella vasilijesimici* nov. sp. из доњовалендиског кречњака – валутка у горњокредним кластитима Метохијске кредне јединице (Мирдита зона). Приказана је пратећа алгална микробиота (*Dasycladales*, *Udoteaceae*, *Codiaceae*), мибробијски епилити, микропроблематика и калциспонгије.

У разноврсној и богатој биоти овог валендиског кречњака доминантан је удио корала, инкрустирајуцих алги и микробиалита.У скупини дазикладалеса, поред више недетерминисаних врста, поменуте су: *Salpingoporella pygmaea*, *Salpingoporella* sp., *Gyroporella lukicae*. Листу фораминифера чине *Cosciniphragma* cf. *C. cribrosum*, *Mohlerina basiliensis*, *Nautiloculina bronnimanni, Neotrocholina valdensis, Neotrocholina* sp., *Placopsilina* sp., *Protopeneropli*s *trochangulata*, *Trocholina alpina*, *Trocholina delphiensis*, *Trocholina* sp., литуолиди, милиолиди и друге ситне бентоске врсте.

За датирање овог валутка најзначајније су калпионелиде – *Calpionellopsis oblonga* и *Remaniella cadischiana*. Оне указују да је овај седименат, који потиче из најмлађих слојева титон–неокомског циклуса, депонован у најнижем доњем валендису. На основу овог податка закључује се да главни кимеријски догађаји у подручју Мирдита зоне нијесу старији од најнижег валендиса. Према расположивим подацима кредни циклус (Метохијска кредна јединица) отпочео је у доба отрива.

Кључне ријечи: *Dasycladales*, нови род, нова врста, *Udoteaceae*, *Codiaceae*, микропроблематика, микробијски епилити, најстарији валендис, касни кимеријски догађаји, Мирдита зона.

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Introduction

Dasycladales *Suppiluliumaella gocanini* were described from Lower Valanginian limestone of the Orahovac region, Mirdita Zone (Fig. 1). In the locality between the villages of Kravoserija and Boka this limestone was not found in situ (RADOIČIĆ, 1972). According to the Geological Map, the sheet Orahovac 1:100 000 (LONČAREVIĆ, 1986), this area is covered by Upper Cretaceous carbonate clastics. On the footpath between the mentioned villages, in a small outcrop of 2–2.5 m thick clastics, horizontally arranged cobblestones in the microbreccia bed were observed. One of them (cobble of cca 15×12 cm) was limestone with large (to 6 cm) coral and other metazoan fragments. On the surface of broken pieces, in the matrix between large fragments (bioclastic packstone-rudstone), some dasycladalean, different coating algal and microbial structures and foraminifera, were observed under a lens. The matrix between large metazoan fragments was used for thin slides (17), in some of which sections of *Suppiluliumaella gocanini* were found.

The purpose of this paper was the revision of *Suppiluliumaella gocanini*, based on which *Zujovicella* nov. gen. is described, and the presentation rich associated biota including new dasycladalean species *Furcoporella vasilijesimici*.

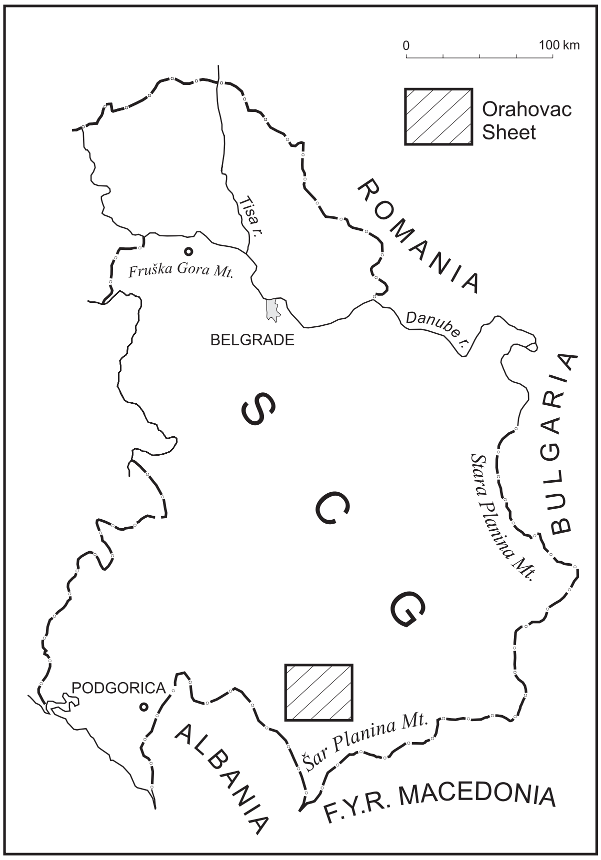

Fig. 1. Location map – sheet Orahovac 1: 100 000.

Kravoseria Coble

The studied limestone coble bears abundant diversified biota. Corals (different species) were its most important component, calcisponge, hydrozoa, mollusk and other metazoa remains were also present. The microbiota consisted of algae (*Dasycladales*, *Udoteaceae*, *Lithocodioidea*), microbial epiliths, foraminifera and miroproblematica; while calpionellids were represented by only a few specimens. The corals were an especially alluring substrate for encrusting algae and similar microbial epiliths. Other metazoan remains and dasycladales were also the subject of epilithic activity.

The list of foraminifera includes: *Coscinophragma* cf. *C. cribrosum* (REUSS), *Mohlerina basiliensis* (MOHLER), *Nautiloculina bronnimanni* ARNAUD-VANNEAU & PEYBERNÈS, *Neotrocholina valdensis, Neotrocholina* sp., *Placopsilina* sp., *Protopeneroplis trochangulata* SEPTFONTAINE, *Trocholina alpina* (LEUPOLD), *Trocholina* cf. *T. delphinensis* ARNAUD-VANNEAU, BOISSEAU & DARSAC, *Trocholina* sp., lituolids, miliolids and other small benthic taxa.

The presence of calpionellids is important for the dating of this coble: *Calpionellopsis oblonga* (CADISCH) (Fig. 2A), *Remaniella cadishiana* (COLOM) (Fig. 2B) and *Tintinnopsella carpathica* MURGEANU & FILIPESCU indicate its lowermost Valanginian age (*Calpionellopsis* Zone).

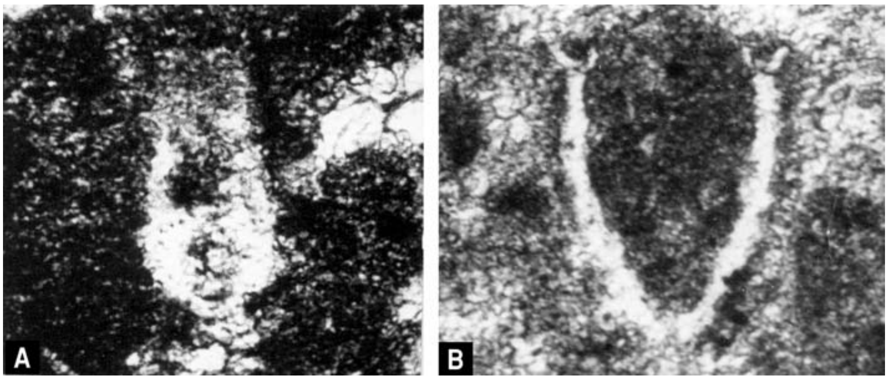

Fig. 2. **A**. *Calpionellopsis oblonga* (CADISCH). × 360; thin slide RR2186. **B**. *Remaniella cadischiana* (COLOM). × 360; thin slide RR2190.

This Valanginian limestone originates from the youngest sediments of the Tithonian–Neocomian cycle, which ended as a consequence of the Main Late Cimmerian Events. A new Cretaceous cycle begins discontinuously in Hauterivian (Metohija Cretaceous Unit). Valanginian shallow water limestone in the area of this cretaceous unit was not known in situ. Resedimented benthic biota of this age occurs in some microbreccia and calcarenite beds of the proximal basinal Tithonian–Neocomian succession, outcropping in the same area.

Valanginian limestone with corals as the essential component and *Zujovicella gocanini* was deposited in the reef thallus area.

Paleontology

Observation on *Suppiluliumaella gocanini* RADOIČIĆ, 1972

The genus *Suppiluliumaella* ELLIOTT, according to the original diagnosis, is characterized by "verticils of long thin primaries with a large conspicuous terminal swelling, each dividing into very short swollen secondaries".

The calcareous sheet of the holotype (ELLIOTT, 1968, Pl. 3, Fig. 1) is micritized, whereas secondary laterals are not well preserved. The presence of secondaries are discernable only at two or three points in this section. The paratype in Fig. 3 is an oblique section corresponding to an inclination of the stalky portion of primaries, while the secondary laterals, in central part of the fragment, were cut obliquely – therefore it is not their real length (they are not so short). The impression that the secondary laterals of some *Suppiluliumaella* species grow out from primaries in the form of a finger-like continuation (SOKAČ & NIKLER, 1983) is not a primary feature – it is only apparent (see BARATTOLO, 1984).

At first sight, *Suppiluliumaella gocanini* (densely set funnel-like whorls built of very long tubular primary laterals which touch each other over a considerable part of their length and form terminal swellings; primaries carry at their ends tufts of the secondary laterals) resembles only the type-species *Suppiluliumaella polyreme*. In fact it differs from any known *Suppiluliumaella* species by having:

1. Larger (wider and longer) primary laterals, with apparent terminal swellings;
2. Quite different, trochophorous secondary laterals which could be extended hairy growth. In other species, although not fully preserved, secondary laterals are described as phloiophorous (ELLIOTT, 1968; BAKALOVA, 1971; DRAGASTAN, 1978, 1989; BARATTOLO, 1984).

These differences are the reason for the doubt as to whether this species belongs to the genus *Suppiluliumaella*. Reexamination of *Suppiluliumaella gocanini* type material (and some new sections) led to the conclusion that this species is not a *Suppiluliumaella*. The primary laterals are only apparently terminated by a "swollen" portion. In fact, a tuft of trochophorous secondaries starts from the top of the tubular primary laterals, enclosing a fertile ampulla. These characteristics indicate the affiliation of this species to the tribus *Dasycladeae*.

Order Dasycladales
Family *Dasycladaceae* KUTZING, 1843
Tribus *Dasycladeae* PIA, 1920
Subtribus *Neomerinae* (PIA, 1927) BASSOULLET *et al.*, 1978

Genus ***Zujovicella*** n. gen.

Type species. *Suppilluliumaella gocanini* RADOIČIĆ, 1972

Origin of name. The genus is dedicated to Prof. JOVAN ŽUJOVIĆ (1856–1936), founder of geology in Serbia and the author of the first geological map of Serbia printed in Vienna 1886.

Diagnosis. Cylindrical or club-shaped thallus with densely set whorls, unfertile whorls can also be present. The fertile whorls consist of densely arranged cylindrical primary laterals each giving a second whorl segment: tufts of trochophorous secondary laterals and a fertile ampulla situated in the center of the tuft. Surface of the calcareous sheet indentated.

Comparisons. The genus *Neomeris* has a cylindrical to clavate thallus, ampulla and two secondary laterals placed in one plane, the thallus surface is faceted. *Cymopolia* has an anarticulated thallus and primaries with ampulla and 4–8 secondary laterals enlarged at the outer ends forming a faceted surface

Zujovicella gocanini (RADOIČIĆ, 1972) nov. comb.
Fig. 3; Pl. 1, Figs. 1–6; Pl. 2, Figs. 1–8

Diagnosis. A large slightly club-shaped thallus of differentiated structure – with a lower unfertile part. A wide central cavity. Densely set funnel-like whorls consisting of close-fitted laterals inclined upward at an angle of 65 to 75° from the horizontal. The long and large rounded at the top cylindrical primary laterals bear a large ooidal fertile ampulla and a tuft of 5 or 6 long trochophorous secondary laterals around the ampulla (Figs. 3, 4). Calcareous skeleton compact, mainly around the distal part of the whorls. The surface of the skeleton is indentated due to the trochophorous form of the second whorl segment.

Dimension (in mm) (based on some additional sections than in 1972; the slightly oblique, deep-tangential section of the holotype is not relevant for the D and d values).

Maximum observed length 11.7.
External diameter 2.593–6.500.
Diameter of central cavity 1.605–3.700.

Axial diameter (reconstruction) about 20 to 25° of D.
Length of primary laterals more than 1.600.
Diameter of primary laterals 0.192–0.320.
Length of secondary laterals to 1.440 or more.
Dimensions of the fertile ampulla 0.240 × 0.450.
Number of primaries per whorl 18–32.

Fig. 3. *Zujovicella gocanini* (RADOIČIĆ) nov. comb. Oblique section of the second whorl segment: laterals protecting a fertile ampulla; × 60; thin slide RR2199.

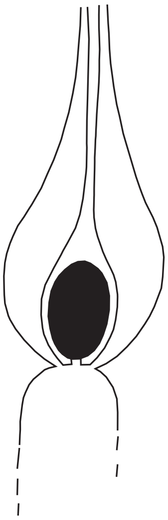

Fig. 4. *Zujovicella gocanini* (RADOIČIĆ) nov. comb. Axial section of the top part of the primary laterals bearing a fertile ampulla and secondary laterals (reconstruction).

Description. It seems that not every whorl in the fertile portion of the thallus is fertile. The fertile ampulla, placed in the center of the rounded at the top primaries, is protected by secondary laterals of a peculiar trochophorous form (Figs. 3, 4; Pl. 2, Fig. 4). Starting as a tubular of 0.048 mm diameter, the secondary laterals become largest (0.160 mm) at the middle of the length, closing the ampulla and distally thinning (Pl. 2, Fig. 4) probably extending in a hairy growth. The cross and oblique sections of the distal tuft portion have a coptocampylodon form (Pl. 2, Fig. 7; Pl. 8, Fig. 10).

The inner part of the thallus – main axis and first segment of the whorls – is usually not calcified. According to a reconstruction, the main axis was narrow, probably not wider than 25% of the external diameter. Calcification was limited to the distal area of the whorls, diminishing toward the interior.The membrane of the primaries, partly preserved in only some specimens, was very thinly calcified (Pl. 1, Figs. 1, 3). The membrane of the fertile ampulla and secondaries was also thinly encrusted (visible as a thin dark line in diverse sections). In fact, the compact calcareous skeleton is formed by a calcified mucilage layer around the secondaries (Pl. 1, Figs. 3, 5; Pl. 2, Figs. 4, 5). Secondary sparry calcite had deposited (before the sheet was coated) mainly in the secondaries and sometimes in the ampulla or inside the primaries. In the slightly oblique deep-tangential section (holotype, Pl. 1, Figs. 1, 3–4), differently preserved second whorl segments are visible. Its different aspect depends also on the cut plane. Hence, for slightly recrystallized segments (= ampullae and basal parts of the secondaries shown in Pl. 1, Fig. 4, arrow 1) it can be wrongly interpreted that the ampulla ("swelling") bears finger-like short secondaries. A similar apparent relation between the ampulla and "short" secondaries is shown by arrow 2. Tangentially cut primaries and tufts are indicated by arrow 3.

The indentated skeleton surface was usually eroded and often corroded by microbial epiliths. The corroding effect in some specimens appears to have been locally arrested. In such cases it seems that the epiliths even contributed to the preservation of some structure by protecting the skeleton from further erosion and dissolution and moderating the effect of further diagenetic processes.

Neomerinae div. sp.
Pl. 4, Fig. 5

Neomerinae are a minor component in this Valanginian algal association. Only an oblique section of a compact cylindrical skeleton (*Drimella*?) and a small fragment of another species have been found. The fragment shown in the same plate Fig. 6, could be related to *Neomerinae*.

Family *Triploporaceae* (Pia 1920) Berger & Kaever, 1992

Tribus *Salpingoporelleae* Bassoullet *et al.*, 1979

Genus ***Furcoporella*** Pia (*in* Trauth), 1918

The genus *Furcoporela* was introduced by Pia from the Middle Eocene in Austria with the species *Furcoporella diplopora* (Pia, 1918). The simple cylindrical thallus of this species is characterized by spaced whorls of horizontally disposed two orders of laterals. The primary laterals are short, divided into two divergent secondaries enlarged to the exterior. Hitherto, the genus was monospecific. (Based on the characteristic of a new species, upward inclined laterals, diagnosis of thus genus should be amplified).

Furcoporella vasilijesimici n. sp.

Pl. 3, Figs. 1–3

Origin of name. The species is dedicated to Dr Vasilije Simić (1902–1990), one of the pioneers of modern geology and paleontology in Serbia.

Holotype. longitudinal oblique section shown in Pl. 3, Fig.1, thin slide RR2190, the author's collection deposited in the Geozavod – Geological Institute in Belgrade.

Isotypes. Specimens in thin slides RR2184 and 2201 figured in Pl. 3, and two poorly preserved specimens in thin slides RR2186 and 2189.

Age. Lowermost Valanginian, based on calpionellids: *Calpionellopsis oblonga*, *Remaniella cadishiana*, and *Tintinnopsella carpathica*.

Diagnosis. Thallus cylindrical with a relatively large axis and spaced whorls consisting of two order of laterals inclined upward, alternating from one whorl to the next. Short primary laterals divided in two vesicular secondaries, slightly swollen at the distal end. Secondary laterals are in a somewhat irregular, oblique position. Calcification is massive, from the axis to the subcortical area.

Dimension (in mm):
Maximum observed length (holotype) 5.440.
Inner diameter 0.740–0.988.
External diameter 1.974–2.024.
Distance between whorls cca 0.370.
Length of primary laterals 0.080.
Length of secondary laterals 0.480.
Distal diameter of secondary laterals 0.096.
Number of primary laterals per whorl 16–18.

Description. The peculiarity of this species lies in the position of the secondary laterals which is reflected in more advanced corrosion and dissolution in some parts of the skeleton. The upward inclined secondaries are irregularly disposed, more in the distal area. They are arranged in an oblique to radial plane, which is evident in the transversal or slightly oblique-transversal sections (Pl 3, Figs, 2 and 3).

Comparison. The thallus structure of this species differs from *Furcoporella diplopora* in having inclined laterals, i.e. funnel like whorls and a different position of the secondaries.

Genus ***Salpingoporella*** Pia, 1918

Salpingoporella pygmaea (Gümbel)

Pl. 4, Fig. 4

This species is represented by a few specimens only.

Salpingoporella ? sp.

Pl. 4, Fig. 10

Fragment of the oblique section showing a specimen with regularly arranged dense whorls of primary laterals (35 or more per whorl).

Genus ***Gyroporella*** Gümbel 1872, emend. Benecke, 1878

According to Bassoullet *et al.*, (1978), the genotype *Gyroporella vesiculifera* is a species with "Aspondyl disposition of laterals of one single order of vesiculiferous type".

Zanin-Buri (1965) in a study of carbonate algae from Trias of the Lombardian Pre-alpes presented very well preserved euspondyle specimens of *Gyroporella vesiculifera* from the Norian of the Dolomites (imprints on a rock surface and sections in thin slides: Pl. 46, Figs. 1, 2, and Pl. 47). In these specimens "I pori sono fittamente and omogeneamente disposti tanto che sono in contatto gli uni cogli altri, la loro disposizione e cosi regolare che si puo trovare un perfetto allineamento in file orizzontali, verticali e diagonali."

As to the disposition of the laterals (aspondyle or euspondyle) see discussion by Barattolo *et al.* (1993). According these authors, the possibility should not be excluded that the genera *Gyroporella* and *Griphoporella* Pia are synonyms, which could be resolved by revision of *Gyroporella vesiculifera* type material.

Gyroporella lukicae Sokač & Velić, 1982

Pl. 3, Figs. 4–10

Gyroporella lukicae, described from the Lower Aptian of Bosnia (Sokač & Velić, 1982), is one of the largely distributed species in Lower Cretaceous starting from Berriasian. Often, it is present in fragments only.

According to the original description, the thin calcareous skeleton is perforated by numerous pores (23–30) of vesiculiferous laterals which "tending to be arranged in more or less clearly marked whorls with approximately alternating neighbouring whorls which are not always clearly visible"

SENOWBARI-DARYAN *et al.* (1994), considering that the genus *Gyroporella* is aspondyle, proposed new combination: *Anisoporella lukicae* (SOKAČ & VELIĆ). The comparison with *Anisoporella* has not been justified. The genus *Anisoporella* has an entirely different structure: "L'arrangement des rameaux se fait en general par serie de deux (= double verticilles) come chez *Oligoporella*. "L'alternance des rameaux est presque la regle, mais les pores sont tantot disposes en quinquonce, tantot par paires, tantot par groupes de trios. Ces trois modes de distribution se retrouvent alternativement sur le meme manchon, dans un ordre de succession quelconque" (BOTTERON, 1961).

In the Kravoseria limestone coble, *Gyroporella lukicae* is a relatively frequent fossil (cylindrical skeleton and numerous fragments), and of very variable dimensions. Besides specimens which correspond to the type material, there are larger forms with densely set more numerous laterals in the whorls (Pl. 3, Figs. 8, 10). The peculiarity of the specimen in Pl. 3, Fig. 9 is the supraterminal growth (note: evidently thinner and denser laterals at top of the rounded thallus).

Dimensions (in mm; extreme values given in brackets):

Bosnia (type locality)	Kravoserija
D = 1.75–3.07	D = 1.13–2.40 (3.52)
d = 1.11–2.48	d = 0.80–1.76 (2.88)
w = 23–30	w = 22–36 (56)

Dasycladales div. sp.

The analyzed thin slides contain some unknown dasycladalean, mainly in fragments. They are, distinguished by symbols *KL1* to *KL8*, illustrated in Pl. 4. Figs. 1–3, 6–9 and 11.

Morphogenus ***Coptocampylodon*** (ELLIOTT, 1963) LJUBOVIĆ-OBRADOVIĆ & RADOIČIĆ, 2003

Three different *Coptocampylodon* morphospecies occur in this limestone: *Coptocampylodon* cf. *fontis* (Pl. 7, Fig. 8), *Coptocampylodon* sp. 1 (Pl. 7, Fig. 7) and *Coptocampylodon* sp. 2 (Pl. 4, Figs. 12, 13).

Order Bryopsidales
Family *Udoteaceae* (ENDLICHER) AGARDH, 1888

Genus ***Pinnatiporidium*** DRAGASTAN, 1990

Pinnatiporidium sp.
Pl. 9, Figs. 3–6

The transverse section of *Nipponophycus ramosus* illustrated by SENOWBARY-DARYAN *et al.* (1994) in Pl. 7, Fig. 3, and the transverse section of *Nipponophycus* sp. illustrated in the same plate, Fig. 8 have a clearly lobed periphery. These specimens differ from numerous *Nipponophycus* talli presented in the same paper in Pl. 7. Poorly preserved, recrystallized specimens of this type are found in the studied thin slides. Some oblique sections, such as those illustrated in Pl. 9, Figs. 3–6, indicate a segmented morphology of the thallus (short hemispherical somewhat irregular flabelliform segments) These sections are very similar to the oblique section of a segmented thallus showed by SANOWBARY-DARYAN *et al.* (1994) in Pl. 5, Fig. 15 as *Pinnatiporidium* sp. cf *Pinnatiporidium cylindricum* DRAGASTAN.

The genus *Pinnatiporidium* is characterized by a segmented thallus with superficial constrictions and segments with three distinct zones: central, lateral (with two types of branching) and cortical (DRAGASTAN, 1990). As shown by the illustrated specimens, these structures are generally not observable due to poorly preserved or recrystallized thalli; the central medular zone was not preserved, while relatively large, second order branches are visible only in the section on Pl. 9, Fig. 4, while treads of thin branching of the cortical zone can be soon on the same plate, Fig. 5.

Genus ***Felixporidium*** DRAGASTAN, 1999

Felixporidium ? sp.
Pl. 9, Fig. 8

The thallus of *Felixporidium*, "built of bush-like hemispherical segments or flabellae," crossed by a large medullary siphon which, in every segment, is followed by two order siphons (filaments) "branched dichotomically and disposed radially". *Felixporidium* is related to *Pinnatiporidium* DRAGASTAN, 1990 by the similar form and structure of the thallus. The differences between the two genera a the generic level is an open question.

In the longitudinal-oblique section of the illustrated specimen, the flabelliform arranged three order laterals appertaining to successive segments are well preserved. Similar flabelliform branching can be discerned on the poorly preserved specimen of *Felixporidium alpidicum* DRAGASTAN, 1999, illustrated in the original publication on Pl. 6, Fig. 8. This species, according to DRAGASTAN, has an inner morphology which is very close to *Pinnatiporidium cylindricum*, (type species of the genus).

Genus ***Nipponophycus*** YABE & TOYAMA, 1928

Nipponophycus ramosus YABE & TOYAMA, 1928
Pl. 9, Figs. 1–2

The few specimens assigned to this species with a cylindrical branching thallus are strongly recrystallized: the medulare zone is represented by a narrow cavity, while the structure of the internal zone is completely obliterated.

Family *Codiaceae* (TREVISAN) ZANARDINI, 1843
Subfamily *Lithocodioidea* BANNER, FINCH & SIMMONS, 1990

Lithocodium aggregatum (ELLIOTT, 1956), BANNER, FINCH & SIMMONS, 1990
Pl. 5, Figs. 1–8; Pl. 6, Figs. 1–4; Pl. 8, Fig. 6

The encrusting alga *Lithocodium aggregatum* characterized by a high degree of variability in both: the thallus morphology and, especially, the internal structure (ELLIOTT, 1956; BANNER *et al.*, 1990). The *Lithocodium* nodules are usually formed by superimposed thalli. This is, certainly, the green alga with the most variable features. Therefore, it seems justified, as noted by BANNER *et al.*, that the genus *Lithocodium* "may subjectively be monotypic".

In the same *Lithocodium* thallus, different arrangements the structure of the medulla and cortex can be observed. The specimen illustrated on Pl. 5, Fig. 4 has one type of *Lithocodium* structure developed only in a part of the growth: a coarse medula followed by some order of variously ramifing filaments, ending with short fine cortical filaments covered by a thin calcareous sheet (Fig. 7 shows detail of Fig. 4). Laterally, this structure grades into a somewhat reduced subcortical zone similar to those of the thallus in the Fig. 3, or grades in a part of the thallus, apparently "terminated" without these structures.

The narrow elongate growth (aspect in the section!) on Pl. 5, Fig. 3 has, immediately below the cortical structure, relatively large septate filaments of the medulla. Here, the ramification is reduced: large medulla filaments immediately give numerous very short fine cortical (bifurcate?) filaments terminating in a thin well preserved calcareous sheet

Solitary corals are usually encrusted by a *Lithocodium* or other *Lithocodioidea* crust and more or less corroded (Pl. 6, Figs. 3, 4,); often it is superimposed by a new *Lithocodium* or another encrusting growth.

The large (cca 30 mm), very irregular, ramified nodula incorporating corals, calcispongia and other bioclasts is, in fact, a mélange of *Lithocodium*, other *Lithocodioidea* and different microbialites (Pl. 6, Figs. 1, 2, 7a, b; Pl. 7, Figs. 1–5). Growth of these organisms is so interweaved that its boundaries are impossible to define. Colonia of *Koskinobullina socialis*, rodophycean alga and encrusting calcispongia (Pl. 7, Figs. 1, 2, 5) were present only in short episodes before further *Lithocodium* growth. On the surface of *Lithocodium* and other *Lithocodioidea*, in some places, thin microbial crusts developed, some of them are illustrated on Pl. 6, Fig. 7, and on Pl. 7, Fig. 3.

Elements encased and more or less corroded by *Lithocodium* are metazoan, their fragments, foraminifera, dasycladales, other algal and problematic structures and different rock grains. The corroding process can results in a more or less disintegrated substratum. It seems that disintegration is usually not an effect of only *Lithocodioidea* activity but also of some preceding microbial chasmoendoliths. For example, in the pores between the skeleton elements of corals and hydrozoa encrusted by *Lithocodioidea*, the earlier activity of microbial chasmoendolith is evident.

Lithocodium aggregatum is one of the widely distributed fossils (Upper Jurassic – Albian, BANNER *et al.*, 1990) particularly in the Lower Cretaceous limestone of both Tethyan margins. In the analyzed limestone, *Lithocodium aggregatum* and similar encrusting growth are important components.

Lithocodioidea KL11
Pl. 9, Fig. 9

The thin compact crust of the only specimen in the available thin slides is characterized by thin bifurcate filaments, perpendicular or subperpendicular to the surface. Similar crust ("aff. KL11") is shown in Fig. 10 on the same plate

Lithocodioidea KL12
Pl. 8 Fig. 2

Agglomeration (encased in *Lithocodium*) of thin-walled, subcircular and irregular rounded cells is the single specimen of this type of structure.

Lithocodioidea KL13
Pl. 8, Fig. 1

A crust with a peculiar subcrustal structure is part of the superimposed growth on *Lithocodium*.

Incertae Sedis (algae)

"Tubiphytes" morronensis CRESCENTI, 1969
Pl. 9, Fig. 7

The enigmatic fossil "*Tubiphytes*" *morronensis* was widespread in the Upper Jurassic and Lower Cretaceous reef areas of both Tethyan margins. Many of those specimens represent a differentiated axial "nubeculariform" part from a coated growth (probably of microbial nature). This taxon is not frequent in the Kravoserija limestone.

"Gryphoporella" perforatissima CAROZZI, 1955
Pl. 3, Fig. 9 p. p.

Poorly preserved dissolved and/or recrystallized specimens of a relatively thin skeleton with a large axial cavity, perforated by numerous fine pores, are ascribed to this CAROZZI's species. According to BASSOULLET *et al.* (1978), dasycladalean affinity of this species is doubtful.

Fossils related to CAROZZI's species were described as *Gryphoporella piae* by DRAGASTAN in 1971, then, based on the same specimens, finding similarity with *Trinocladus pinarensis* KEIJZER, DRAGASTAN in 1978 introduced a new genus *Pseudotrinocladus*. The doubt in the dasycladalean nature of this species seems justified. This fossil could be related to udoteacean algae.

Microproblematica KL15
Pl. 8, Fig. 7

The small claviform corpuscles with a thin regularly reticulate wall are parts of a larger structure.

Family *Wetheredelidae* VACHARD, 1977

Genus ***Koskinobullina*** CHERCHI & SCHROEDER, 1979

Koskinobullina socialis CHERCHI & SCHROEDER, 1979
Pl. 7, Figs. 1, 2 p. p.

Koskinobullina socialis is interpreted as "small vesicular individuals forming colonies of varying dimensions which are fixed upon a substrate" "either as solitary individuals or, more frequently, in the form of crust-like agglomeration" (CHERCHI & SCHROEDER, 1984).

Lithocodium and similar structures alternate with crust-like *Koskinobullina* agglomerations as those shown on Pl. 7, Fig. 1. In the same plate, Fig. 2, the colonia of *Koskinobullina socialis* is covered by rodophycean alga.

Microbial epiliths and other microbiota

Microbial epilith KL16
Pl. 6, Fig. 6

Lammelar (stromatolithic) microbial buildup with fine horizontal filaments. The same structure in Fig. 1, also developed on *Lithocodium aggregatum* nodula, is poorly preserved and is not clearly visible in this photograph.

Microbial epilith KL17 and KL18
Pl. 8, Figs. 3, 4

The microbial crust coating of an about 7.2 mm long bioclast seems homogeneous without a clear internal structure (except for a few large pores). On the upper side of the bioclast the microbial crust is thicker with a tuberculate surface (Pl. 8, Fig. 3). Meanwhile, on the photograph made at low exposition, two different organisms are evident. In the first thin encrusting micritic layer (KL17, calcisponge? crust, Fig. 4) perpendicular to the surface, wedge-like spicules with upward oriented wider ends were noted (wedge-like form of spicules could be apparent!). This even thick layer was encrusted by microbialite of a tuberculate surface (KL18, Fig. 4) in which a fine tubular filamentous tissue could be discerned.

The thin crust of atuberculate surface, in Fig. 8 on plate 6, corroding a mollusk shell has large pores only in the figured part of the growth. Excluding this element of the structure, the tissue of the crust seems similar to that of the microbialite KL18.

Microbial epilith KL19
Pl. 7, Fig. 3

On a part of a, *Lithocodium* mélange nodula, a fine complex crust was developed. It consists of a barely discernible, densely porous micritic tissue covered by thin porous calcitic lamina.

Microbial epilith KL20
Pl. 6, Fig. 7 a, b

On the same melange nodula, in two parts, a crust of fine, chain-like, slightly interlaced threads were developed. They are longitudinal sections of fine tubules of 0.016 mm diameter. In Fig. 7b transversal sections of tubules are visible.

Microbial epilith KL21
Pl. 6, Fig. 5

Two growth phases of this microbialite corroding hydrozoan skeleton are evident: epilithic and chasmoendolithic in the skeleton pores.

Microbial chasmoendolith KL22
Pl. 8, Fig. 8

In this case, the pores in the *Cladocoropsis*? skeleton has been lined by the microbial chasmoendolit.

Calcisponge (or ***Lithocodioidea***?) KL23
Pl. 8, Fig. 9

A small micritic thallus with aninsufficiently clear internal structure – sponge spicules?

Calcisponges, usually not well preserved, in the analyzed limestone are more abundant than immediately apparent. Some of them are illustrated on Plates 7 (*Aka* sp.).

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Резиме

Нове Dasycladales и микробиота из доњовалендиског кречњака Мирдита зоне

Приказане је богата алгална и друга микробиота из доњовалендиског кречњака – валутка нађеног у горњокредним кластитима Метохијске кредне јединице. Из овог валутка била је описана дазикладалеска врста *Suppiluliumaella gocanini* Radoičić, 1972, која је сада, на основу додатног материјала, детаљније проучена. То је резултирало увођењем новог рода, *Zujovicella*, који је посвећен проф. Јовану Жујовићу, оснивачу геологије у Србији и аутору прве геолошке карте Србије. Такође је описана и нова врста рода *Furcopporella* посвећена др Василију Симићу – *Furcoporella vasilijesimici*.

Zujovicella n. gen. (типска врста *Suppiluliumaella gocanini* Radoičić, 1972).

Дијагноза: Цилиндричан или кијицаст талус са густим пршљеновима фертилних али и стерилних огранака. Фертилни пршљенови састоје се од густо сложених цилиндричних примарних огранака који носе други сегмент пршљена: праменове трохофорних секундарних огранака са фертилном ампулом у средини. Површина кречњачког омотача назубљена.

Род *Zujovicella* разликује се од родова *Neomeris* и *Cymopolia* по томе што род *Neomeri*s има два секундарна дистално проширена огранка по примарном и фасетирану површину скелета, а што род *Cymopolia* има чланковит талус са 4–8 дистално проширених огранака који такође формирају фасетирану површину.

Furcoporella vasilijesimici n. sp.

Дијагноза: цилиндричан талус са релативно пространом аксијалном осом и одвојеним пршљеновима према оси нагнутих огранака. Кратки примарни огранци дају по два весикуларна дистално заобљена огранка, они леже у равни косо постављеној према аксијалној равни. Калцификација масивна, од централне осе до дисталног дијела огранака.

Furcoporella vasilijesimici разликује се од врсте *Furcoporella diplopora* по љевкастим пршљеновима односно по положају огранака – они леже у равни која косо сијече аксијалну раван.

Асоцијацију дазикладалеса чине још *Griphoporella lukicae*, *Salpingoporella pygmaea*, *Salpingoporella* sp., *Neomerinae*, као и више неодређених таксона (фрагменти 10 врста). Осим корала и других метазоа, значајну компоненту овог биокластичног кречњака чине представници *Lithocodioidea* и микробиалити.

Старост валутка, најнижи доњи валендис, одређена ја на основу калпионелида: *Calpionellopsis oblonga* и *Remaniella cadischiana*

У подручју Метохијске кредне јединице валендиски кречњаци нијесу познати *in situ*. Анализирани валутак потиче из најмлађих слојева титон неокомског циклуса. Најстарији седименти кредног циклуса (Метохијска кредна јединица) отривске су старости.

Plate 1

Figs. 1–6. *Zujovicella gocanini* (Radoičić, 1972) nov. comb.

1. Holotype, slightly oblique deep-tangential section; × 15.5; thin slide RR2196.
2. Transversal section, fragment coated by a microbial epilith, arrow: transversal section of the tuft with a fertile ampulla in the center; × 17.5; thin slide RR2188.

3–5. Details from Fig. 1; × 35; 3–4: note the different preservation of the laterals in successive whorls.

6. Tangential-oblique section through secondary laterals and topmost part of the primary lateral; × 50; thin slide RR2199.


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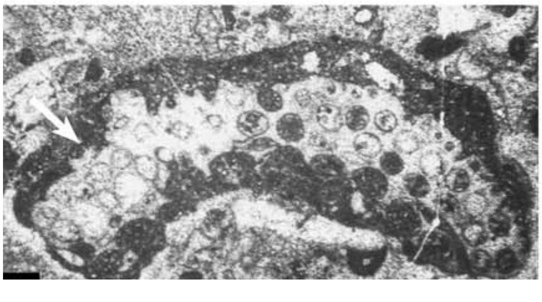

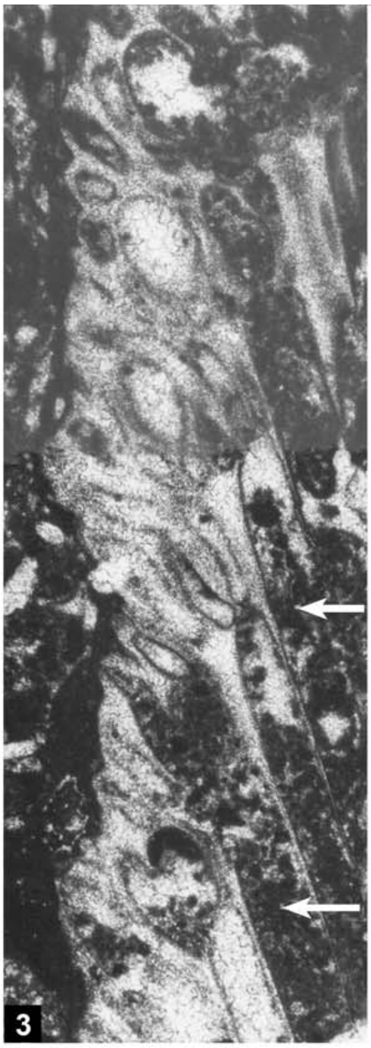
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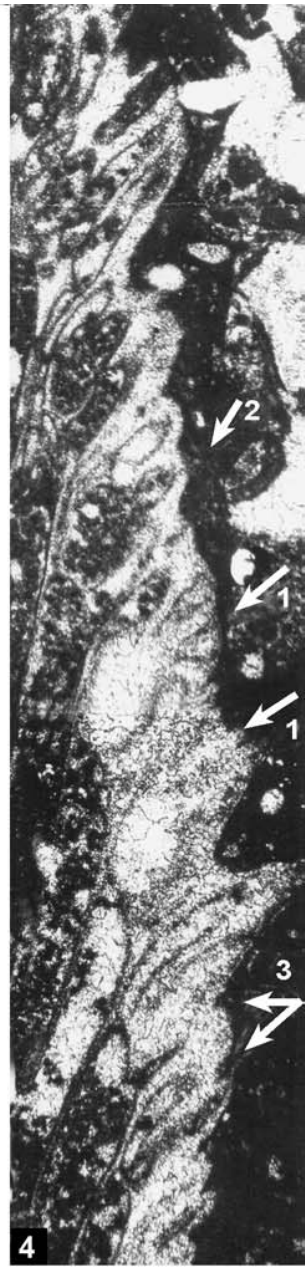

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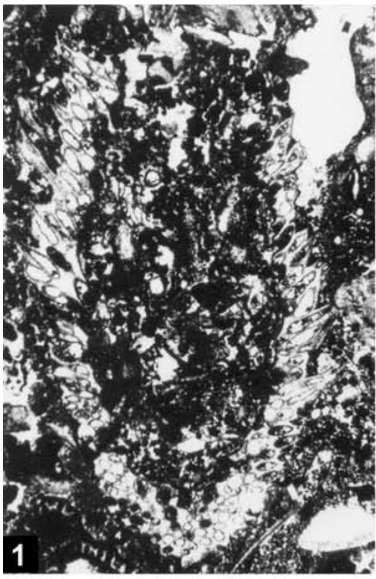
Plate 2

Figs. 1–8. *Zujovicella gocanini* (Radoičić, 1972) nov. comb.

1. Oblique section of the largest specimen; × 7.5; thin slide RR2200.
2. Oblique section; × 20; thin slide RR2187.
3. Oblique section; × 15; thin slide RR2194.
4. Longitudinal-oblique section of the second whorl segments; note: tuft of secondaries with, between them, a tangentially cut fertile ampulla; × 40; thin slide RR2188.
5. Transversal section; × 15; thin slide RR2199; note: a thin black line of the calcified membrane of secondaries, and, around them, calcified mucilage. On the right an encrusting foraminifer *Placopsilina* sp. Microbial endolith partly superimposed by *Placopsilina* (arrow); the axial surface of the calcareous sheet more corroded.
6. Tangential-oblique section through primary laterals; × 30; thin slide RR2193.
7. Different oblique section of tufts (coptocampylodon form); × 20; thin slide RR2199.
8. Transversal slightly oblique section of a poorly preserved specimen; × 20; thin slide RR2187.

Fig. 9. *Coptocampylodon* sp. Shallow tangential section through a distal part of tufts of secondary laterals (aff. *Zujovicella*); × 30, thin slide RR2195.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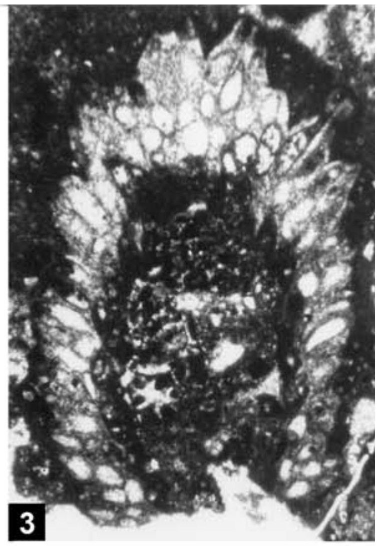
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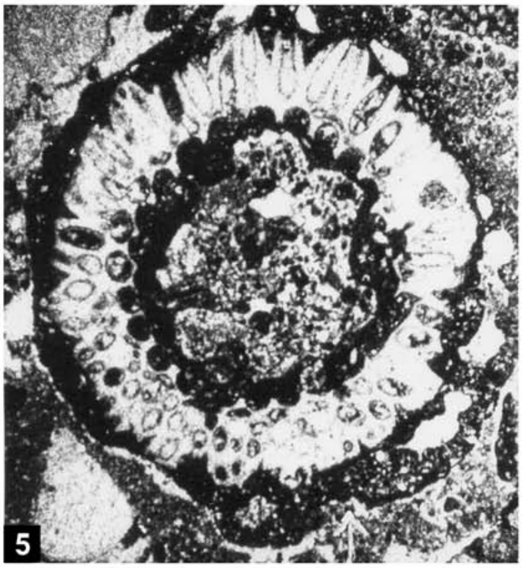
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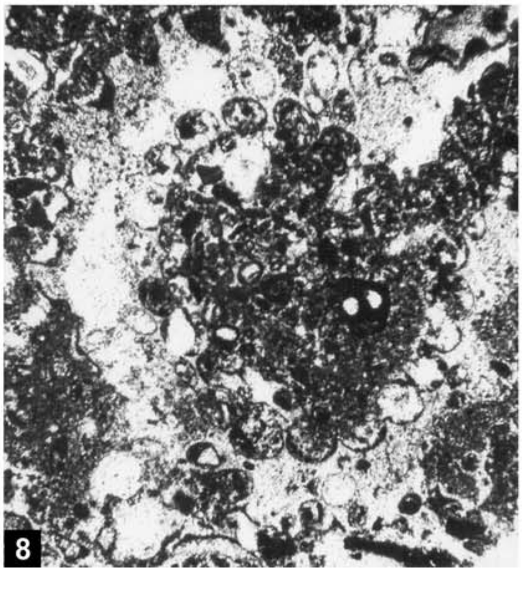
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Plate 3

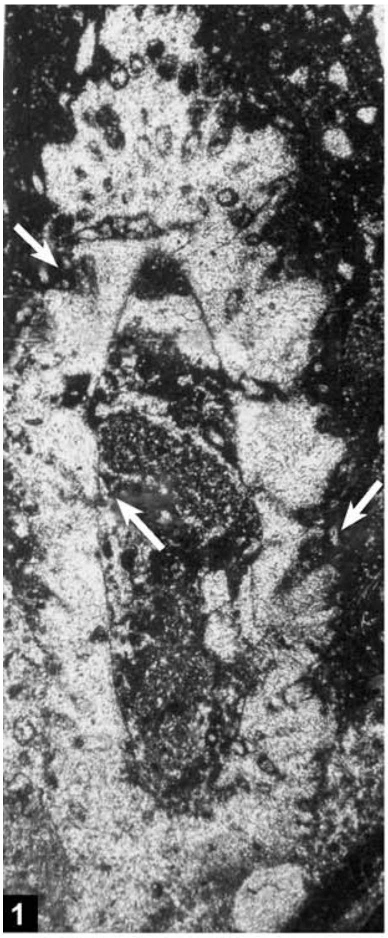
Figs. 1–3. *Furcoporella vasilijesimici* nov. sp.

1. Holotype, longitudinsal-oblique section, × 25, thin slide RR2190; arrow 1 = short primary and secondary laterals, arrow 2 = claviform secondary laterals.

2, 3. Transversal slightly-oblique sections; × 20; thin slides RR2184. 2201, arrows: position of the secondary laterals in pairs.

Figs. 4–10. *Gyroporella lukicae* Sokač & Velić, 1982.

4, 5, 7–10; × 20; 6, × 15; thin slides RR2188, 2185, 2192, 2186, 2193, 2200, 2200. Note in the Fig. 9 (arrow): smaller and denser laterals at the rounded top of the thallus below supraterminal growth; upper left: a part of a section of "*Gryphoporella*" *perforatissima*.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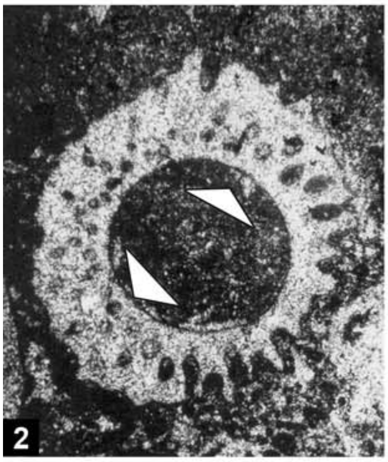
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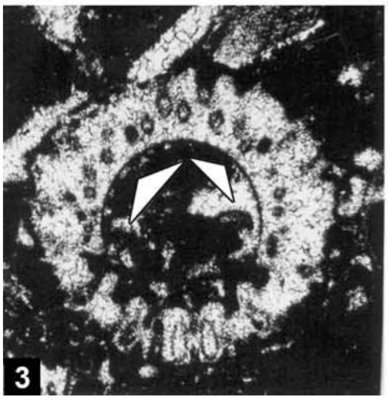
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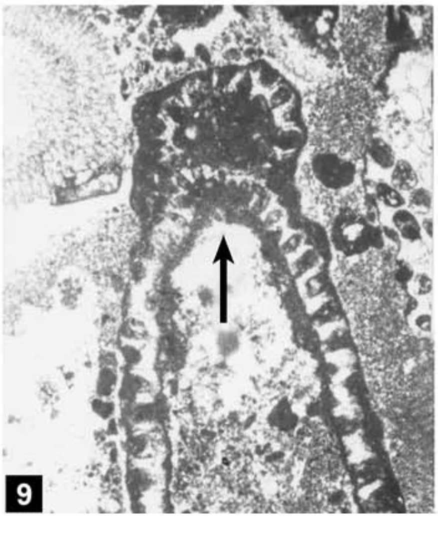
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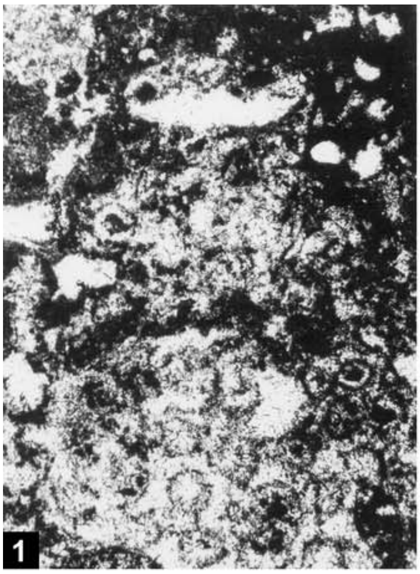
Plate 4

Figs. 1, 2.	*Dasycladales* KL1 and KL2. × 30; thin slides RR2201, 2190.
Fig. 3.	*Dasycladales* KL3 (*Suppiluliumaella*?). × 17.5; thin slide RR2194.
Fig. 4.	*Salpingoporella pygmaea* (Gümbel). × 35; thin slide RR2189.
Fig. 5.	*Neomeris* (*Drimella*?). × 30; thin slide RR2195.
Fig. 6.	*Dasycladales* KL4, *Neomerinae*? × 30; thin slide 2197.
Fig. 7.	*Dasycladales* KL5. × 20; thin slide RR2197.
Fig. 8.	*Dasycladales* KL6. × 30; thin slides RR2190.
Fig. 9.	*Dasycladales* KL7. × 20; thin slide RR2197.
Fig. 10.	*Salpingoporella* sp. × 60; thin slide RR2195.
Fig. 11.	*Dasycladales* KL8. × 20; thin slide RR2197.
Figs. 12, 13.	*Coptocampylodon* sp. 2. × 30; thin slides RR2200, 2201.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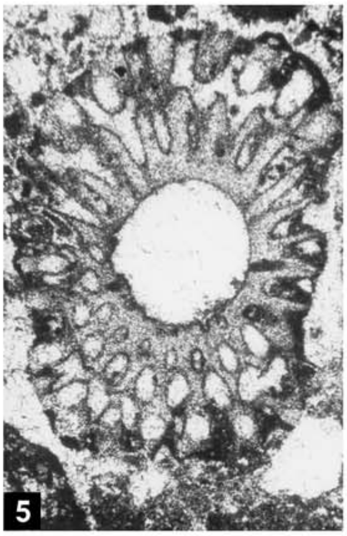
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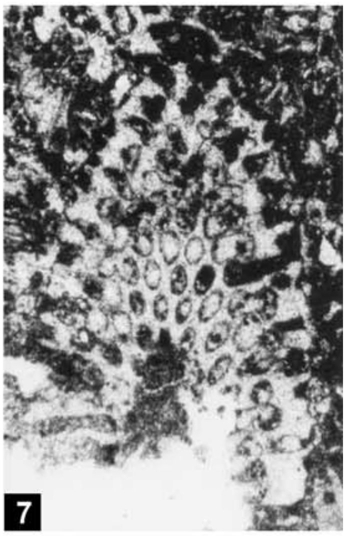
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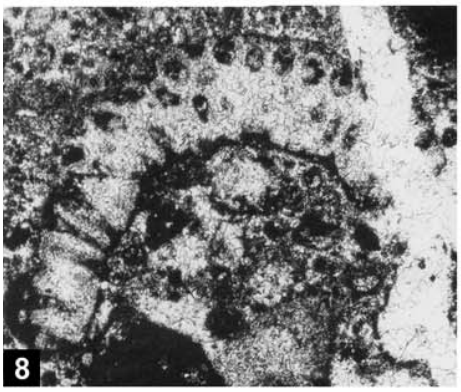
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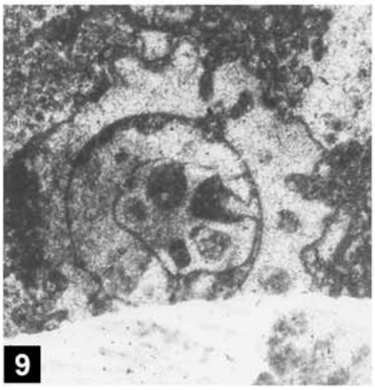
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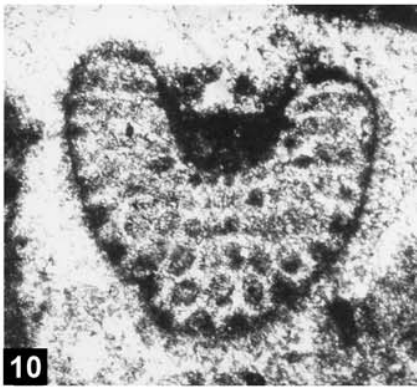
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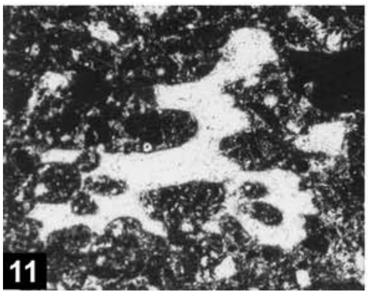
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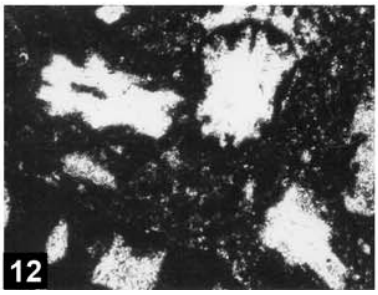
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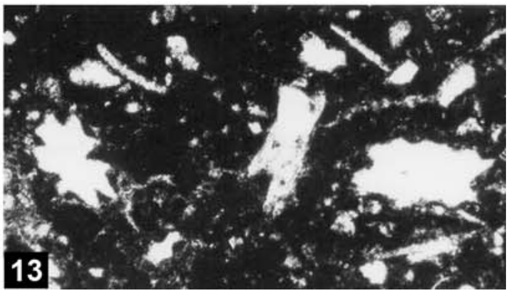
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PLATE 5

Figs. 1–8. *Lithocodium aggregatum* (ELLIOTT, 1956) BANNER, FINCH & SIMMONS.
1. × 25; thin slide 2188.
2. × 30; thin slide RR2195.
3, 5, 7. × 20; thin slide RR2190.
4. × 15; RR2190, arrow 1 = detail shown in Fig. 7; arrow 2 = medulla similar to those in Fig. 3.
6. × 30; thin slide RR2184.
8. × 15; thin slide RR2201.


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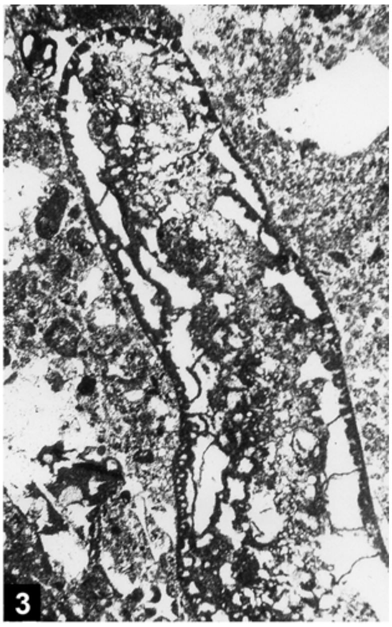
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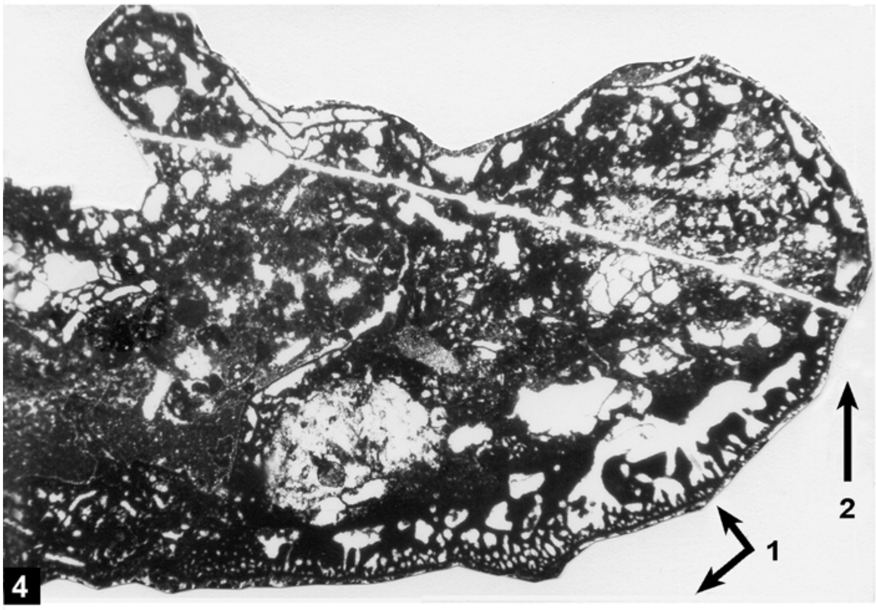

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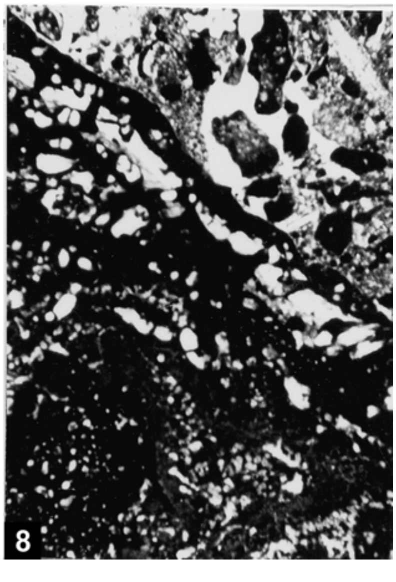
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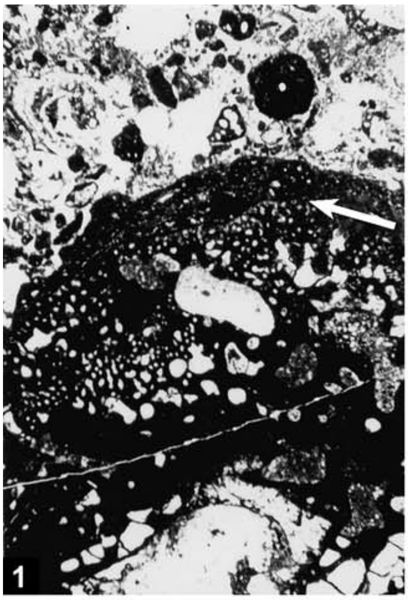
PLATE 6

Fig. 1.	*Lithocodium aggregatum* (ELLIOTT) BANNER, FINCH & SIMMONS. × 12.5; thin slide RR2191; arrow = boundary with microbialite KL16.
Fig. 2.	*Lithocodium aggregatum* (ELLIOTT) with micritic crust (KL20, not visible in this photograph); upper righ t= *Protopeneroplis trochangulata* ARNAUD-VANNEAU & PEYBERNÈS; × 30; thin slide RR2191.
Fig. 3.	Microbial crusts (arrow) englobed in *Lithocodium*. × 15; thin slide RR2189.
Fig. 4.	Coral encrusted and corroded by *Lithocodium* (part of the same melange nodula shown in Fig. 1). × 15; thin slide RR2189.
Fig. 5.	Microbialite (in advanced phase chasmoendolith) KL21. × 30; thin slide RR2199.
Fig. 6.	Microbialite KL16, (stromatholitic crust on *Lithocodium*). × 35; thin slide 2201.
Fig 7a, b.	Microbialite KL20, longitudinal and transversal section of tubules. a = × 35; b = × 90; thin slide RR2191.
Fig. 8.	Microbialite, growth partly aff. KL18. × 30; thin slide RR2198.
Fig. 9.	Algal? encrusting structure. × 30; thin slide RR2199.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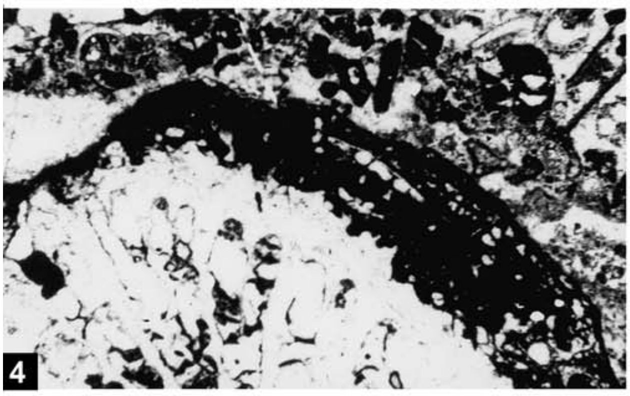
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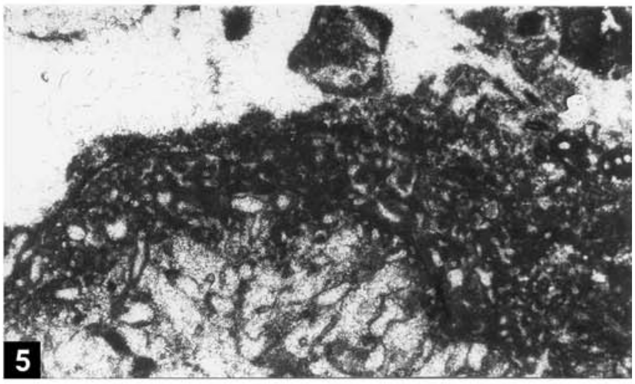
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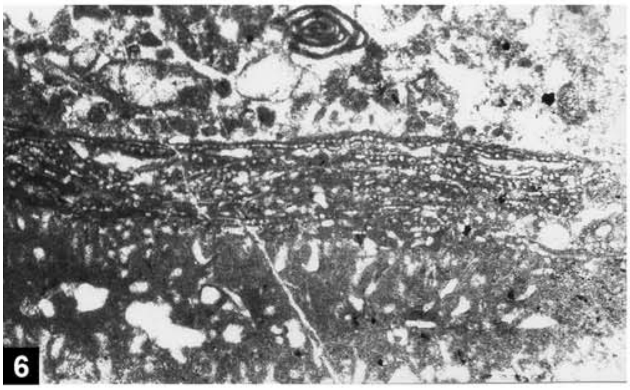
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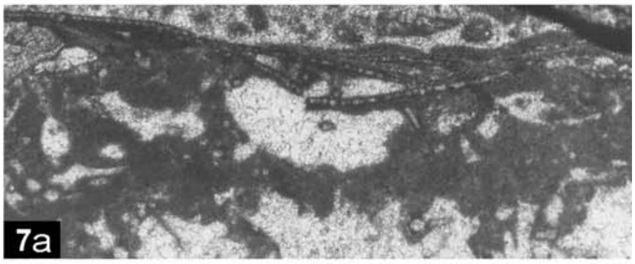
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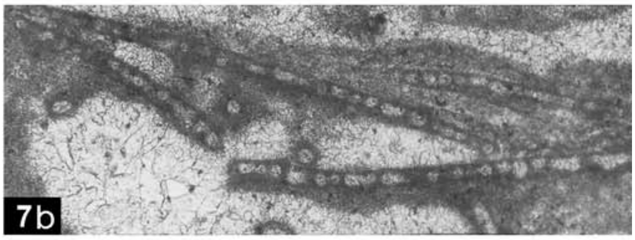
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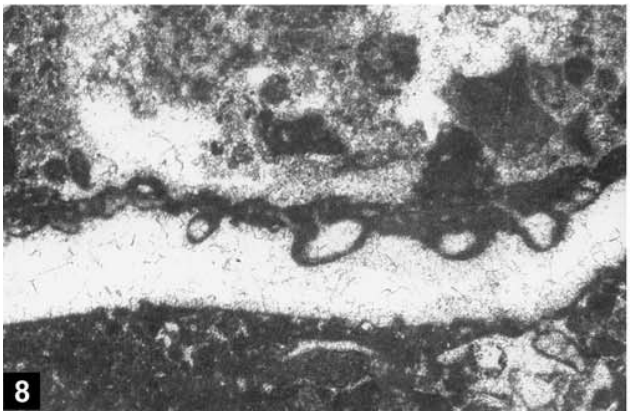
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PLATE 7

Fig. 1. Part of *Lithocodium* melange nodula with episodes of *Koskinobullina socialis* colonial growth (K). × 60; thin slide RR2191.

Fig. 2. A part of the same nodula with *Koskinobullina socialis* and rodophycean alga. × 35; thin slide 2191.

Fig. 3. Microbialite KL19, on the melange nodula. × 50; thin slide RR2191.

Fig. 4. Calcisponge encased by *Lithocodium* melange nodula. × 30; thin slide RR2191.

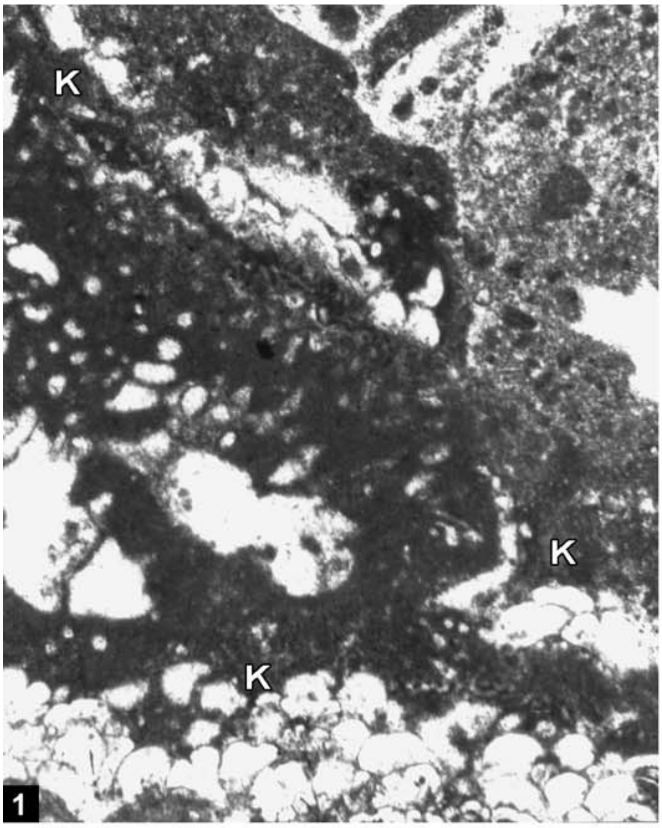
Fig. 5. Encrusting calcisponge encrusted by *Lithocodium*. × 20; thin slide RR2191.

Fig. 6. *Aka* sp. × 30; thin slide RR2190.

Fig. 7. *Coptocampylodon* sp. 1. × 30; thin slide RR2189.

Fig. 8. *Coptocampylodon fontis* (PARTULIUS). × 40; thin slide RR2199.

Fig. 9. *Zujovicella gocanini* (RADOIČIĆ, 1972) nov. comb. Oblique section of the distal part of secondary laterals (coptocampylodon form); × 30; thin slide RR2918.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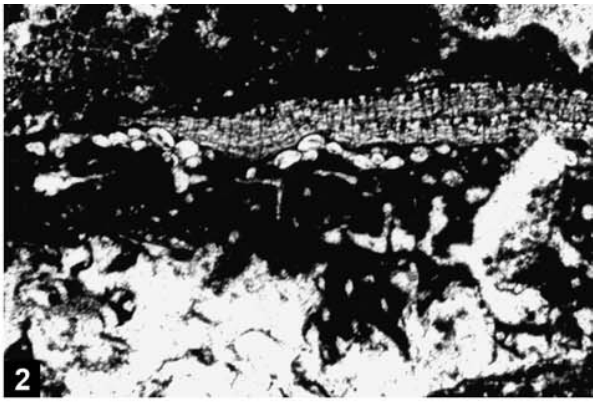
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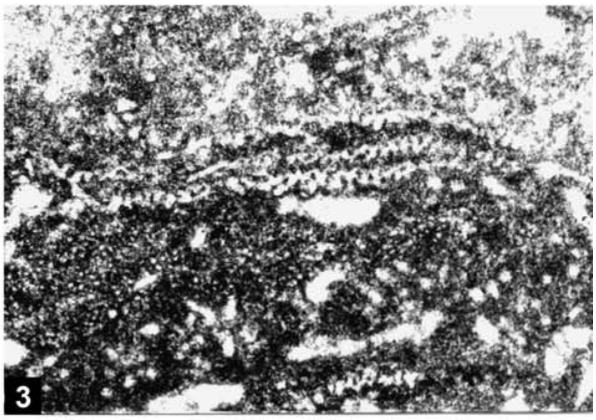
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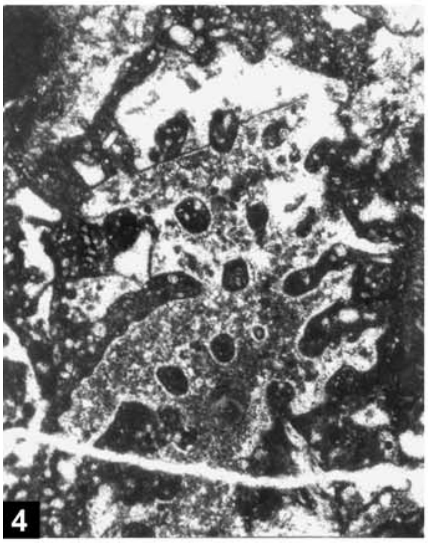
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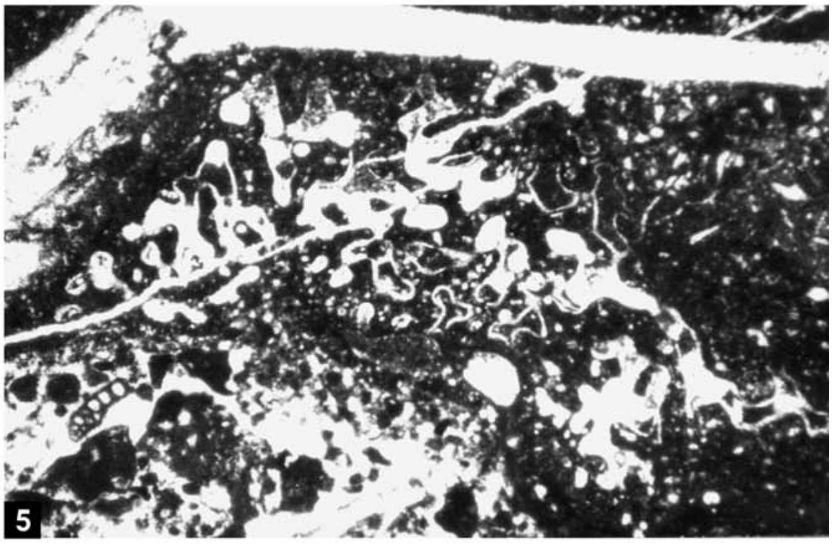
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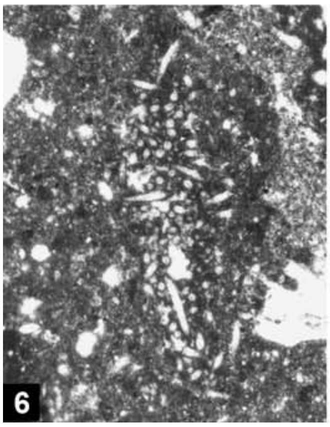
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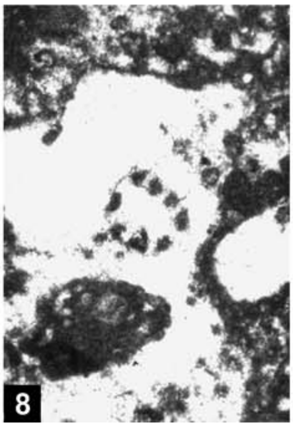
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PLATE 8

Fig. 1.	*Lithocodioidea* KL12. × 30; thin slide RR2191.
Fig. 2.	*Lithocodioidea* KL11 englobed in *Lithocodium* nodula. × 35; thin slide RR2194.
Figs. 3, 4.	*Lithocodioidea* KL17. × 7.5. KL18; × 35; thin slide RR2189. Fig. 4 = detail of Fig. 3 (in the photograph made at low exposition, two different crusts are evident); 1 = KL17 and 2 = KL18.
Fig. 5.	Different *Lithocodioidea* and microbial crusts, a part of the *Lithocodium* nodula coating coral (Fig. 6). × 40; thin slide RR2201.
Fig. 6.	Recrystallized coral? Coated and corroded by *Lithocodium* (Fig. 5 = topmost part of this nodula); × 7.5; thin slide RR2201.
Fig. 7.	Problematica KL15. × 30; thin slide RR2197.
Fig. 8.	Microbial chasmoendolits KL22 in pores of a *Cladocoropsis*? skeleton. × 35; thin slide RR2196.
Fig. 9.	*Calcisponge* (or *Lithocodioidea*?) KL23. × 17.5; thin slide RR2196.
Fig. 10.	*Calcisponge*. × 35; thin slide RR2189.


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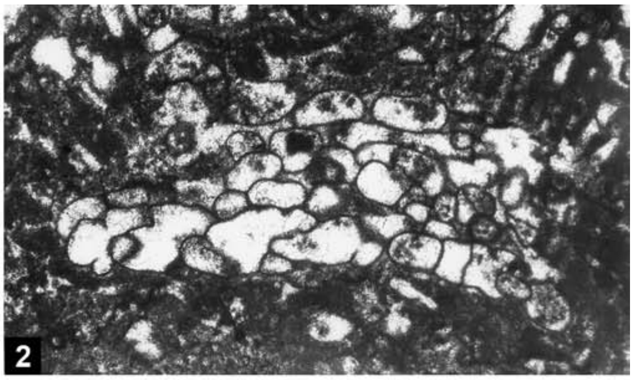
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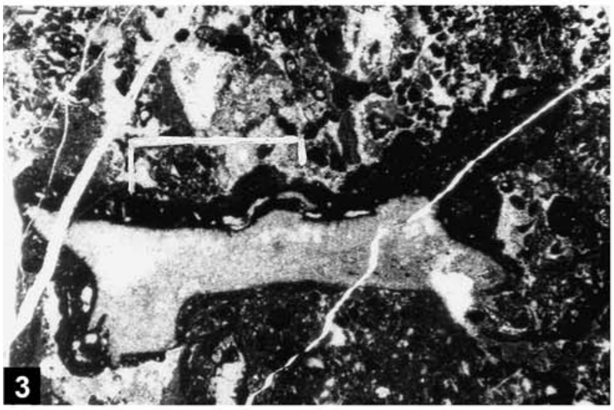
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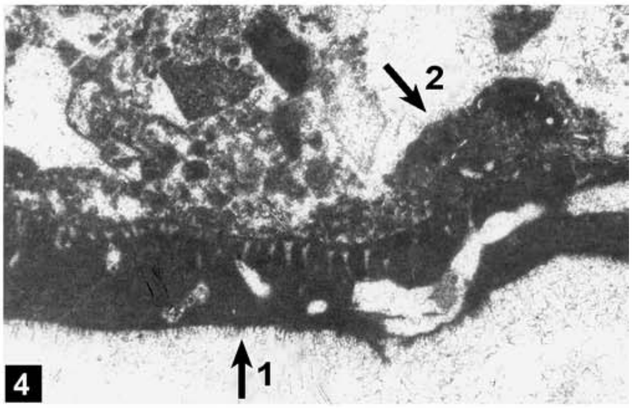
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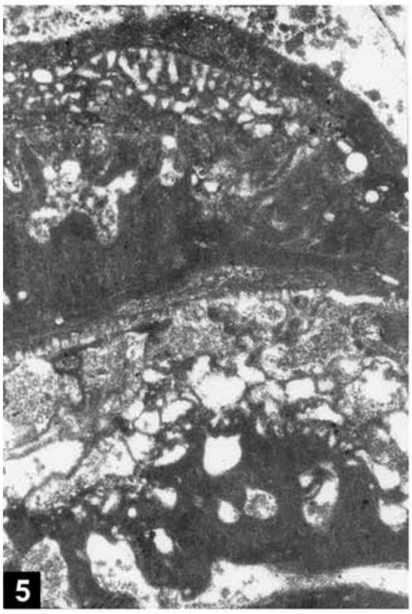
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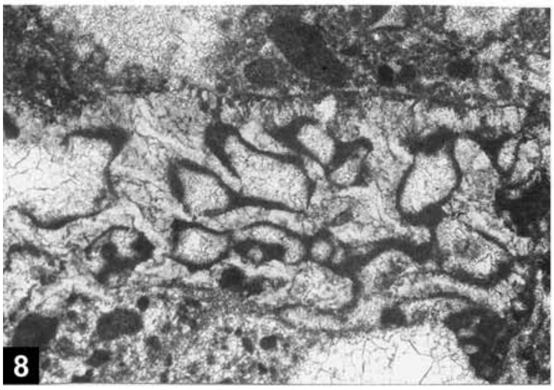
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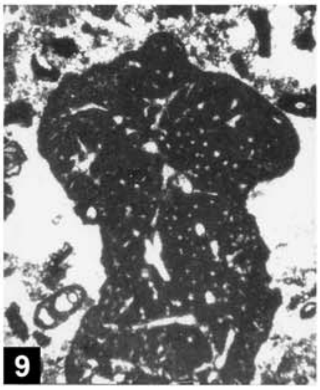
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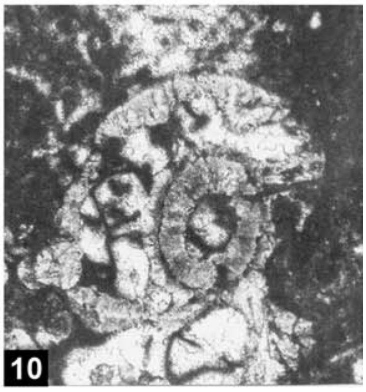
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PLATE 9

Figs. 1, 2.	*Nipponophycus ramosus* YABE & TOYAMA. Longitudinal and transversal section (coated by microbialite); × 30; thin sections RR2198, 2191.
Figs. 3–6.	*Pinnatiporidium* sp. Transversal, slightly oblique (3, 4) and oblique sections (5, 6) (coated by more or less thin microbial epiliths); × 30; thin slides RR2199, 2189, 2194.
Fig. 7.	"*Tubiphytes*" *morronensis* CRESCENTI. × 35; thin slide RR2191.
Fig. 8.	*Felixporidium*? sp. Oblique section. × 40; thin slide RR2190.
Fig. 9.	*Lithocodioidea* KL11. × 30; thin slide RR2199.
Fig. 10a, b.	*Lithocodioidea* aff. KL11. a = × 15; b = × 35; thin slide RR2194.


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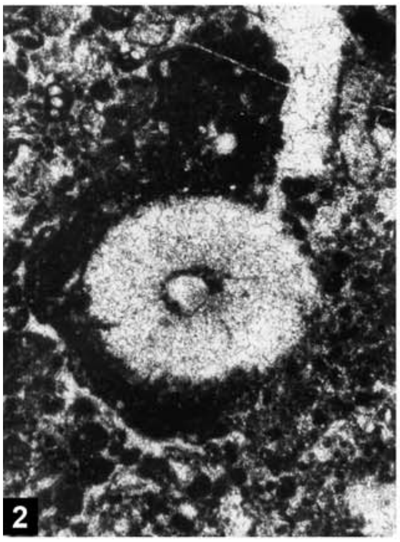
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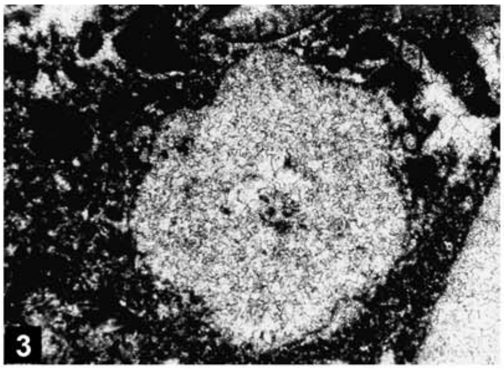
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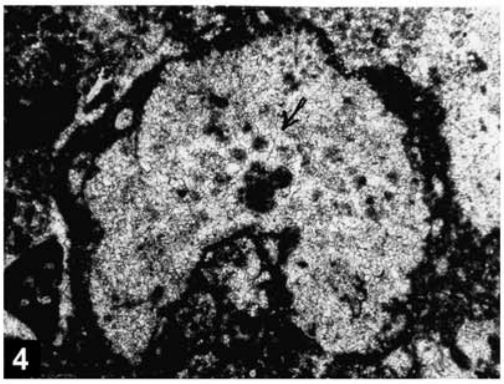
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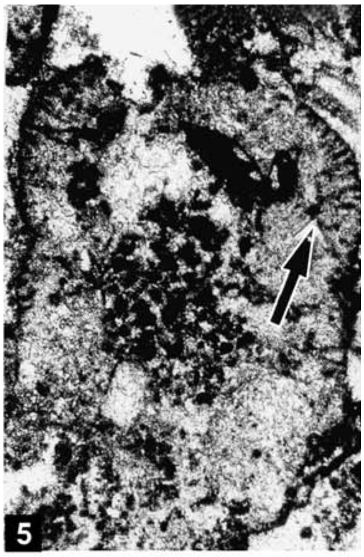
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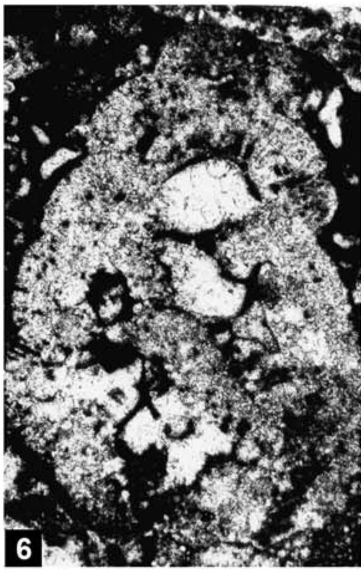
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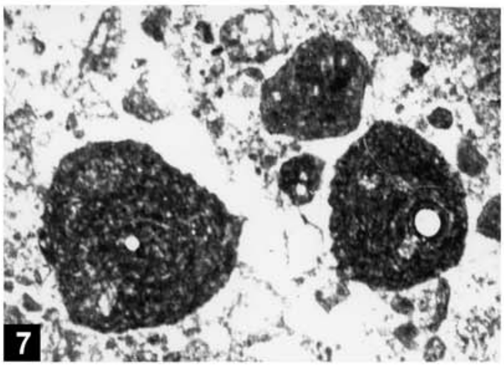
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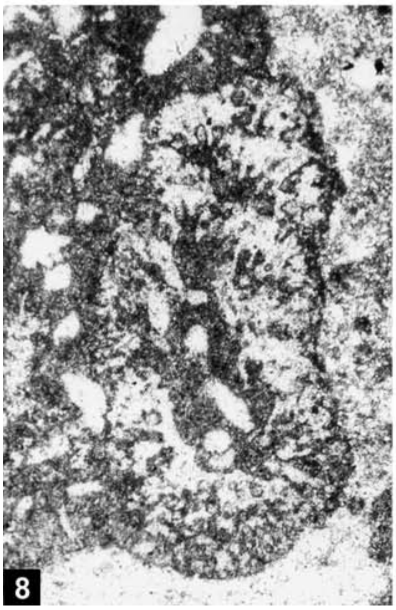
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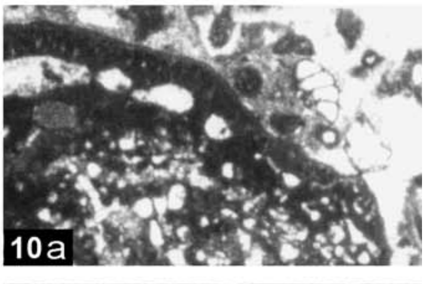
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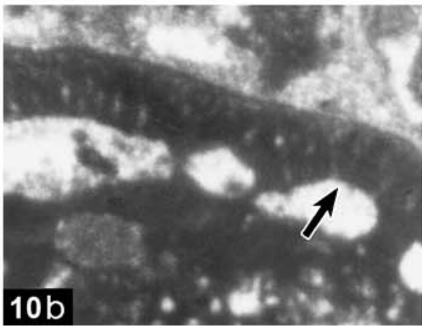
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