

Upper Jurassic Calcareous Algae from the Madonie Mountains, Sicily

Oberjurassische Kalkalgen aus dem Madonie Gebirge, Sizilien

by

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Abstract

The Calcareous algae of Upper Jurassic (Tithonian) reef limestones exposed in Piano di Battaglia in Madonie Mountains (Central Sicily) are briefly described. Following taxa have been found:

Chlorophyceae: Dasycladales: *Anisoporella* sp., *Clypeina jurassica* FAVRE, 1927, *Epimastoporella jurassica* (ENDO, 1961), *Neoteutloporella socialis* (PRA-TURLON, 1963), *Salpingoporella annulata* CAROZZI, 1953, *Salpingoporella enayi* BERNIER, 1984, *Salpingoporella ettaloni* BERNIER, 1984, *Salpingoporella johnsoni* (DRAGASTAN, 1971), *Salpingoporella pygmaea* (GÜMBEL, 1891), *Suppiluliumaella delphica* (CARRAS, 1989), and *Tersella* ? sp. — Caulerpales (Udo-teaceae): *Carpathocodium anae* (DRAGASTAN, 1971), *Nipponophycus ramosus* YABE & TOYAMA, 1928, *Margueritiella* ? sp. cf. *M. densa* DRAGASTAN, 1990, and *Pinnatiporidium* sp. cf. *P. cylindricus* DRAGASTAN, 1990. — Thaumtoporellales: *Thaumtoporella parvovesiculifera* (RAINERI, 1927).

Rhodophyceae: *Solenopora helvetica* PETERHANS, 1929.

Incertae sedis: *Bacinella irregularis* RADOIČIĆ, 1969, *Koskinobullina socialis* CHERCHI & SCHRÖ-

DER, 1979, *Lithocodium carpathicum* (MIŠIK, 1979), *Mitcheleania americana* (JOHNSON, 1961), *Ortonella* ? sp., *Diversocallis moesicus* DRAGASTAN & BUCUR, 1978, „*Tubiphytes*” *morroneis* CRESCENTI, 1969.

Epimastoporella jurassica (transferred from the genus *Epimastopora*) and *Suppiluliumaella delphica* (transferred from the genus *Celyphia* ?) are nov. comb. The genus *Neoteutloporella* and the species *Suppiluliumaella delphica* and *Nipponophycus ramosus* are emended and new diagnoses are given.

Zusammenfassung

Die Kalkalgen der in Piano di Battaglia (Madonie Gebirge; Zentral-Sizilien) aufgeschlossenen oberjurassischen (Tithon) Riffkalke werden kurz beschrieben. Folgende Taxa wurden gefunden:

Chlorophyceae Dasycladales: *Anisoporella* sp., *Clypeina jurassica* FAVRE, 1927, *Epimastoporella jurassica* (ENDO, 1961), *Neoteutloporella socialis* (PRA-TURLON, 1963), *Salpingoporella annulata* CAROZZI, 1953, *Salpingoporella enayi* BERNIER, 1984, *Salpingoporella ettaloni* BERNIER, 1984, *Salpingoporella johnsoni* (DRAGASTAN, 1971), *Salpingoporella pygmaea* (GÜMBEL, 1891), *Suppiluliumaella delphica* (CARRAS, 1989), *Tersella* ? sp. — Caulerpales (Udo-teaceae): *Carpathocodium anae* (DRAGASTAN, 1971), *Nipponophycus ramosus* YABE & TOYAMA, 1928, *Margueritiella* ? sp. cf. *M. densa* DRAGASTAN, 1990, und *Pinnatiporidium* sp. cf. *P. cylindricus* DRAGASTAN, 1990. — Thaumtoporellales: *Thaumtoporella parvovesiculifera* (RAINERI, 1927).

Rhodophyceae: *Solenopora helvetica* PETERHANS, 1929.

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Epimastoporella jurassica (transferiert aus der Gattung *Epimastopora*) und *Suppiluliumaella delphica* (transferiert aus der Gattung *Celyphia* ?) sind neue Kombinationen. Die Gattung *Neoteutloporella* und die Arten *Suppiluliumaella delphica* und *Nipponophycus ramosus* werden revidiert und neu definiert.

1. Introduction

During the field work and sampling of Upper Triassic carbonates exposed in Piano di Battaglia (Madonie Mountains, Central Sicily) some Upper Jurassic (Tithonian) reef carbonates have also been collected from this area. These carbonates, representing the marginal platform facies of CATALANO et al. (1974), are well exposed along the street on the NE side of Monte Mufara (Fig. 1, unit 4). The aim of this collection was to investigate the rich coral fauna of these carbonates developed partly as framestones. Apart of the coral-algal framestone some calcarenite and calcirudite also occur.

The rich coral fauna of these Tithonian reefs is composed of solitary, cerioid, and dendroid types with a high diversity. Apart from abundant corals, ellipsactinid hydrozoans(?) or sponges(?) are relatively frequent reef builders. Some sphinctozoid and inozoid sponges with very low diversity and abundance do also occur. Large nodular colonies of chaetetids (sclerosponges) and colonies of the dasycladacean alga *Neoteutloporella socialis* (PRATURLON) are the next important organisms within the Tithonian reef carbonates. Remarkable is the colony of udoteacean genus *Nipponophycus ramosus* YABE and TOYAMA which can be easily confused with dendroid corals in the field. Other organisms, like "*Tubiphytes*" and *Bacinella* are also abundant organisms.

From the 140 collected samples more than 100 large-sized (10 x 15 cm) thin-sections have been made. The algae, described in this paper, reveal the role, abundance, diversity and association of algae occurring within the Tithonian reef facies are different to that of the lagoonal facies represented mainly by porostromate cyanophyceans documented by CATALANO et al. (1974).

The investigated material is housed at Institute of Paleontology, University of Erlangen-Nürnberg (material: "Jura – B. Senowbari-Daryan").

2. Geological setting

In Sicily it is possible to recognize the foreland area that constitutes the southern sector of the island, and one E–W trending chain that consists of some south verging tectonic units. The Madonie Mountains represent a segment of the Sicilian Chain and are constituted by the overlapping of a series of tectonic units generated after the Early Miocene and deriving from the deformation of the original paleogeographic domains during the Mesozoic stretching phases. We can distinguish: a) Mesozoic-Tertiary

successions having carbonate platform characteristics of margin and slope type (Panormide Domain); b) Mesozoic-Tertiary successions having basin characteristics (Imerese Domain).

During the Lower Miocene, these domains are deformed and thrust on to progressively more external domains, forming a thrust belt that constitutes the segment of the chain under study (ABATE et al., 1982, 1988a, 1988b; CATALANO & D'ARGENIO, 1978; MONTANARI, 1987).

In this paper we pay particular attention to calcareous algae found in peloidal and bioclastic calcilutites, calcarenites – calcirudites, algal biolithites, coralgal calcarenites, and calcirudites, outcropping in the Madonie Mountains near Piano di Battaglia (Fig. 1). These rocks have been interpreted as deposited in the back reef and marginal zone (reef) of the Panormide Carbonate Platform.

Fig. 1 shows the stratigraphic and tectonic relationships of a series of units deriving from the deformation of the Panormide Carbonate Platform and its margin. These units are overthrust on units derived from the deformation of the Imerese Basin. The extension of the outcrops and the locality where samples have been collected are shown in Fig. 1.

3. Description of calcareous algae

Class Chlorophyceae

Order Dasycladales

Family Seletonellaceae

Genus *Epimastoporella* ROUX, 1979

Epimastoporella jurassica (ENDO, 1961) nov. comb.
(Pl. 5, Fig. 9)

1961 *Pseudoepimastopora jurassica* n. sp. – ENDO, p. 61–62, pl. 14, figs. 1, 2; pl. 15, figs. 3, 4.

We identified only fragments of an alga having the structure of *Pseudoepimastopora jurassica* ENDO, 1961. If we consider ROUX's redefinition (1979) of this algal group, the species under discussion belongs to the genus *Epimastoporella*. It differs from *Epimastoporella cretacea* (DRAGASTAN) in pore shape and size (DRAGASTAN, 1967).

Family Triploporellaceae

Genus *Anisoporella* BOTTERON, 1961

Anisoporella sp.

(Pl. 4, Figs. 9, 10, 12, 13)

The genus *Anisoporella* was introduced by BOTTERON (1961) for dasyclad algae with euspondyle vesiculiferous branches. This was meant as a possibility to delimit this alga-type from the species belonging to the genus *Gyroporella* which are characterized by aspondyle vesiculiferous branches. This differentiation was acknowledged by HURKA (1969), OTT (1972) and BYSTRICKY (1986). Two species assigned to this genus

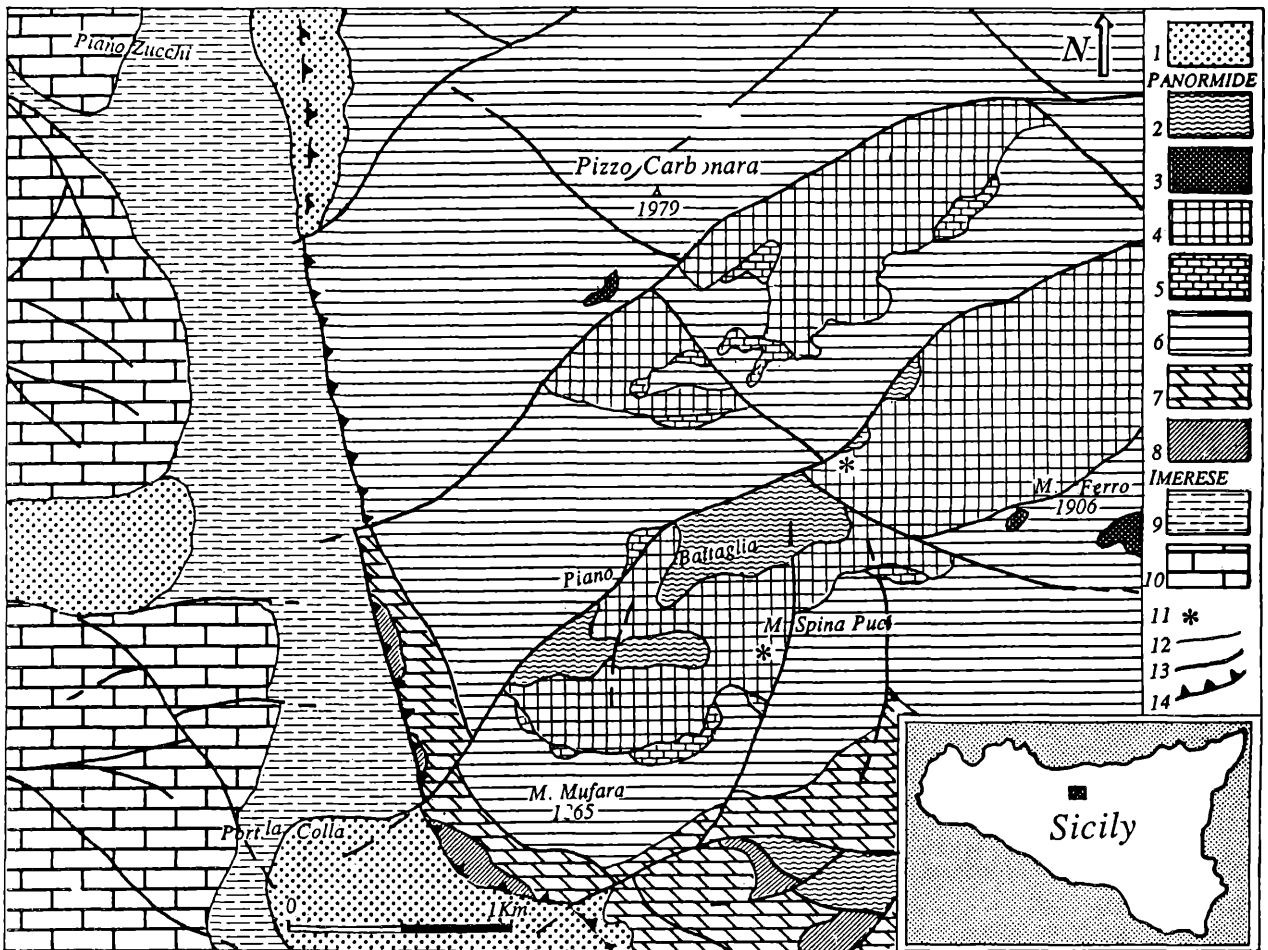


Figure 1: Geological map of the area between Pizzo Carbonara and M. Mufara (Madonie Mountains).

1. Debris (Quaternary). Sequences derived from the deformation of Panormide Domain: 2. Sandstone, sandy-clays with planctonic foraminifera. “Flysch Numidico”. Lower Miocene-Upper Langhian. 3. Marly calcilutites with planctonic foraminifera (*Globotruncana* sp., *Globorotalia* sp.). Upper Cretaceous-Oligocene. 4. Calcilutites and peloidal calcarenites with intraclasts, corallgal calcirudites, algal limestones, loferitic limestones. Tithonian-Lower Cretaceous. 5. Calcilutites and marly limestones, nodular limestones with ammonites and belemnites, biocalcilites with brachiopods. Malm. 6. Limestones, dolomitic limestones with sponges and hydrozoa (reef complex). Norian. 7. Massive dolomites and dolomitized breccias. Norian. 8. Claystones, calcilutites with planctonic pelecypods (*Halobia* sp.) and marls with calcareous breccia intercalations. “Mufara Formation”. Carnian. Sequences derived from the deformation of Imerese Domain: 9. Dark claystones sometimes with manganese, sandy-claystones. “Flysch Numidico” Lower Miocene-Upper Langhian. 10. Reddish marly calcilutites with planctonic foraminifera (*Globotruncana* sp., *Globorotalia* sp.). “Caltavuturo Formation”. Middle Cretaceous-Oligocene. In the Lower part siliceous claystones, radiolarites, marls with radiolarians, graded calcarenites, and calcirudites. “Crisanti Formation” Upper Liassic-Middle Cretaceous. 11. Locality of outcrops. 12. Stratigraphic boundaries. 13. Faults. 14. Overthrusts.

found in Triassic deposits are already known: *Anisoporella occidentalis* BOTTERON, 1961, and *Anisoporella anisica* (ZANIN-BURRI, 1965). SOKAČ & VELIČ (1982) described a new species of *Gyroporella* from Aptian deposits, *Gyroporella lukicae*. The diagnosis and the illustrations give evidences that it is an alga with eu-spondyle arrangement of the branches. Consequently it belongs to the genus *Anisoporella* and we propose the new combination *Anisoporella lukicae* (SOKAČ & VELIČ). FARINACCI & RADOIČIĆ (1991) illustrate several specimens assigned to the genus *Gyroporella*, one of them (Pl. 12, Fig. 4) being assigned to the species *Gyroporella lukicae*. In fact it is the same alga we identified in the Upper Jurassic of Sicily which belongs to the genus *Anisoporella*. The general aspect of the thallus, resembles

Anisoporella lukicae, differences consisting only in the dimensions of their branches (length and distal diameter). Dimensions (in mm): D = 1.62–2.16; d = 1.25–1.74; d/D = 0.77–0.80; h = 0.12; l = 0.17–0.23; p (dist.) = 0.09–0.15.

Genus *Neoteutloporella* BASSOULLET et al., 1978

Neoteutloporella socialis (PRATURLON, 1963)

BASSOULLET et al., 1978 emend.

DE CASTRO, 1993

(Pl. 3, Fig. 10; Pl. 5, Figs. 1, 2, 12)

This alga builds some peculiar colonies. PRATURLON (1963) estimates that it formed real submarine “prairies” No doubt this represents the most characteristic feature of this alga, probably unique among Mesozoic dasycladales. Their thalli are so close together that the process of

calcification and subsequent diagenesis led to the formation of a rigid mass typical for a reef environment. Moreover, it seems that successive generations grow out one above the other after intervals of interruption.

A relatively recent description of some algal colonies of *Neoteutloporella socialis* is given by DRAGASTAN et al. (1987). These authors emphasize the differences between *Neoteutloporella socialis* and *Campbeliella striata* CAROZZI, a species which has some morphologic similarities with the former, according to JAFFREZO (1980). The presence of two rows of branches within each whorl of *Neoteutloporella socialis* is mentioned as essential difference. This fact was also noticed by BERNIER (1984) who emphasized the specific difference but supposed the existence of a possible generic identity of the two algae, the genus *Campbeliella*, however, having priority in this case.

The two species have been recently studied by DE CASTRO (1993) on account of a relatively well-preserved material. The author noticed that both algae have ramifications of several orders, different from one genus to the other. *Campbeliella* has three orders of ramifications (primary, secondary and tertiary, the latter being characterised by several constrictions), while *Neoteutloporella* has only two orders of ramifications (primary and secondary). Primary ramifications are short, stout and bear 4–6 long secondary ramifications provided with several constrictions along their course. Thus, although *Campbeliella* and *Neoteutloporella* are very similar at first sight, they differ mainly by the fact that *Neoteutloporella* has only two orders of ramification (instead three for *Campbeliella*).

A doubt always existed concerning the shape of ramifications in *Neoteutloporella*. The specimens we have identified seem to indicate that ramifications are rather phloiophorous then trichophorous (Pl. 5, Figs. 1, 2, 12). According to DE CASTRO (1993) the secondary ramifications are acrophorous or slightly phloiophorous on the main course of their length, but they decrease rapidly in width on the distal end, giving to the ramification as a whole a trichophorous character. Secondary ramifications tend to be distributed on two adjacent levels, which explain the presence of the “two branch rows within each article” mentioned by some authors as an essential character.

Considering the already mentioned remarks, DE CASTRO (1993) proposed an emended diagnosis of the genus *Neoteutloporella* and of the type species, *Neoteutloporella socialis* (PRATURLON, 1964). Subsequently to this emendation, the species *Teutloporella obsoleta* CAROZZI is assigned to the emended genus *Neoteutloporella*, *Teutloporella triasina* (SCHAUROTH) is excluded from this genus and assigned to the new genus *Eoteutloporella* DE CASTRO, 1993, and *Teutloporella galaeformis* RADOIČIĆ is assigned to the genus *Seliporella* SARTONI & CRESCENTI, 1962.

Concerning *Neoteutloporella socialis*, the fact that it forms “colonies” must be, in our opinion, also emphasized as an

important specific character, unrecorded to other Mesozoic species of Dasycladales.

Genus *Salpingoporella* PIA, 1918

Most of the algae identified in the Upper Jurassic deposits from the Madonie Mountains belong to this genus. It is a group frequently recorded in reef environments, including the species *Salpingoporella johnsoni* (DRAGASTAN), *S. ettaloni* BERNIER, *S. pygmaea* (GÜMBEL), and *S. enayi* BERNIER. On the contrary, *Salpingoporella annulata* CAROZZI, a species rather characteristic of protected environment, especially of the middle infralittoral (CONRAD, 1977), is much less common.

Salpingoporella annulata CAROZZI, 1953

(Pl. 4, Fig. 5; Pl. 5, Fig. 13)

A well-known species in the whole Mesogean area with a stratigraphical distribution ranging from Upper Bathonian(?) to Lower Valanginian. *Salpingoporella annulata* was, however, most frequently found in Upper Jurassic deposits (see the synonymy list in BASSOULLET et al., 1978).

Salpingoporella gr. *enayi* BERNIER, 1984

(Pl. 4, Figs. 8, 11, Pl. 5, Fig. 16)

Salpingoporella gr. *ettaloni* BERNIER, 1984

(Pl. 3, Figs. 1–5)

Salpingoporella gr. *johnsoni* DRAGASTAN, 1989

non 1971

(Pl. 3, Figs. 7–9)

Salpingoporella gr. *pygmaea* (GÜMBEL, 1891)

BASSOULLET et al., 1978

(Pl. 2, Figs. 1–6; Pl. 4, Fig. 4)

These four species have some common morphologic characteristics. In order to delimit the species of this group, BERNIER (1984) used a diagram in which the outer diameter as well as the d/D-ratio are represented. Thus, the author distinguished several “fields” characteristic for each species.

HOFMANN (1991) considers *Salpingoporella johnsoni* and *Salpingoporella ettaloni* as junior synonyms of *Salpingoporella pygmaea*, starting with PIA’s (1925) emended diagnosis of this species, and ending with the reexamination made by BASSOULLET et al. (1978). However, we have to mention that although HOFMANN (1991) refers to BERNIER’s diagram and denies its value as a modality of specific differentiation, he uses another type of diagram (D related to d, instead of D related to d/D).

We also used BERNIER’s diagram for the Sicilian specimens (Fig. 2). At first sight, HOFMANN’s idea (1991) seems to be justified: for most of the analysed specimens there is no clearcut distinction between the fields occupied by each species. Thus, there are several specimens (Fig. 2) which have transitional characteristics.

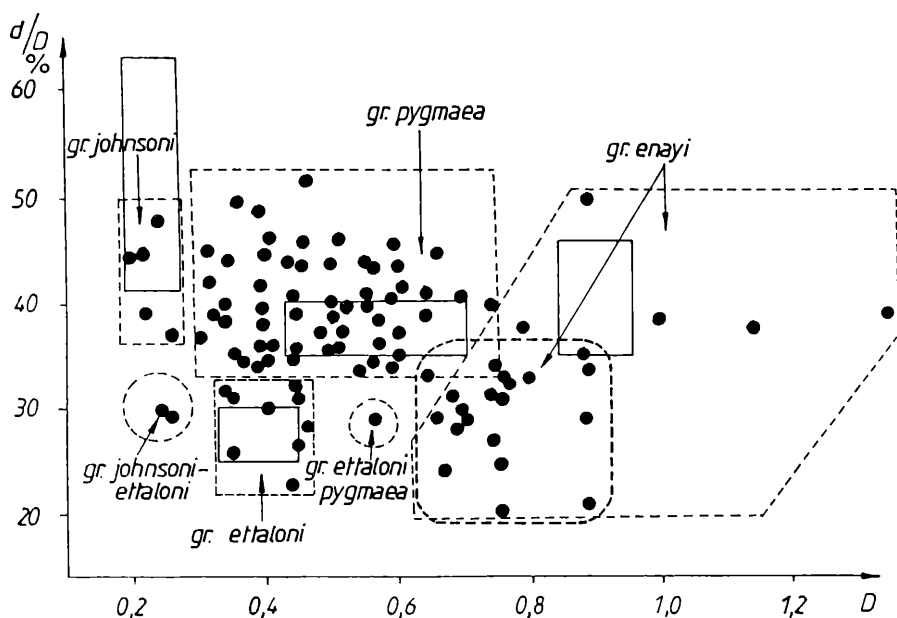


Figure 2: Comparative diagram between D and d/D ratio, for the species of the genus *Salpingoporella* recorded in the Upper Jurassic limestones from Madonie Mountains. The thin uninterrupted line marks the fields separated by BERNIER (1984) for the mentioned species; the thin interrupted line indicates the enlarged fields of the same species starting from the Sicilian material; the thick interrupted line marks the field of specimens assigned to the *Salpingoporella enayi* group, but having a d/D ratio much lower than the type species.

The three parameters (D , d and d/D) are not the only ones which need to be taken into consideration for the morphologic definition of a certain species. The height (h) between the whorls, the branch diameter (p) and the number of branches per whorl (w) are equally important; in fact all the biometric parameters express some morphological characteristics which can be taken as criteria for a specific definition (Tab. 1). Consequently, the synonymy proposed by HOFMANN (1991) does not seem to be entirely justified. Furthermore, a simple comparison of the specimens from Pl. 1, Figs. 1, 2 with those from Pl. 1, Figs. 5, 6, 8 (HOFMANN, 1991) raises serious questions concerning their synonymy. If the idea of a "biologic series" (i.e. the ontogenetic stages of the same species) is considered, we estimate that it would be necessary to evaluate a more or less in situ population including all the forms that can be assigned to the same species at the same stratigraphical level (i.e. within the same sample). Also, the comparative study of material collected in several localities of the Mesogean area would be necessary in order to give a satisfactory answer to this taxonomic problem.

The diagram in Fig. 2 shows that the variability boundaries

for *Salpingoporella* species can and may be extended, compared to those considered by BERNIER (1984).

The same diagram also illustrates the occurrence of a group (thick undivided line) which, owing to the dimensions of the thallus, resemble *Salpingoporella enayi* differing from it, however, by the smaller d/D ratio. We identified these algae as *Salpingoporella gr. enayi* (Pl. 2, Fig. 14; Pl. 4, Figs. 1–3, 6, 7). The peculiar feature of this form (Tab. 1) is given, in fact, by the relatively narrow axial cavity and by its long branches (as compared to the *Salpingoporella enayi* type forms). According to Fig. 2 a new species could be separated. However, considering the difficulties of specific determination within this group, we believe that its assignment to the *enayi* group is more suitable.

GRANIER (1988) assumes that the original view regarding the species *Salpingoporella pygmaea* (GÜMBEL, 1891) is too restrictive (D ranging from 0.75 to 1 mm) and leads to the individualisation of an exceedingly high number of species. He assigns to *Salpingoporella pygmaea* some forms more than 1 mm in diameter (which probably can be assigned to the species *Salpingoporella enayi*).

Till an acceptable answer to the taxonomic problems

	<i>S. johnsoni</i>	<i>S. ettaloni</i>	<i>S. pygmaea</i>	<i>S. gr. enayi</i>	<i>S. enayi</i>
L	–	4.68	3.90	4.4	–
D	0.20–0.27	0.34–0.46	0.35–0.75	0.66–0.89	0.78–1.35
d	0.08–0.11	0.09–0.14	0.11–0.41	0.15–0.31	0.30–0.53
d/D	0.37–0.48	0.23–0.32	0.32–0.52	0.20–0.38	0.30–0.53
h	0.03–0.05	0.04–0.07	0.04–0.08	0.07–0.12	0.08–0.10
l	0.06–0.08	0.12–0.16	0.10–0.25	0.28–0.50	0.20–0.40
p(d)	0.02–0.05	0.03–0.06	0.03–0.08	0.07–0.10	0.08–0.10
w	10–12	12–15	15–25	16–18	22–2

Table 1: Comparison of characters of different *Salpingoporella*-species (Dimensions in mm).

regarding these algae will be available, we consider it is better that the specimens we have identified in the Jurassic deposits from the Madonie Mountains should be assigned to the groups of species already published.

Genus *Suppiluliumaella* ELLIOTT, 1968
Suppiluliumaella delphica (CARRAS, 1989)
 nov. comb., emend.
 (Pl. 1, Figs. 1–8)

1989 *Clypeina* ? *delphica* n. sp. – CARRAS, p. 63–70, pls. 1–3.

With reservations, this alga was assigned to the genus *Clypeina* by CARRAS (1989) due to the very close whorls, cemented one to another. This character contradicts the diagnosis of the genus. Starting from its initial diagnosis, the species could be assigned to the genus *Similiclypeina* (BUCUR, 1993). On the other hand, our researches revealed the presence of secondary ramifications on the top of the primaries which makes the assignment of this species to the genus *Suppiluliumaella* necessary. At the same time the diagnosis of the species has to be emended to include the occurrence of secondaries.

Emended diagnosis Large dasycladalean alga with cylindrical or slightly claviform thallus consisting of closely set verticils, the space between verticils being very thin and discontinuous. Each branch is made up of one primary and three to four secondary ramifications. Within the verticils, primary ramifications are inclined with respect to the axial cavity in their proximal and middle part, gradually curving on the distal side where they reach a subhorizontal position. They gradually widen in distal direction; in the latter, the widening is relatively sudden and much more evident. The secondaries are short, phloiophorous, poorly calcified or obliterated by processes of early diagenetic micritization.

The axial sections (see especially Pl. 1, Fig. 8) show the shape of primaries with the distal widening characteristic for the genus *Suppiluliumaella*. The secondaries can be noticed with great difficulty either because of poor calcification of the outer part of the thallus, or of early diagenetic micritization which generated the micritic envelope on the majority of the studied specimens. Some specimens, however, clearly show the existence of these ramifications (Pl. 1, Figs. 4–6) which, in our opinion, are also visible in some of the specimens figured by CARRAS (1989) (e.g., Pl. 1, Fig. 1, on the left side, approximately at the base of the upper third).

Suppiluliumaella delphica was described by CARRAS (1989) from Upper Kimmeridgian – Lower Portlandian limestones of Greece. Its identification in the Madonie Mountains widens this stratigraphic distribution upward to the terminal Tithonian. Moreover, this alga was figured by MIŠIK & SYKORA (1981, Pl. 5, Fig. 6) as undetermined Dasycladaceae, and recently by SOTAK & MIŠIK

(1993) as *Suppiluliumaella* cf. *verae* (SOKAČ & NIKLER) (Pl. 7, Fig. 7) and as *Clypeina* ? *delphica* by CARRAS (Pl. 7, Figs. 2–5). This is the third species of *Suppiluliumaella* discovered within Jurassic deposits (the other two are *Suppiluliumaella leini* DRAGASTAN, 1989, and *Suppiluliumaella riedeli* DRAGASTAN, 1989).

Dimensions (in mm): L (maximum observed) = 8.80; D = 1.92–3.72; d = 1.14–1.98; d/D = 0.42–0.53; h = 0.14–0.17; l_1 = 0.40–0.94; l_2 = 0.12–0.14; p_1 (dist.) = 0.15–0.21; p_2 (dist.) = 0.09–0.12; w_1 = 38–40; w_2 = approx. 3–4.

Genus *Tersella* MORELLET, 1951

Tersella ? sp.
 (Pl. 5, Fig. 3)

We have found some very rare specimens of an alga with a large axial cavity with the calcified part reduced to the distal extremity of its branches. This part seems to correspond to the end of the primary branches and to the secondaries, as it occurs in the club-shaped portion of the thallus of *Tersella*-species. The small number of specimens and the absence of a complete thallus do not allow a more exact assignment.

Family Acetabulariaceae

Genus *Clypeina* MICHELIN, 1845,
 emend. REZAK, 1957

Clypeina jurassica FAVRE, 1927
 (Pl. 5, Figs. 4–6)

Clypeina jurassica is a species seldom observed in the studied deposits. The characteristic aspect of its thallus as well as its large distribution within the Jurassic deposits of the whole Mesogean area make it easily identifiable.

Order Caulerpales

Family Udoteaceae

Genus *Carpathocodium* DRAGASTAN, 1985
Carpathocodium cf. *anae* (DRAGASTAN, 1971)

DRAGASTAN, 1985

(Pl. 5, Fig. 11; Pl. 6, Figs. 1–5, 7)

The specimens recorded in the Tithonian limestones from Sicily allow some further observations concerning this species. According to the diagnosis (DRAGASTAN, 1985), the cortical zone consists of fascicles of filaments either parallel (longitudinal) or perpendicular to the outer surface. The medullar zone corresponds to a large hollow space or to some sinuous longitudinal filaments, separated by large intervals. The author also mentions that the most representative characteristics of *Carpathocodium anae* have been illustrated by RADOIČIĆ (1960), MIŠIK (1979), and MIŠIK & SYKORA (1981). A comparison of the specimens illustrated by the previously mentioned authors suggests that there are two varieties of this species. Both have an axial cavity represented either by a hollow (uncalcified) space (Pl. XXII, Fig. 1 in DRAGASTAN, 1985; Pl. 6, Figs. 3, 5 in the present paper), or by a zone

with thin filaments delimited by uncalcified intervals (Pl. 6, Figs. 2, 7 in the present paper). However, considering the cortical zone, there are specimens with fascicle-grouped filaments (Pl. XXII, Fig. 1 and Pl. XXIII, Fig. 1 in DRAGASTAN, 1985), which generate characteristic fragments after mechanical disintegration. These fragments have been very frequently recorded (Pl. XXII, Figs. 2–6 in DRAGASTAN, 1985). The filaments of one fascicle are closely grouped and usually have a polygonal cross-section. On the other hand, there are specimens with a compact cortex made up of multiple (polychotomic) branching filaments, initially oblique and subsequently perpendicular to the outer surface. The filaments are not very closely set within the cortex (they usually have a round cross-section) the space between them being filled with a fine micritic matrix (possibly a mixture with organic substance).

The specimens figured in this paper as well as those illustrated by MIŠIK (1979) and MIŠIK & SYKORA (1981) correspond to the latter variety.

Genus *Nipponophycus* YABE & TOYAMA, 1928

Nipponophycus ramosus YABE & TOYAMA, 1928, emend.

(Pl. 6, Figs. 8–11; Pl. 7, Figs. 1–3, 5–7, 9; Pl. 8)

YABE & TOYAMA (1928) assigned *Nipponophycus ramosus* to the red algae comparing it to recent *Furcellaria*. According to these authors, *Nipponophycus* has a medullar zone consisting of several thin segmented filaments parallel to the thallus axis (Pl. 2, Fig. 3 in the original paper). Dichotomically branched subcortical and cortical filaments with a polygonal cross-section extend laterally from the previous filaments. The diameter of medullar and cortical filaments is quite similar and of very small dimensions (8 mm according to YABE & TOYAMA, 1928).

The original description of *Nipponophycus ramosus* does not correspond entirely to the given figures. The presence of vertical partitions of the filaments in the medullar zone (noted also by ENDO, 1961, p. 59), as well as the presence of tetraspores, is quite hypothetical. Moreover, the small diameter of the medullar filaments seen only on the specimen in Pl. 2, Fig. 3 of the original paper can be an effect of a longitudinal-tangential section passing by the inner part of the lateral zone. Consequently, considering the internal structure of the alga, we believe that BAS-SOULLET et al. (1983) were right in assigning *Nipponophycus ramosus* to the Udoteaceae. Our observations on the specimens from Madonie Mountains support this assignment. However, to avoid confusion in interpreting it, we consider as necessary to emend the diagnosis of the species as follows: “Udoteacean alga with cylindrical, multiple branched (= dendriform) thallus. Medullar zone consisting either of a small number of filaments with a relatively large diameter parallel-subparallel to the longitudinal axis, or to a central cavity. They continue laterally with subcortical filaments, with di-, tri- or plurichotomic branching, decreasing in diameter and

ending cortically with thin filaments more or less perpendicular to the thallus axis.”

Because YABE & TOYAMA (1928) have not designated a holotype, we designate here the specimen from Pl. XVIII (I), Fig. 6 (the long branched specimen in the middle of the photo) of the original paper as **lectotype**.

The abundance of this alga in the Upper Jurassic limestones from Madonie Mountains allows a more detailed description:

The cylindrical-subcylindrical thallus does not present any visible constrictions or other signs of a segmentation-articulation process. On the other hand, the branching of the thallus is quite clear (Pl. 6, Figs. 9–11; Pl. 8). It is a multiple dendriform branching, with 3 or 4 short branches starting from each ramification nodule. Outer diameter varies between 0.48–1.74 mm (frequently 0.96–1.44 mm). The medullar zone, 0.20–0.48 mm in diameter (often 0.28–0.36 mm), consists of a small number of filaments, 0.010–0.017 mm in diameter, parallel-subparallel to the longitudinal axis of the thallus (Pl. 7, Fig. 6). Frequently the medullar zone is completely uncalcified, being represented by a central tubular cavity (Pl. 6, Fig. 8; Pl. 7, Fig. 2; Pl. 8). The filaments of the lateral zone, branching several times towards periphery start from the medullar zone. In most specimens, the lateral zone, which represents the most significant part of the thallus, is strongly recrystallized, its internal structure being obliterated. Only a few specimens in which the filaments were filled with micritic sediment before recrystallisation, preserve this structure (Pl. 6, Figs. 10–11; Pl. 7). The thin cortical zone *sensu stricto* is well differentiated in only a few specimens (Pl. 7, Figs. 3, 8). The filaments of this zone are 0.015–0.020 mm in diameter, gradually widening towards the periphery to 0.035 mm.

In some specimens there is a different structure in the lateral and cortical zones. Thus, before branching, the subcortical filaments widen, giving rise to a swelling (utricles) (Pl. 7, Fig. 4). These specimens probably represent a new species of the genus.

Concerning the paleoecology of *Nipponophycus ramosus*, this species was a reef building organism, if we take into consideration the dendriform morphology of the thallus. From this point of view, it played a similar ecological role as some Triassic forms such as *Collarecodium oenipontatum* BRANDNER & RESCH, 1980, and *Egericodium hungaricum* FLÜGEL et al., 1991/ 1992.

Genus *Margueritiella* DRAGASTAN, 1990

Margueritiella? sp. cf. *Margueritiella densa*

DRAGASTAN, 1990

(Pl. 5, Figs. 10, 14)

The specimens of Madonie Mountains resemble the type species of the genus *Margueritiella* mostly by the structure of the filaments with “moniliform” outline and repeated branching. The scarcity of the identified specimens, however, does not allow an evaluation of the general

thallus morphology and therefore a definite assignment is still impossible.

Genus *Pinnatiporidium* DRAGASTAN, 1990
Pinnatiporidium sp. cf. *Pinnatiporidium cylindricus*
 DRAGASTAN, 1990
 (Pl. 5, Fig. 15)

We have found rare specimens with a thallus morphology and structure similar to *Pinnatiporidium cylindricus*. In addition, our specimens are smaller (the outer diameter is 1.1 mm) as dimensions (3.0–3.2 mm) given for the type species by DRAGASTAN, 1990.

Order Thaumtoporellales

Genus *Thaumtoporella* PIA, 1927

Thaumtoporella parvovesiculifera (RAINERI,
 1922); PIA, 1927
 (Pl. 11, Figs. 1–4)

The thorough study of this group of algae by DE CASTRO (1988, 1990), brought several new data regarding their morphology and systematic position. In the Jurassic limestones from Madonie, *Thaumtoporella parvovesiculifera* occurs in crust-like shapes of variable sizes, frequently associated with crusts of *Bacinella irregularis* RADOIČIĆ (Pl. 11, Figs. 3, 4).

Class Rhodophyceae

Family Solenoporaceae

Genus *Solenopora* DYBOWSKY, 1877

Solenopora helvetica PETERHANS, 1929
 (Pl. 9, Figs. 1–7)

In several samples we recorded large (10 cm) solenoporacean thalli of branch-like shape. The cell filaments are closely juxtaposed and consist of cells between 20–30mm/60–100mm in size. However, there is a certain confusion concerning the Jurassic Solenoporaceae and, in our opinion, a critical reconsideration of the described species is necessary.

Family Gymnocodiaceae

Genus *Permocalculus* ELLIOTT, 1955

Permocalculus sp.
 (Pl. 9, Fig. 8)

Moniliform thallus, with an uncalcified medullar zone and a cortical zone with thin filaments branching towards the periphery. They originate from larger subcortical (medullar) filaments, partially visible on the outer side of the axial cavity. The cortical filaments develop into a fan-like shape, each group of fans corresponding to a segment of the moniliform thallus. It is highly probable that this specimen represents new species.

Dimensions (in mm): outer diameter = 1.30; diameter of the medullar cavity = 0.46–0.67; subcortical filament diameter = 0.10–0.15; cortical filament diameter = 0.015–0.020, broadening to 0.030 toward the periphery.

? *Permocalculus* sp.
 (Pl. 9, Fig. 9)

Within the same thin section, we recorded an algal thallus containing an extremely wide medullar cavity (3.78 mm for an outer diameter of 4.5 mm), and a cortical zone consisting of short filaments decreasing from 0.050 to 0.020 mm in diameter. Among these there are several ovoid bodies 0.15 to 0.16 mm in diameter, possibly reproductive organs of a *Permocalculus* specimen.

Porostromata and incertae sedis with algal affinity

Genus *Mitcheledeania* WETHERED, 1886

Mitcheledeania americana (JOHNSON, 1961);
 DRAGASTAN, 1985
 (Pl. 10, Figs. 1–5)

Nodular-subnodular thallus up to 12 mm in diameter, consisting of filaments 0.040 to 0.060 mm in diameter. The filaments are pseudobranching (cf. DRAGASTAN, 1985) and are characterized by irregular constrictions.

Genus *Diversocallis* DRAGASTAN, 1969

Diversocallis moesicus DRAGASTAN &
 BUCUR, 1978; DRAGASTAN, 1985
 (Pl. 10, Figs. 6–9)

Our samples contain several specimens with hemispherical thallus 2–3 mm in diameter, consisting of 7–15 mm filaments radially set in growth areas of unequal thickness.

Genus *Ortonella* GARWOOD, 1914

Ortonella ? sp.
 (Pl. 10, Fig. 11)

A single specimen, with nodular thallus, having thin (15 µm) bifurcated (Y-shaped) filaments.

Genus *Koskinobullina* CHERCHI &
 SCHRÖDER, 1979

Koskinobullina socialis CHERCHI
 & SCHRÖDER, 1979
 (Pl. 10, Fig. 10)

Our samples contain relatively small colonies made up of the characteristic, hemispheric, fibrous calcite walled cells with fine pores in their upper part (CHERCHI & SCHRÖDER, 1979).

Genus *Lithocodium* ELLIOTT, 1956

Lithocodium aggregatum ELLIOTT, 1956
 (Pl. 11, Figs. 5–8)

MÍŠIK (1979) created the new genus *Pseudolithocodium* (type species *Pseudolithocodium carpaticum*), which, according to the author, differs from *Lithocodium* ELLIOTT, 1956 by the densely set cortical filaments. In our opinion, the general structure of *Pseudolithocodium* is similar to that of the genus *Lithocodium* and the characteristics underlined by MÍŠIK (1979) may have eventually a specific value. Otherwise, comparing the specimens

illustrated by MIŠIK (1979, pl. 1, Figs. 2–8) and those illustrated in the present paper (Pl. 11, Figs. 5–8) with the specimen illustrated by ELLIOTT (1956, Pl. 1, Fig. 2), one cannot observe essential differences to justify a generic, and even a specific separation.

Genus *Bacinella* RADOIČIĆ, 1959
Bacinella irregularis RADOIČIĆ, 1959
(Pl. 11, Figs. 3, 4)

Considered by SEGONZAC & MARIN (1973) as representing a growing stage of *Lithocodium* crusts, *Bacinella irregularis* appears, however, more frequently as their own crusts. In the Madonie Mountains, *Bacinella irregularis* is frequently associated with *Thaumatoporella parvovesiculifera* (RAINERI).

Genus *Tubiphytes* MASLOV, 1956
“*Tubiphytes*” *moronensis* CRESCENTI, 1969
(Pl. 11, Figs. 9–11)

“*Tubiphytes*” *moronensis* was described by CRESCENTI (1969) as a species of the genus *Tubiphytes* MASLOV, 1956 (calcareous trichom of cyanophycean alga, according to the author). It was considered by DRAGASTAN (1969) as microoncolith, and by FLÜGEL & STEIGER (1981) as an oncoidic structure around a nodophtalmiid foraminifer. MIŠIK (1979) considers the species as synonym of *Tubiphytes obscurus* MASLOV, 1956. Subsequently, “*Tubiphytes*” *moronensis* was assigned unequivocally to the Nubeculariidae foraminifers by BERNIER (1984). Recent studies (SENOWBARI-DARYAN & FLÜGEL, 1993) proved that *Tubiphytes obscurus* has a structure quite different from the Upper Jurassic-Lower Cretaceous forms. On the other hand, it is probable that the core of “*Tubiphytes*” *moronensis* corresponds to nubeculariid forams. However, it remains to be seen whether the whole “envelope” represents the wall of the same foraminifers, since the SEM observations made by one of the present authors (B. SENOWBARI-DARYAN) show some differences in this respect.

4. Conclusion

The assemblage of calcareous algae identified in the Upper Jurassic deposits of the Madonie Mountains (Sicily) mostly comprises species well known in the whole Mesogean area. They are here associated with a coral and sponge fauna which represented the main bioconstructional elements in the reef environment of the Panormide Platform of the studied area (CATALANO et al., 1974).

The dasycladalean assemblage is dominated by species of the genus *Salpingoporella*, frequently found in the reef environment (*S. johnsoni*, *S. pygmaea*, *S. ettaloni*, *S. enayi*). *Neoteutloporella socialis* produced some colonies which are unique among Mesozoic dasycladaceans while *Suppiluliumaella delphica*, seems to be a species characteristic

of the same depositional environment. On the other hand, *Clypeina jurassica* and *Salpingoporella annulata*, two species frequently recorded within the inner part of the carbonate platforms from the Upper Jurassic are very rare in the studied area.

Among the Udoteaceae, *Carpathocodium anae*, is relatively frequent and *Nipponophycus ramosus* is important because its dendriform thallus was a real building element within the reef. The Solenoporaceae as well as the incrusting forms of *Bacinella-Lithocodium* type belong to the same environment.

Porostromata, characteristic for the inner part of the platform, are relatively scarce.

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PLATE 1

Figs. 1–8. *Suppiluliumaella delphica* (CARRAS), nov. comb.

1. Longitudinal-oblique section. Sample J302; x 16.
2. Longitudinal section. Sample J302; x 17.
3. Oblique section. Sample J302; x 19.
4. Transverse-oblique section. Arrow points to the secondary (?) ramifications. Sample J64; x 27.
5. Detail of the Fig. 7, pointing out the secondary(?) ramifications (arrow). Sample J312; x 28.
6. Detail of a transverse section showing the secondary ramifications (arrow). Sample J312; x 28.
7. Transverse-oblique section. Sample J312; x 19.
8. Longitudinal-oblique section. Sample J312; x 17.

PLATE 1

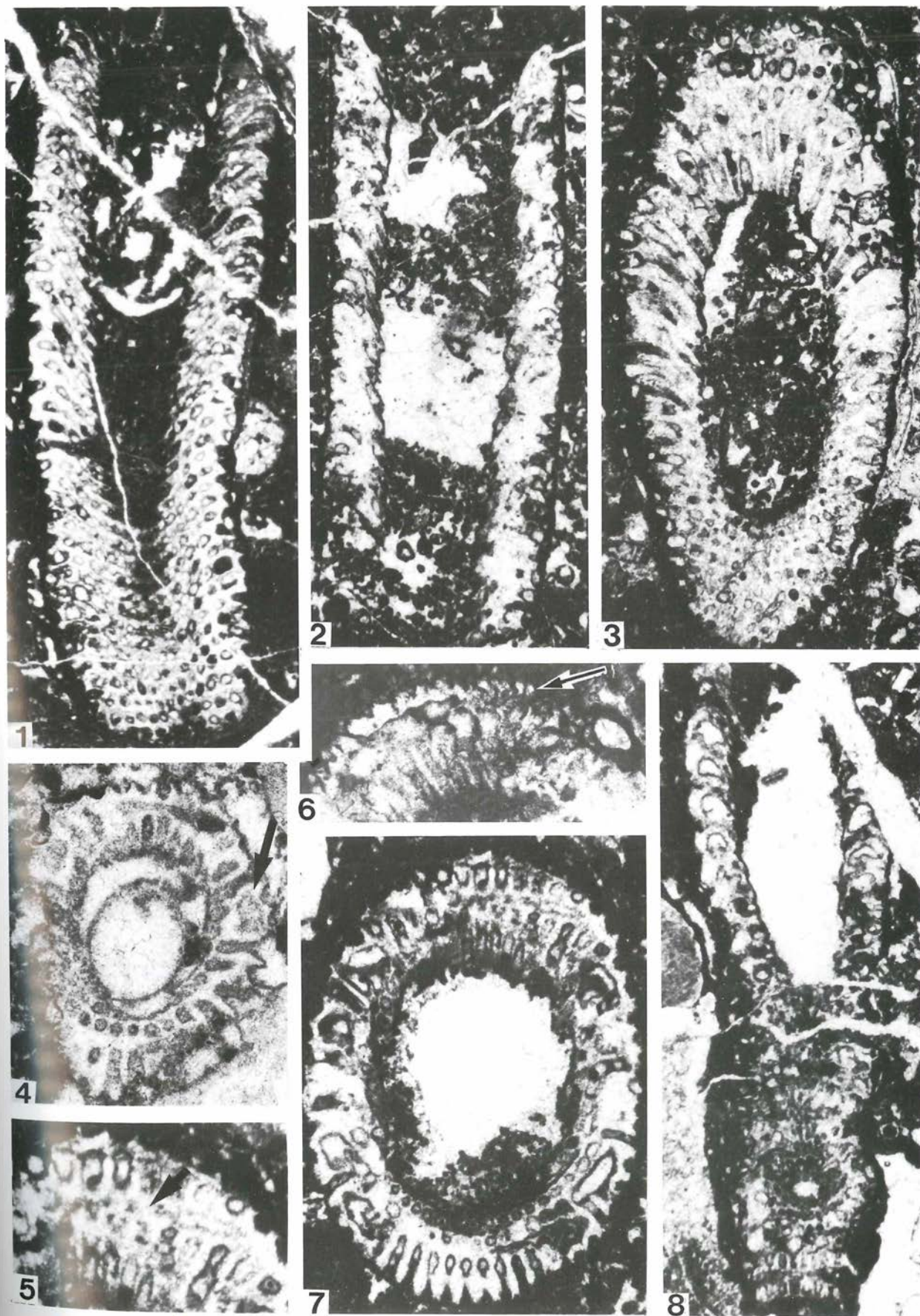


PLATE 2

Figs. 1–6. *Salpingoporella pygmaea* (GÜMBEL).

- 1, 2. Oblique sections. Sample J59; x 38.
3. Longitudinal section. Sample J37; x 63.
4. Longitudinal section. Sample J22; x 25.
5. Transverse-oblique section. Sample J22; x 63.
6. Transverse section. Sample J66; x 65.

Figs. 7–11. *Salpingoporella* gr. *ettaloni* BRERNIER – *pygmaea* (GÜMBEL).

7. Oblique section. Sample J51; x 75.
8. Oblique section. Sample J51; x 63.
9. Oblique section. Sample J304; x 75.
10. Transverse section. Sample J59; x 75 (together with the foraminifer *Trocholina alpina* (LEUPOLD)).
11. Transverse section. Sample J304; x 75.

Figs. 12, 13. *Salpingoporella* gr. *pygmaea* (GÜMBEL) – *enayi* BERNIER.

12. Oblique section. Sample J59; x 75.
13. Oblique section. Sample J59; x 32.

Fig. 14. *Salpingoporella* gr. *enayi* BERNIER. Longitudinal section. Sample J314; x 55.

PLATE 2

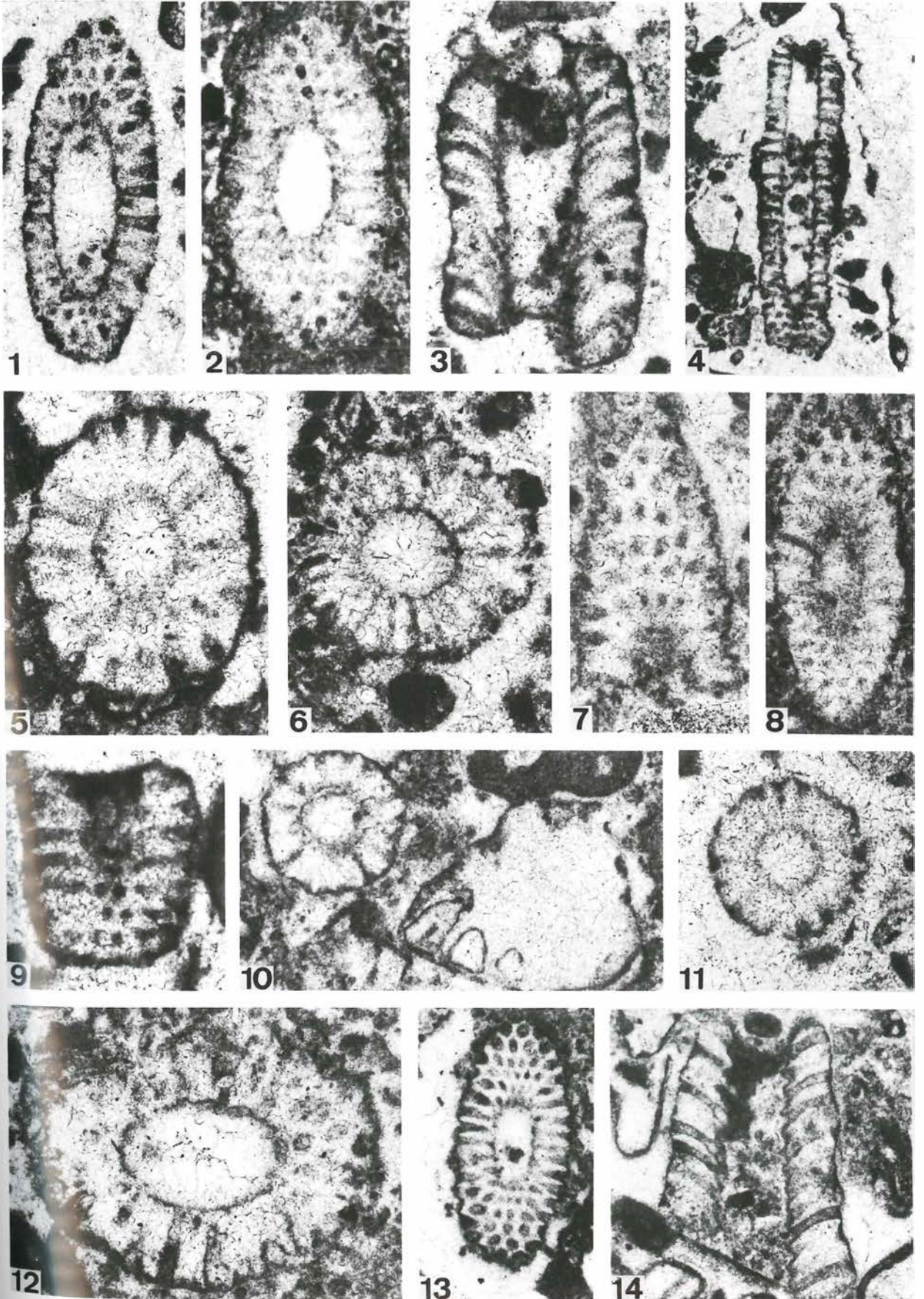


PLATE 3

Figs. 1–5. *Salpingoporella ettaloni* BERNIER.

1. Longitudinal section. Sample J72; x 50.

2. Oblique section. Sample J57; x 63.

3. Longitudinal section. Sample J24; x 75.

4. Oblique section. Sample J41; x 65.

5. Longitudinal section. Sample J41; x 115.

Fig. 6. *Salpingoporella* gr. *johnsoni* DRAGASTAN – *ettaloni* BERNER. Longitudinal section. Sample J32; x 115.

Figs. 7–9. *Salpingoporella johnsoni* DRAGASTAN.

7. Transverse-oblique section. Sample J48; x 100.

8. Longitudinal section. Sample J304; x 63.

9. Longitudinal-oblique section. Sample J78; x 75.

Fig. 10. *Neoteutloporella socialis* (PRATURLON). Thin section through many fan-like shaped colonies. Sample J36; x 2.

PLATE 3

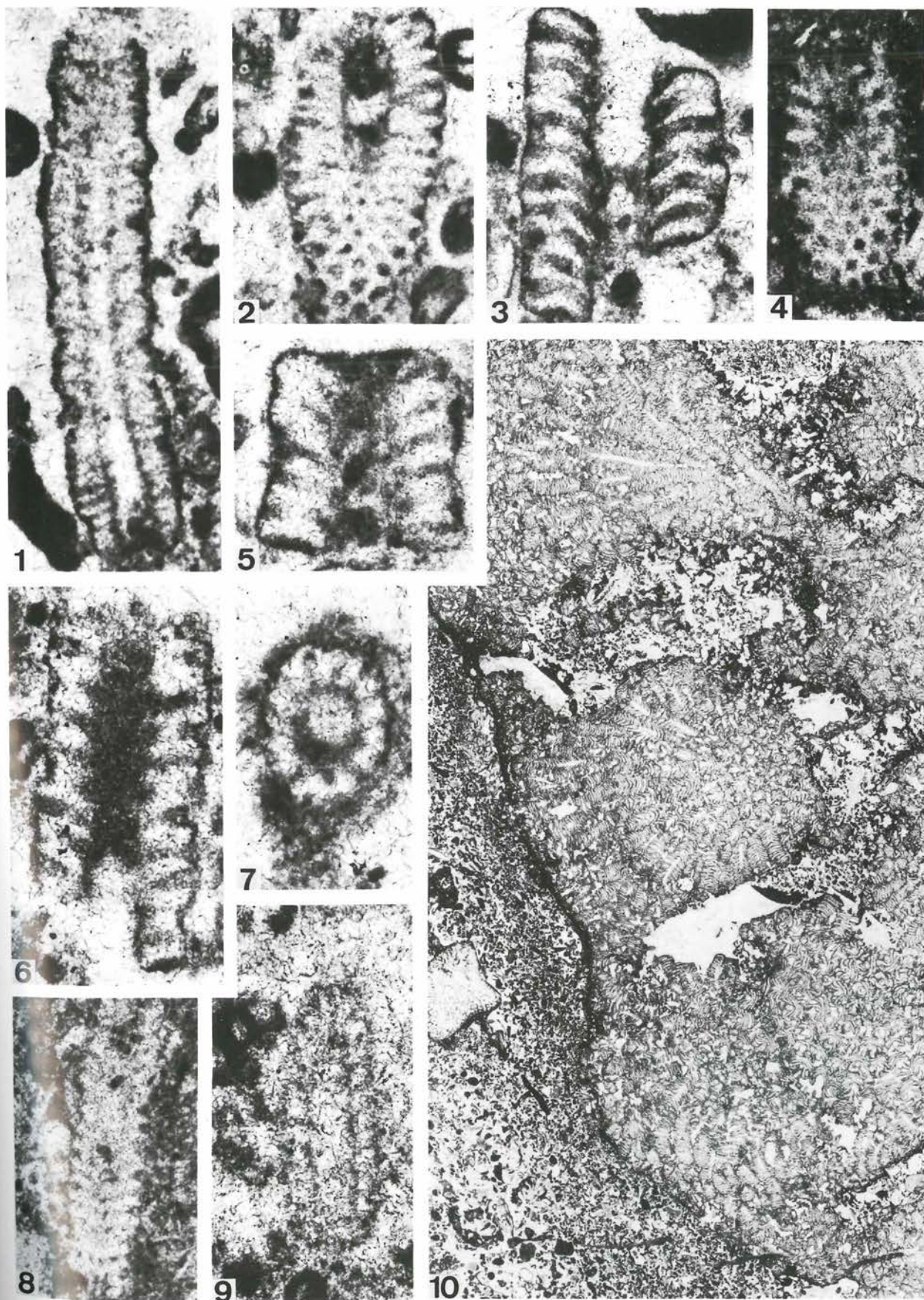


PLATE 4

Figs. 1–3, 6, 7. *Salpingoporella* gr. *enayi* BERNIER.

1. Longitudinal-oblique section. Sample J302; x 16.
2. Oblique section. Sample J48; x 40.
3. Oblique section. Sample J314; x 63.
6. Transverse-oblique section. Sample J314; x 50.
7. Transverse-oblique section. Sample J314; x 63.

Fig. 4. *Salpingoporella pygmaea* (GÜMBEL). Transverse section. Sample J66; x 63.

Fig. 5. *Salpingoporella annulata* CAROZZI. Oblique section. Sample J319; x 62.

Figs. 8, 11. *Salpingoporella enayi* BERNIER.

8. Oblique section. Sample J303; x 25.
11. Longitudinal section; Sample J66; x 55.

Figs. 9, 10, 12, 13. *Anisoporella* sp.

9. Fragment in longitudinal section. Sample J103; x 20.
11. Longitudinal-oblique section. Sample J302; x 27.
12. Fragment in oblique section. Sample J103; x 26.
13. Tangential section. Sample J55; x 20.

PLATE 4

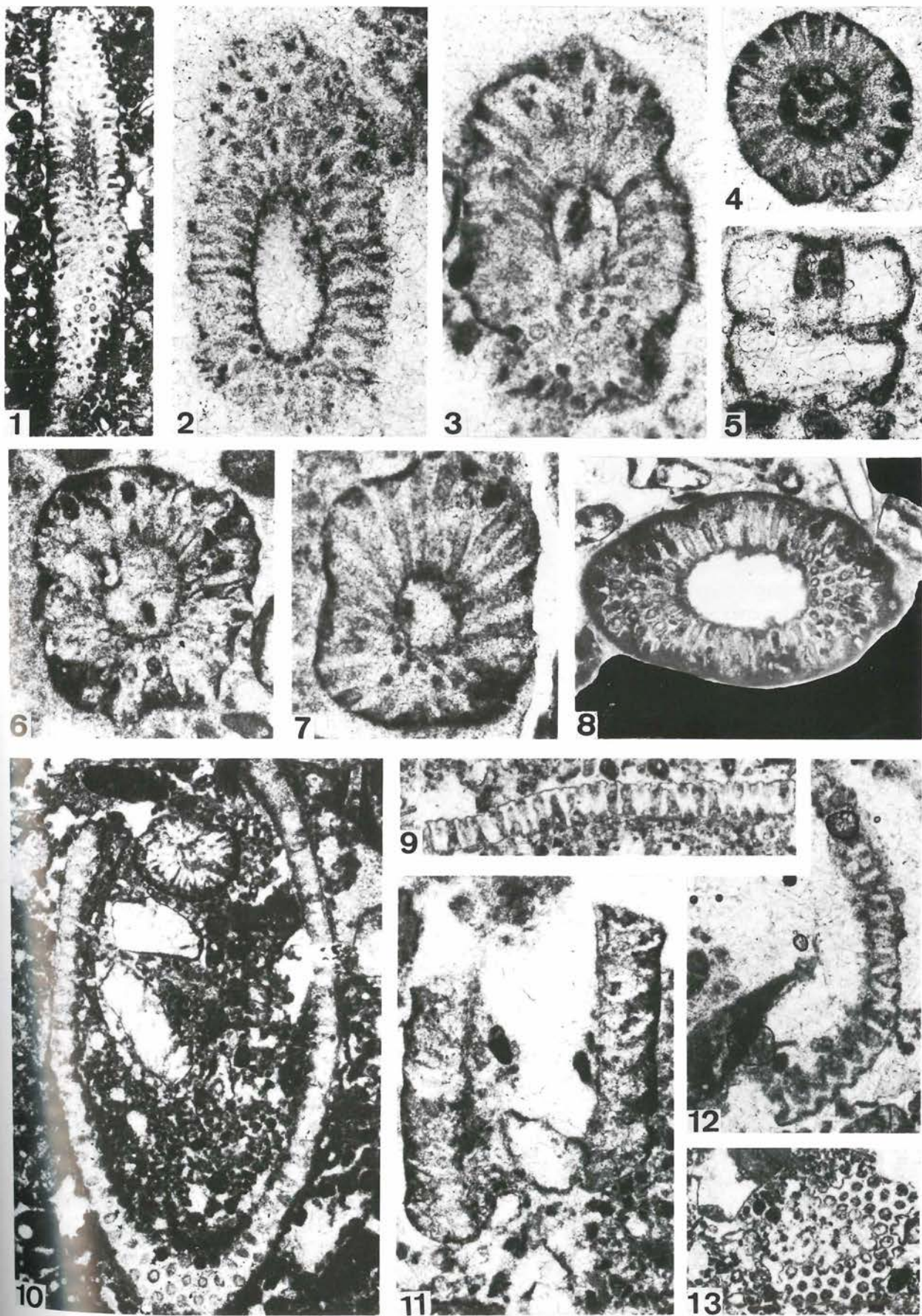


PLATE 5

- Figs. 1, 2, 12. *Neoteutloporella socialis* (PRATURLON). Transverse (1, 12) and oblique (2) sections through verticils. Sample J36; x 30.
- Fig. 3. *Tersella* ? sp. Fragment in longitudinal-oblique section. Sample J80; x 30.
- Figs. 4–6. *Clypeina jurassica* FAVRE.
4. Tangential section through two verticils. Sample J57; x 63.
5. Tangential section cutting two ramifications. Sample J57; x 63.
6. Transverse-oblique section through a verticil. Sample J57; x 38.
- Figs. 7, 8. Dasyclad fragments belonging probably to *Neoteutloporella socialis* (PRATURLON).
7. Sample J306; x 30. 8). Smple J 104; x 63.
- Fig. 9. *Epimastoporella jurassica* (ENDO) nov. comb. Fragment in longitudinal section. Sample J103; x 75.
- Figs. 10, 14. *Margueritiella* ? sp. cf. *Margueritiella densa* DRAGASTAN. Transverse-oblique sections. Sample J1; 1.; x ;8: 14: x 20;
- Fig. 11. *Carpathocodium* cf. *anae* (DRAGASTAN). Oblique section. Sample J302; x 70.
- Fig. 13. *Salpingoporella annulata* CAROZZI. Oblique section. Sample J66; x 35.
- Fig. 15. *Pinnatiporidium* sp. cf. *Pinnatiporidium clyindricus* DRAGASTAN. Longitudinal-oblique section. Sample J1; x 20.
- Fig. 16. *Salpingoporella enayi* BERNIER. Oblique section. Sample J302; x 43.

PLATE 5

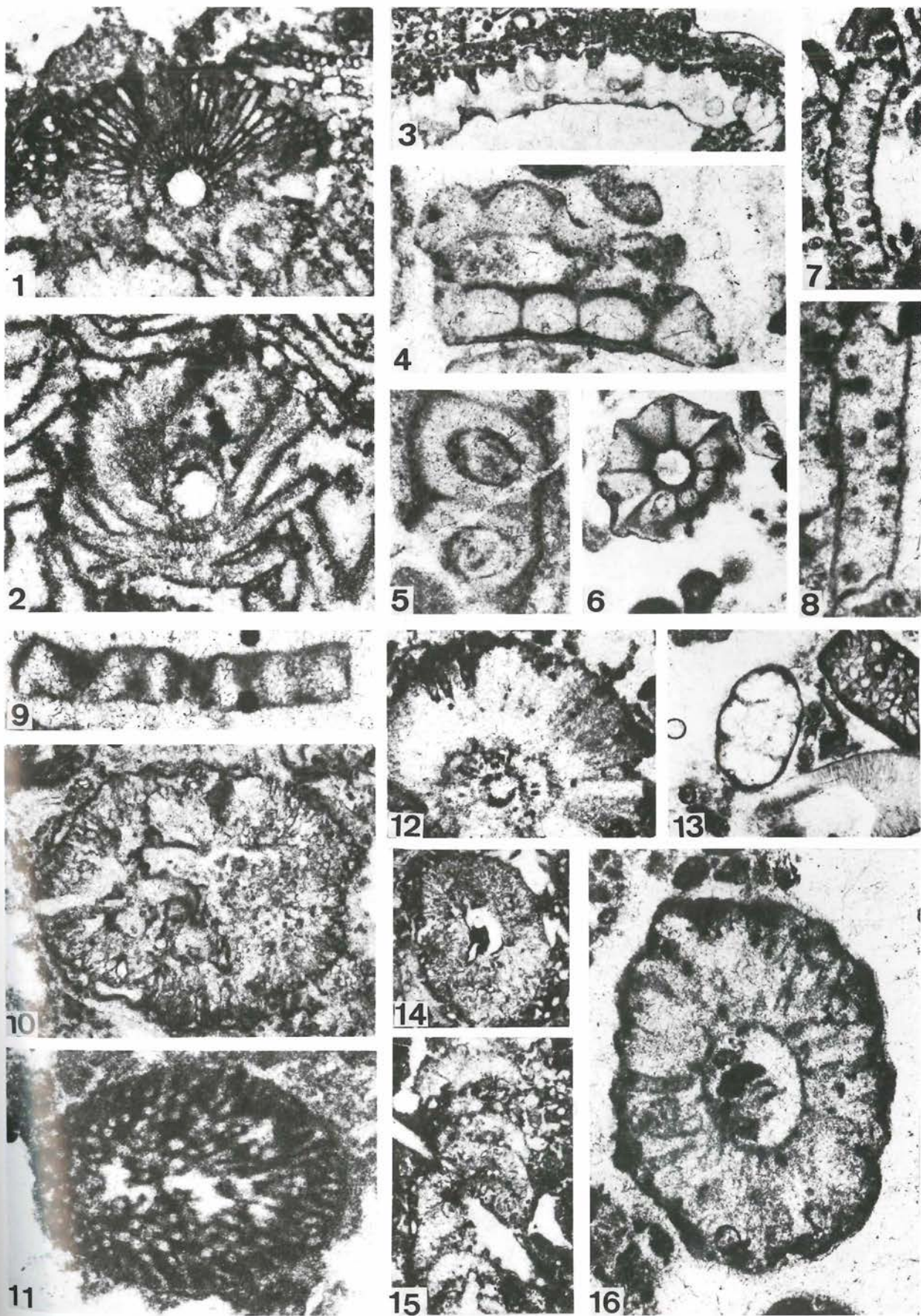


PLATE 6

Figs. 1–5, 7. *Carpathocodium cf. anae* (DRAGASTAN).

1. Longitudinal-tangential section. Sample J59; x 54.
2. Longitudinal-oblique section. Sample J313; x 38.
3. Longitudinal section. Sample T6; x 32.
4. Transverse-oblique section. Sample J1; x 50.
5. Longitudinal section. Sample J304; x 42.
7. Transverse-oblique section. Sample J304; x 63.

Fig. 6. Udoteacean alga, indet. Transverse-oblique section. Sample J50; x 32.

Fig. 8–11. *Nipponophycus ramosus* YABE & TOYAMA.

8. Transverse section. Sample J37; x 7.
9. Transverse and oblique sections. Sample T6; x 5.
10. Oblique section. Sample J32; x 32.
11. Longitudinal-oblique section showing the ramification of the thallus. Sample J305; x 32.

PLATE 6

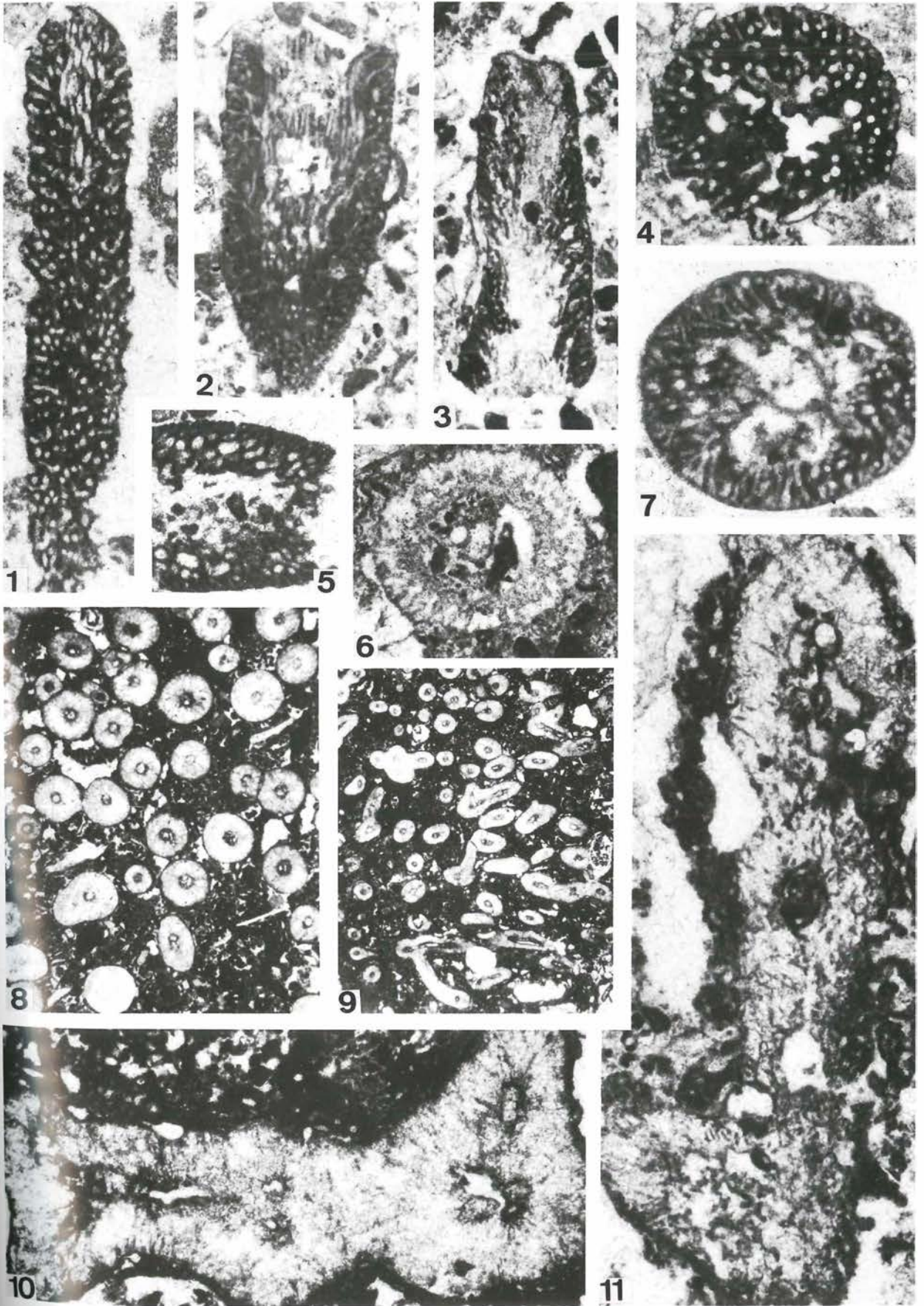


PLATE 7

Figs. 1–3, 5–7, 9. *Nipponophycus ramosus* YABE & TOYAMA.

1. Oblique section. Sample J305; x 55.
2. Oblique section. Sample J305; x 45.
3. Transverse-oblique section. Sample J54; x 38.
5. Transverse-oblique section. Sample J23; x 45.
6. Longitudinal section. Sample J305; x 32.
7. Oblique section. Sample J305; x 38.
9. Oblique section. Sample J302; x 28.

Figs. 4, 8. *Nipponophycus* sp.

4. Transverse section. Sample J302; x 55.
8. Transverse section. Sample J304; x 55.

PLATE 7

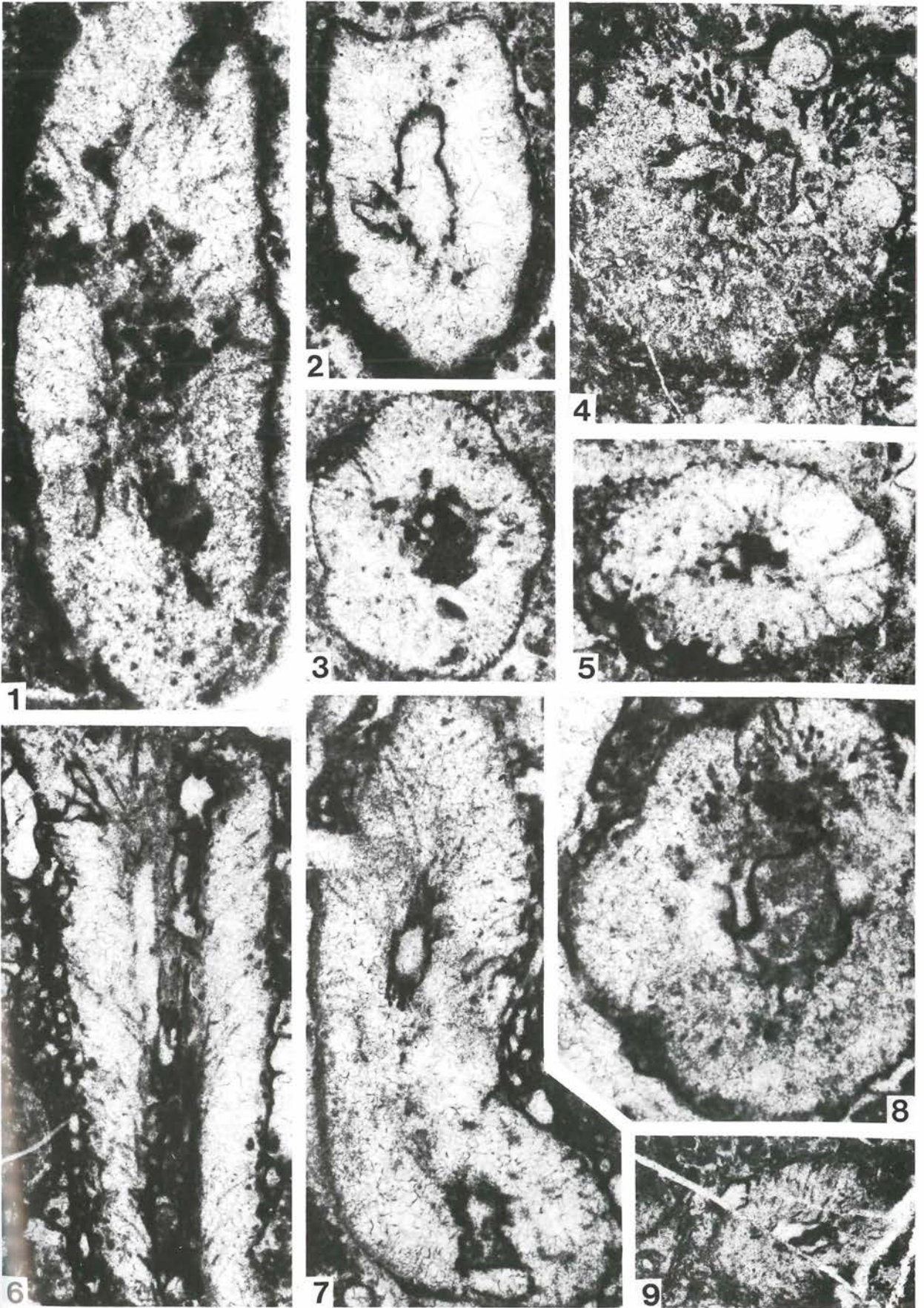


PLATE 8

Nipponophycus ramosus YABE & TOYAMA.
Framebuilder in transverse section. Sample J37; x 5.

PLATE 8

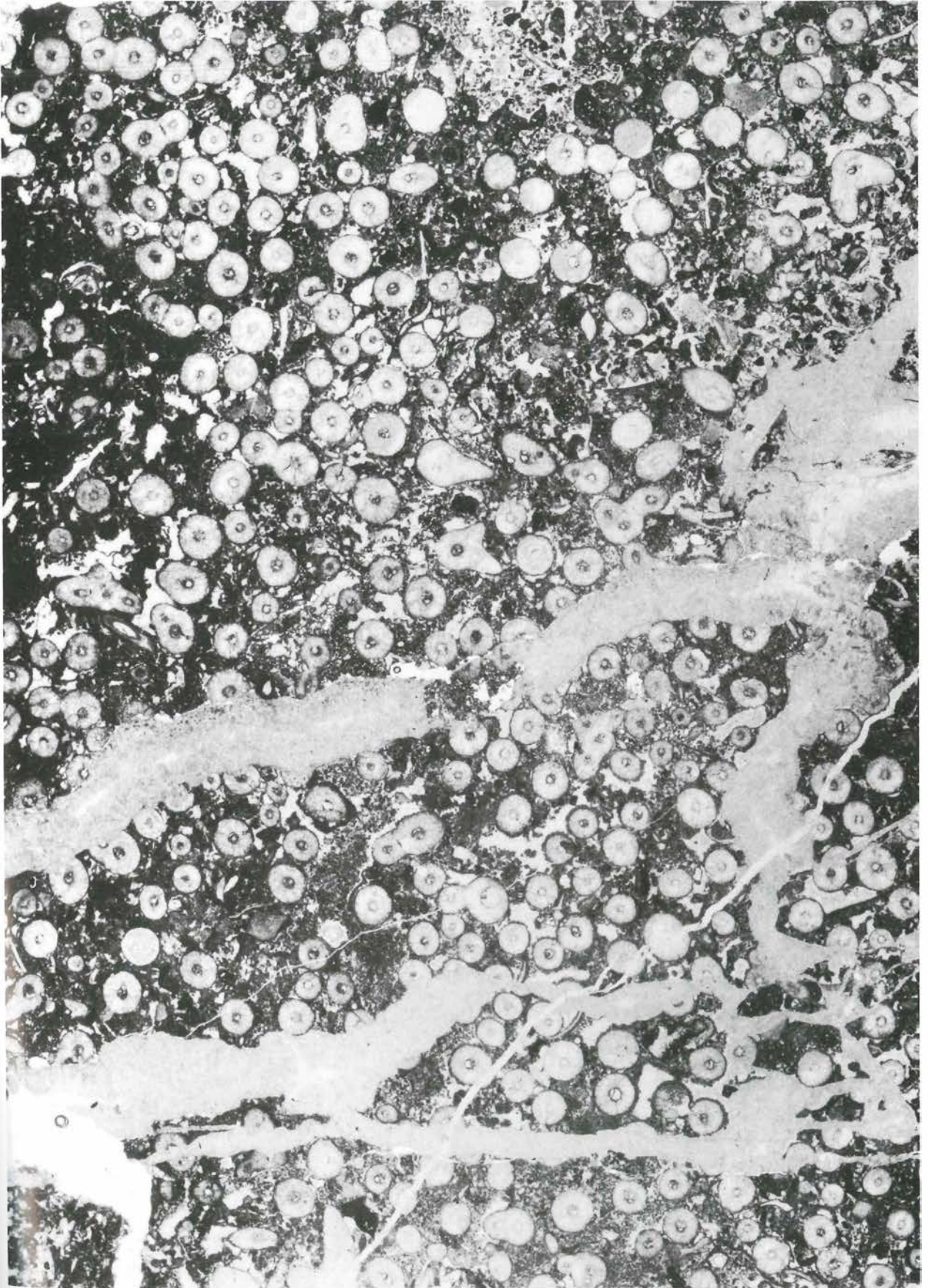


PLATE 9

Figs. 1–7. *Solenopora helvetica* PETERHANS.

1. Longitudinal section through a ramified branch. Sample J120; x 2,5.
2. Oblique section. Sample J321; x 10.
3. Longitudinal-oblique section. Sample J58; x 5.
4. Oblique section. Sample J304; x 8.
5. Longitudinal section. Detail showing the cell structure. Sample J120; x 20.
6. Longitudinal section. Sample J120; x 8.
7. Longitudinal-oblique section. Sample J120; x 8.

Fig. 8. *Permocalculus* sp. Longitudinal section. Sample J49; x 32.

Fig. 9. *Permocalculus* ? sp. Oblique section. Sample J49; x 15.

PLATE 9

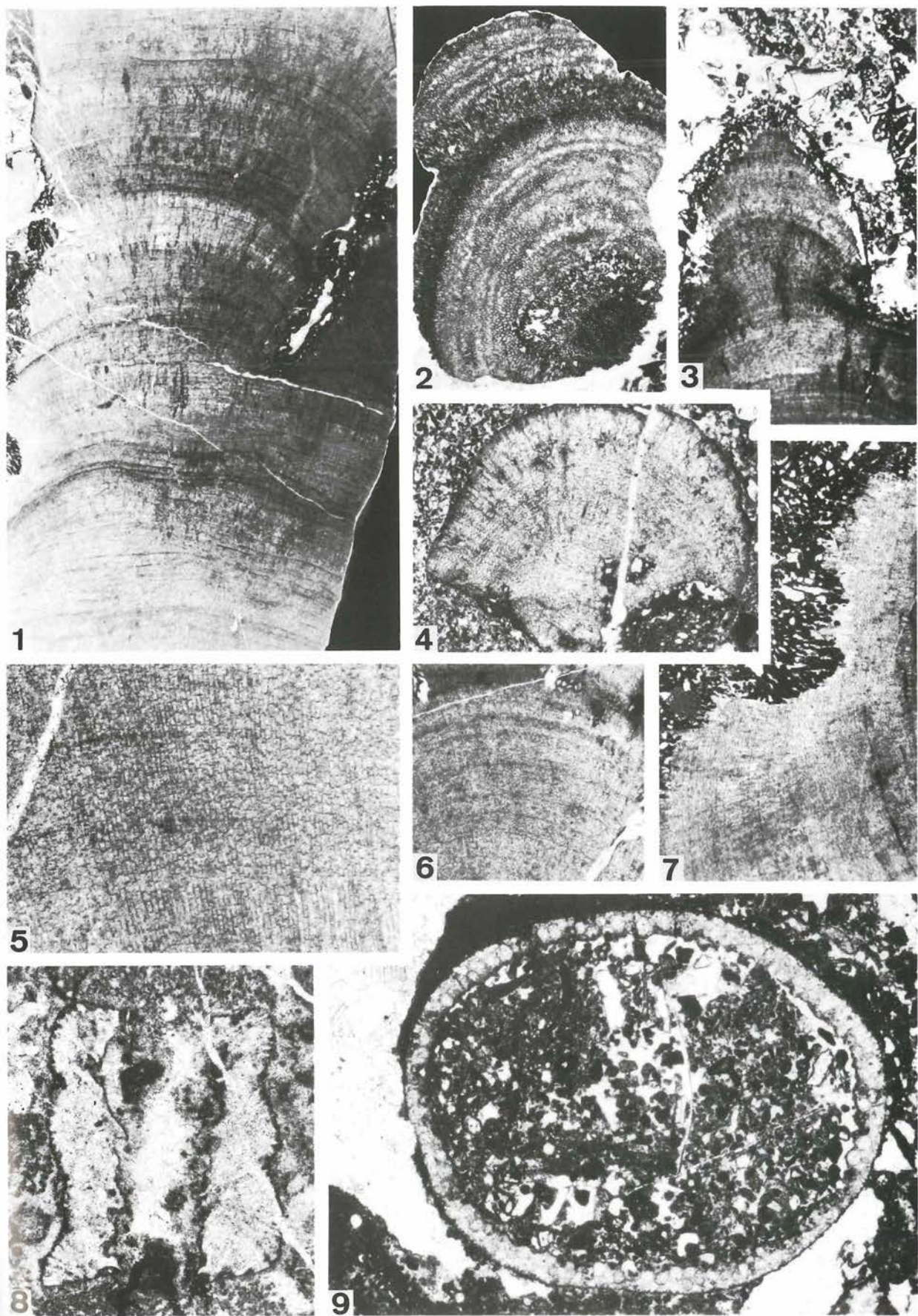


PLATE 10

Figs. 1–5. *Mitcheldeania americana* (JOHNSON). Longitudinal and oblique sections.

1. Sample J32; x 16.
2. Sample J45; x 20.
3. Sample J302; x 20.
4. Sample J302; x 16.
5. Sample J109; x 16.

Figs. 6–9. *Diversocallis moesicus* (DRAGASTAN & BUCUR). Longitudinal-oblique sections.

6. Sample J304; x 38.
7. Sample J102; x 38.
8. Sample J59; x 32.
9. Sample J56; x 92.

Fig. 10. *Koskinobullina socialis* CHERCHI & SCHRÖDER. Sample J69; x 50.

Fig. 11. *Ortonella?* sp. Sample J2; x 13.

PLATE 10

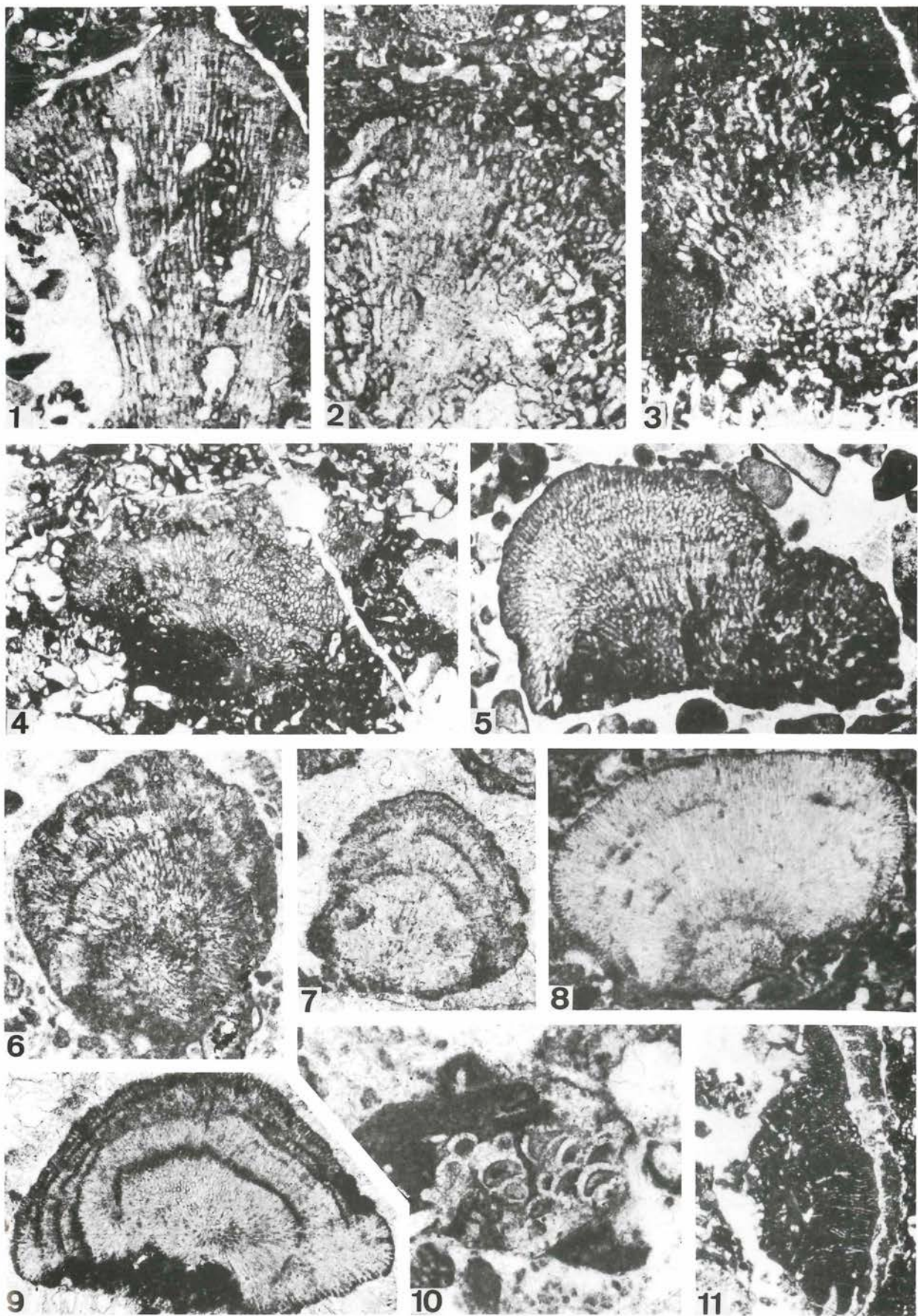


PLATE 11

- Figs. 1, 2. *Thaumatoporella parvovesiculifera* RAINERI.
1. Transverse-oblique section. Sample O.Nr.; x 35.
2. Longitudinal section. Sample J111; x 70.
- Figs. 3, 4. *Bacinella irregularis* RADOIČIĆ and *Thaumatoporella parvovesiculifera* RAINERI.
3. Sample J300; x 13.
4. Sample J33; x 10.
- Figs. 5–7. *Lithocodium aggregatum* ELLIOTT.
5. Sample O.Nr.; x 52.
6. Sample O.Nr.; x 38.
7. Sample J312; x 20.
- Fig. 8. *Lithocodium*-crust around a coral skeleton. Sample J78; x 17.
- Figs. 9–11. “*Tubiphytes*” *moronensis* CRESCENTI.
9. Sample O.Nr.; x 26.
10. Sample J78; x 33.
11. Sample J57; x 26.

PLATE 11

