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MESOZOIC ALGAE OF FAMILY PROTOHALIMEDACEAE DRAGASTAN, LITTLER & LITTLER, 2002 (CHLOROPHYCOTA): A CRITICAL REVIEW

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Abstract: The Mesozoic carbonate platforms from different parts of the Alpine realm (Transylvanian Carbonate Platform, Romania, Plassen Formation, Northern Calcareous Alps, Austria and central Parnassus Zone, Hellenides, Greece) revealed the presence of algal taxa with a primitive morphology of the thalli segments, included in the group of green-siphonous algae, as the Family *Protohalimedaceae*. This represents a group of Paleo-Mesozoic algae species ancestral to the Family *Halimedaceae* (Triassic-Recent).

The prolific genera of this group during the Mesozoic (Late Triassic, Late Jurassic-Early Cretaceous) were: *Felixporidium* Dragastan, 1999 (*F. triasicum* Dragastan, Kube & Richter, 2000, *F. atanasiui* (Dragastan, 1978) Dragastan 1985, *F. renatae* Dragastan & Richter, 2003, *F. balcanicus* Dragastan & Richter, 2003 and *F. flabelliforme* Dragastan & Richter, 2003) and *Pinnatiporidium* Dragastan, 1990 emend. Schlagintweit & Dragastan, 2004 (*P. cylindricus* Dragastan, 1990, *P. alpidicum* nov. comb. (Dragastan, 1990) Schlagintweit & Dragastan, 2004, *P. untersbergensis* Schlagintweit & Dragastan, 2004). Two former species, described initially as *Cayeuxia elliotti* (Dragastan, 1971) and *Bevocastria toomeyi* (Dragastan, 1985) are now transferred first taxon to the genus *Tethysicodium* and the second one to the genus *Pinnatiporidium*.

The genera *Carpathocodium* Dragastan, 1985 (*C. anae*), *Cortiporidium* Dragastan, 1990 (*C. calcareus*), *Tethysicodium* Dragastan, 1985 (*T. wrayi*), *Margueritiella* Dragastan, 1990 (*M. densa*) and *Akrokorinthiella furcata* Richter, Dragastan & Gielisch, 1992 are revised.

Some taxa such as *Felixporidium atanasiui*, *Pinnatiporidium untersbergensis*, *Carpathocodium anae* are assumed index species for the Late Kimmeridgian-Berriasian – Early Valanginian and *Felixporidium renatae*, *F. balcanicus*, *F. flabelliforme* and *Akrokorinthiella furcata* for the Valanginian-Hauterivian.

A phylogeny of some families from Order *Siphonales*, Class *Siphonophyceae* (Chlorophycota) is also presented.

Key words: Mesozoic, algae Protohalimedaceae, Siphonophyceae, Chlorophycota, phylogeny revision of genera and species.

INTRODUCTION AND EVOLUTIVE PATHWAY

In the last decade, the intensive studies of green-siphonous algae (Chlorophycota) from different Late Triassic, Late Jurassic to Early Cretaceous Alpine carbonate platforms brought about the discovery of several new genera and new species. The taxa described by different authors were treated with uncertain systematic positions along the years being assigned to different taxonomic rank (Tappan 1980, Silva 1980, 1982, Silva *et al.* 1996, Dragastan 1969, 1971, 1975, 1978, 1980, 1981, 1985, 1985a, 1990, 1990a, 1999, 2000, 2002, Dragastan & Düzbastillar 1993, Dragastan *et al.*, 1997, Hillis-Colinvaux 1980, 1984, 1986, Flügel, 1975, 1988, Bassoullet *et al.*, 1983, Darga & Schlagintweit 1991, Bucur, 1978, 1985, 1988, 1994, Dragastan *et al.*, 1997, Dragastan & Richter, 1999, Dragastan & Ciobanu, 2002, Dragastan, Littler & Littler 2002, Dragastan & Soliman 2002, Schlagintweit, 1990, Schlagintweit, Gawlick & Lein 2003, Schlagintweit & Dragastan 2004, Schlagintweit *et al.* 2004, 2005, Senowbari Daryan & Link 2004 and Herbig & Dragastan, 2005).

The new family *Protohalimedaceae* (Chlorophycota) introduced by Dragastan, Littler & Littler 2002 contains taxa from Silurian-Permian and from the Late Triassic to Cretaceous considered an ancestral and primitive group from which the family *Halimedaceae* is separated.

Definition of rank Protohalimedaceae: Thalli composed by cylindrical branched or not branched, hemisphaerical, spheroidal or fan-shaped and different shape of segments: cylindrical, ovoidal to sphaeroidal, flabelliform, fan-shaped, somewhat flattened during Mesozoic. Segments disposed in different ways, vertical, uniaxial each-others superposed or vertically and bilaterally with segments disposed on both sides of the axis. The segments growing vertical and lateral, overlapping each others.The segments are frequently crossed by an uniaxial medullar siphon, also multiaxial in some cases, or as an empty hollow. The medullar siphon entered in each segment having an cylindrical–bilateral disposition.

The cortex has different thickness. It is crossed by various shaped primary, secondary, tertiary and quaternary series of siphons (Dragastan, Littler & Littler 2002).

The *Protohalimedaceae* represents a primitive group of green siphonous algae with variable number of cortical siphons (1-4) in some cases dichotomously branched.

Within this group it is difficult to use the terms utricle instead of cortical siphons. In Littler & Littler 2000 utricle is defined as „swollen, terminal end of a siphon generally in the cortex or surface layer„.

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The stratigraphical range and evolution of the green siphonous genera of Class *Siphonophyceae* Haeckel 1894 (*Chlorophycota* Engler 1903) covered the Cambrian–Ordovician to Recent time-span.

In a series of papers Chiuvashov, Luchinina & Shuysky 1987, Shuysky & Shrishova 1988 and Shuysky, 1987, 1996 described the morphology of thalli for many new taxa included in the Order *Siphonales*.

In a short note, Shuysky 1996 introduced a scheme on p.153, fig. 5 which represents the first attempt to establish the phylogeny of algae from Order *Siphonales* during the Phanerozoic (Text-Fig.1).

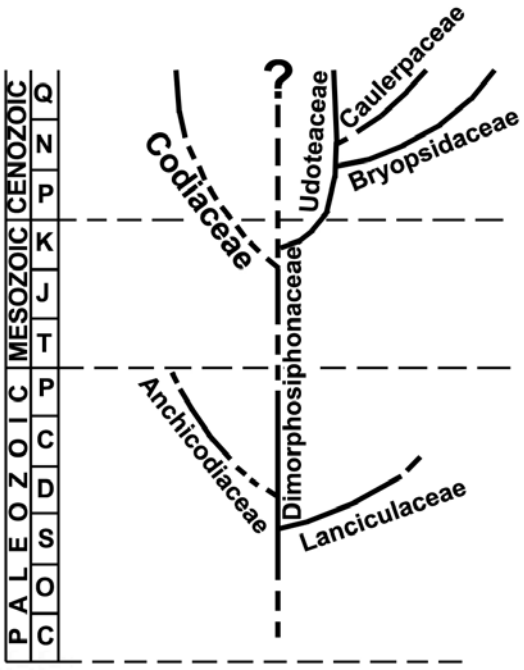

Fig. 1 – Schematic phylogeny of the families from Order *Siphonales* (from Shuysky, 1996)

In this scheme, the main evolutive line of the Order *Siphonales* is the family *Dimorphosiphonaceae* (genera *Dimorphosiphon* and *Dimorphosiphonoides* and many others, see Dragastan *et al.* 2002), which has representatives from Ordovician until Permian/Triassic boundary.

After this boundary, the same line continued intermittently until Recent ?, but with a „small" re-occurrence between Late Triassic–Jurassic including here the genus *Boueina* Toula 1883, Tribe *Boueineae* Shuysky 1987, a genus which is considered a junior synonym of the genus *Halimeda* by Dragastan, Littler & Littler 2002.

From *Dimorphosiphonaceae* main line (see Shuysky 1996) two evolutive lines are detached, one belonging to the Family *Anchicodiaceae* and a second one to the Family *Lanciculaceae* .

The family *Anchicodiaceae* included genera from Devonian until Permian (*Eugonophyllum*, *Anchicodium*, *Ivanovia*, *Paradella*, *Calcifolium*). The morphology of genera belonging to this family is different not owing a real siphonous structure and belonging to a group of phylloidal red algae.

The second family *Lanciculaceae* is a branch-line having a Devonian stratigraphic range with thalli formed by cylindrical, sphaeroidal contorted segments crossed by an uniaxial-medullar siphon and only primary cortical siphons.

In the scheme of Shuysky the presence of the *Dimorphosiphonaceae* during the time span between Cretaceous and Recent is presumed without mentioning some representative taxa. In the same scheme of Shuysky during Jurassic / Cretaceous until Recent the evolutive line of the family *Codiaceae* is shown to include a „mixture" of different taxa such as *Hedstroemia*, *Cayeuxia*, *Ortonella*, *Palaeoporella* and *Arabicodium.* Today is largely accepted (Johnson, 1961, 1969, Konishi 1961, Elliott 1957, 1965, 1982, Mamet, 1976, Mamet & Roux, 1980, Roux 1985, Dragastan, 1970, 1971, Dragastan *et al.* 1997, Dragastan, Littler & Littler 2002, Mamet & Villa, 2004) that now this family includes only the genus *Codium* and other genera correspond to different ranks like the family *Pseudoudoteaceae* (*Hedstroemia*) or to cyanophyceans (*Ortonella, Cayeuxia* syn. with *Rivularia*). The family *Udoteaceae* is indicated as a line which starts from Cretaceous and continued till the Recent containing only species of the genus *Halimeda*. From this line, two families evolved, the *Bryopsidaceae* at the Paleogene/Neogene boundary and the *Caulerpaceae* separated during the Middle Neogene, but both groupes without further commentaries and listing of representative taxa.

The Recent data accumulated during the last decade allows to conceive a new evolutive scheme for the green-siphonous algae of Class *Siphonophyceae* Haeckel 1894, Phylum *Chlorophycota* Engler 1903.

The stratigraphical range of this group of algae covered the Cambrian - Ordovician to the Recent time-span (Text-Fig. 2).

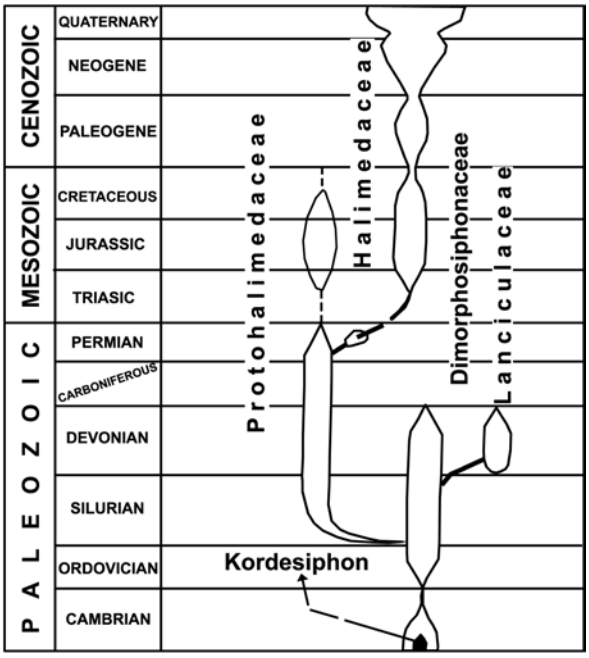

Fig. 2 -The Phanerozoic evolution - lines of some green - siphonous calcareous algae

Order Siphonales, Class Siphonophyceae , Phylum Chlorophycota .

The ancestor of siphonophyceans algae could be the genus „*Kadvoya* „ Korde 1973 (Family *Kadvoyaceae* Korde) recorded and described from the Early Cambrian and considered a primitive red alga of Class *Protofloridomorphophyceae* Korde 1973. From all the original figures in Korde, only the specimens of *Kadvoya mirabilis* shown on Pl. XVII, Fig. 4 presents „traits" of green siphonous algae, being the most representative .

For the mentioned specimen (Korde, 1973, Pl. XVII, Fig.4) which we cosider a siphonous alga and we propose here the new genus *Kordesiphon* with the following diagnosis: Thallus composed by cylindrical segments, with an uniaxial medullar siphon and a cortex crossed by primary ovoidal – claviform siphons, probably continued with secondary long, tubular to slightly claviform siphons, simple not branched.

Type species: *Kordesiphon princeps* n. gen., n. sp. (Pl. 10, Fig.1) dedicated to famous paleoalgologist K.B.Korde .

Remarks: In the description, Korde (1973: p. 142) remarked „that the specimens at Pl. XVII , Figs. 3-4 could be compared with siphonous algae„.

From the ancestral genus *Kordesiphon* found in Early Cambrian by Korde the evolutive line continued with taxa from family *Dimorphosiphonaceae* during Ordovician-Devonian. The line continued, as Shuysky (1996) correctly assumed with interruption until Late Jurassic when *Abacella unica* Dragastan 1990 appeared as Upper Jurassic taxon from Getic carbonate platform, Southern Carpathians (Romania).

A Devonian branch of family Lanciculaceae evolved from *Dimorphosiphonaceae* as a lateral line with „special" shape of segments crossed by uniaxial medullar siphon and cortex with only primary siphons not branched ending with ovoid bodies which may be considered as sporangia. According to Shuysky, the *Lanciculaceae* show similarities with dasycladaceans, especially *Diploporaceae* and *Acetabulariaceae* .

During the Silurian, a new evolutive line separated the family *Protohalimedaceae* comprising two different stocks of genera, one with Paleozoic and the other with Late Triassic-Cretaceous representatives (Dragastan, Littler & Littler 2002).

During Permian-Triassic, another family, the *Halimedaceae* evolved from *Protohalimedaceae* group of genera and continued long time crossing Mesozoic –Cenozoic until Recent.

During Recent time and Pliocene –Pleistocene, the phytocommunities of genus *Halimeda* were enlarged with 35 species (37 species ?) spreading worldwide in all tropical and subtropical areas of the Oceans (Herbig & Dragastan, 2005).

GEOLOGICAL SETTING

The closure of the Tethys Ocean starting in the Middle Jurassic caused the sequence deposits of carbonate clastic radiolaritic flysch basins, and the installation of shallow water carbonate facies in a large areas of shelf (undathem) or platforms depositional settings.

The main taxa of protohalimedaceans algae (Order *Siphonales* Kirchner 1878) were discovered and described from the followings Mesozoic shelf carbonate platforms:

-*Transylvanian* and other *carbonate platforms*, Late Jurassic – Early Cretaceous on the Romanian territory;

-*Northern Calcareous Alps*, Late Jurassic – Early Cretaceous deposits on the Austrian territory and

- *Peloponnesus* and *Subpelagonian* Zone, Methana, Akrokorinth, Early Cretaceous and Subpelagonian Zone, Hydra Island, Late Triassic reef basin, Greece.

TRANSYLVANIAN CARBONATE PLATFORM – Transylvanian carbonate platform representing a large shelf carbonatic area defined by Patrulius *et al.* (1976) during Jurassic-Cretaceous was a source of discoveries regarding new genera and species from the family *Protohalimedaceae.*

The main type localities with siphonous algae are located in the Bicaz Gorges, Hăghimaş Mts., East Carpathians (Text-Fig. 3). From this area the following taxa were described: *Felixporidium atanasiui* from Bicăjel and Făgetul Ciucului Massifs, *Pinnatiporidium cylindricus* from Suhard Massif, *P. alpidicum* (= Felixporidium alpidicum, holotype from Northern Calcareous Alps) and from Făgetul Ciucului Massif and *Carpathocodium anae.*

The taxa *Tethysicodium wrayi*, *T.elliotti* and *Margueritiella densa* were described from the Făgetul Ciucului Massif.

Subsequently some taxa like *Pinnatiporidium cylindricus*,*Tethysicodium wrayi* were reported also from Vânturarița and Mateiaş Massifs, Getic carbonate platform, Southern Carpathians and also *Carpathocodium anae* from the Pui Zone.

The other taxa described from Late Jurassic by Dragastan in 1985 and 1990a from different localities of shallow – shelf water deposits are:

- *Cortiporidium calcareus*, Vânturarița, Getic carbonate platform, Southern Carpathians and Cetea Hill, Trascău Mts., Southern Apuseni;

- *Palaeoporella jurassica*, Vânturarița, Getic carbonate platform, Southern Carpathians and Aştileu, Bihor carbonate platform, Northern Apuseni;

- *Palaeoporella tubulata*, Făgetul Ciucului Massif, Transylvanian carbonate platform, Bicaz Gorges, Hăghimaş Mts., East Carpathians;

- *Lowvillia paucipora* from Giuvala Massif, Getic carbonate platform and

- *Pinnatiporidium toomeyi* from Presaca Ampoiului, Southern Apuseni.

The taxon *Banatocodium surarui* Bucur 1994 was discovered on Caraşova in the Lower Barremian limestone, Banat, Getic carbonate platform, Southern Carpathians.

In the majority of the cases, the most dominant and abundant species from the Mesozoic *Protohalimedaceae* algae correspond to genera *Pinnatiporidium* and *Felixporidium.*

age based on benthic foraminifera and dasycladaceans (Schlagintweit *et al.* 2003, 2005). After an initial shallowing upwards phase with slope and platform margin deposits, the Late Kimmeridgian and Early Tithonian is represented by transgressive –regressive cycles including the repeated occurence of tidal flats and open lagoonal facies followed by the closed lagoon.

Fig. 3 -Structural units and carbonate platforms of Romanian Carpathians and foreland (from Patrulius, 1976): Bd-Bedeleu; A-Aiudului Gorges; R-Rimetea; Turda Gorges; Hg-Haghimas, incl. Bicaz Gorges; Ot-Olt ; P-Persani; Ce-Cernavoda, (★) occurences with *Protohalimedaceae* algae .

The species *Pinnatiporidium cylindricus* and *Carpathocodium anae* represented by entire segments thalli or as broken segments only with cortex occur frequently in the mudstones-wackestones from outer shelf, barrier rim to the slope deep sea basin as allodapic elements (Dragastan 1999).

The species of genera *Tethysicodium*, *Felixporidium*, *Margueritiella*, *Cortiporidium*, *Palaeoporella*, *Lowvillia* and some *Pinnatiporidium* predominantly found in wackestones, washed –out packstones and in oolitic or bioclastic grainstones of the back-reef environment corresponding to the inner and middle shelf.

NORTHERN CALCAREOUS ALPS – In the Northern Calcareous Alps on the top of advancing nappes and uplifted blocks, shallow water platform carbonates containing abundant microfossils and calcareous algae evolved in a shallowing upward cycles from basinal sediments (e.g. Frisch & Gawlick, 2003, Schlagintweit *et al.*, 2003 and 2005). Recent investigations have shown that at the type-locality Mt. Plassen, the Plassen Formation is Kimmeridgian to Lower Berriasian in

Here especially the subtidal parts of these cycles are rich in siphonous green algae and cyanophyceans (e.g. genera *Hedstroemia*, *Garwoodia*, *Pseudoudotea*, *Pseudomitcheldeania*, *Bicaziella*, *Rivularia* and *Paraortonella*, Schlagintweit *et al.* 2005).

In the uppermost Tithonian, poorly-washed out packstones, bindstones, bioclastic packstones occur (back-reef facies) grading into coral-stromatoporoid reefal limestones with ellipsactinids followed by slope and finally basinal facies with Upper Berriasian calpionellids (*Oblonga* Subzone, e.g.Grün & Blau 1997).

Within this back-reef facies of Late Tithonian age, representatives of the protohalimedacean *Pinnatiporidium* occur. In a comparable facies, but of Upper Kimmeridgian age. The taxon *Pinnatiporidium untersbergensis* has been described from the Plassen Formation of Mount Untersberg near Salzburg (Schlagintweit & Dragastan 2004).

By far the most abundant occurences of *Pinnatiporidium* and *Felixporidium* are form the Lärchberg Formation in the area of Lofer, e.g.

Mount Dietrichshorn (Darga & Schlagintweit 1991) and the Litzelkogel-Gerhardstein complex (Text-Fig. 4). Worthmentioning that Mount Dietrichshorn is the type –locality of *Felixporidium alpidicum* Dragastan 1999 recently transfered to the genus *Pinnatiporidium* (Schlagintweit & Dragastan 2004).

Representatives of *Pinnatiporidium* and *Felixporidium* occur frequently in wackestones and poorly washed –out packstones to rudstones of a sheltered back-reef environment. The couplet „reefal facies - back-reef lagoon" occurs twice, in the Late Kimmeridgian and in the Late Tithonian-Early Berriasian, with two abundance peaks of *Pinnatiporidium* various species.

assemblages with *Salpingoporella pygmaea*, *Paraortonella richteri* and *Teutloporella obsoleta* (Kimmerdgian-Tithonian in age) and with *Rivularia theodori*, *Ortonella lemoineae* and *Andersenolina alpina* (Berriasian-Valanginian or Neocomian in age).

The protohalimedacean alga *Akrokorinthiella furcata* Richter, Dragastan & Gielisch 1992 was described from the Neocomian of Mount Akrokorinth situated NE of the Peloponnese. Initially assigned to family Codiaceae, subfamily Halimedoidea, the alga, consisting of a thallus formed by ovoidal segments superposed each-others more or less laterally, crossed by an

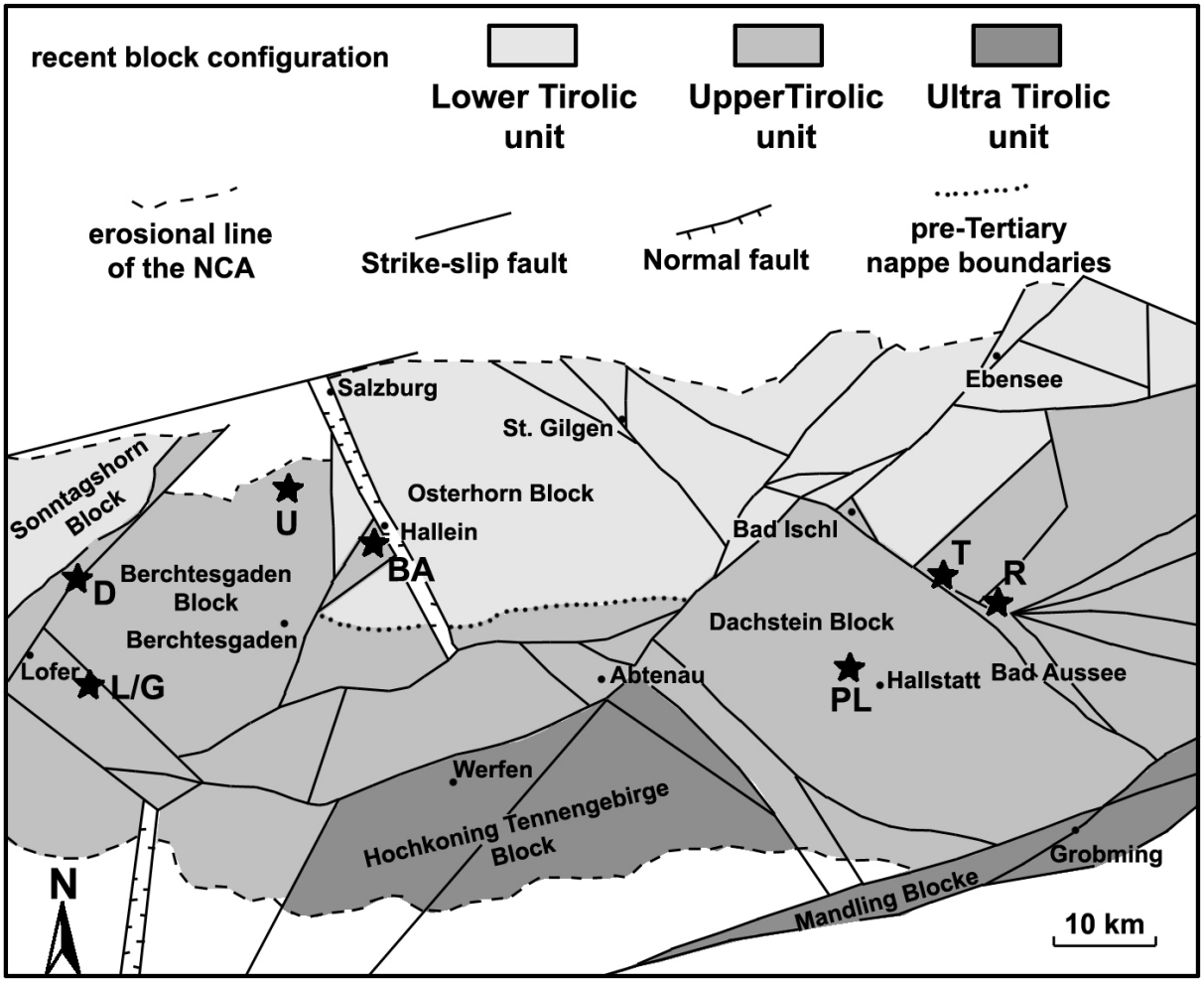

Fig. 4 -Recent tectonic block configuration of Central Northern Calcareous Alps after Fritsch & Gawlick (2003) with (★) occurences of *Felixporidium*, *Pinnatiporidium and Rivularia barmsteinensis* from U-Untersberg; B-Bramsteine; T - Tressenstein; PI-Plassen; D-Dietrichshorn; Li-Ge-Litzekogel - Gerhardstein (from Schlagintweit, Missoni, Lein & Gawlick, 2004)

SUBPELAGONIAN CARBONATE PLATFORM – In the Hellenic geotectonic framework of the zonation, the sedimentary series of Akrokorinth - Methana areas of NE Peloponnese and Hydra Island (Greece) are located in the Subpelagonian Zone (Text-Fig.5) on the southernmost margin of the Pelagonian platform transitional of the Pindos Zone (Richter *et al.*1992 and Dragastan, Kube & Richter 2000).

AKROKORINTH AREA – The Jurassic-Cretaceous boundary crossing the Akrokorinth limestone sequences was marked between the

uniaxial medullar siphon and the cortex with one to four series of siphons corresponds to a prothalimedacean-type thallus structure. With respect to this observation, Richter *et al.* (1992) remark, that it „is an alga with a siphonous organisation level".

In the same location also *Franconiella peloponnesiaca* Richter, Dragastan & Gielisch 1992 was found which by his morphology with siphonous blade was transfered from the family Codiaceae to the family Pseudoudoteaceae.

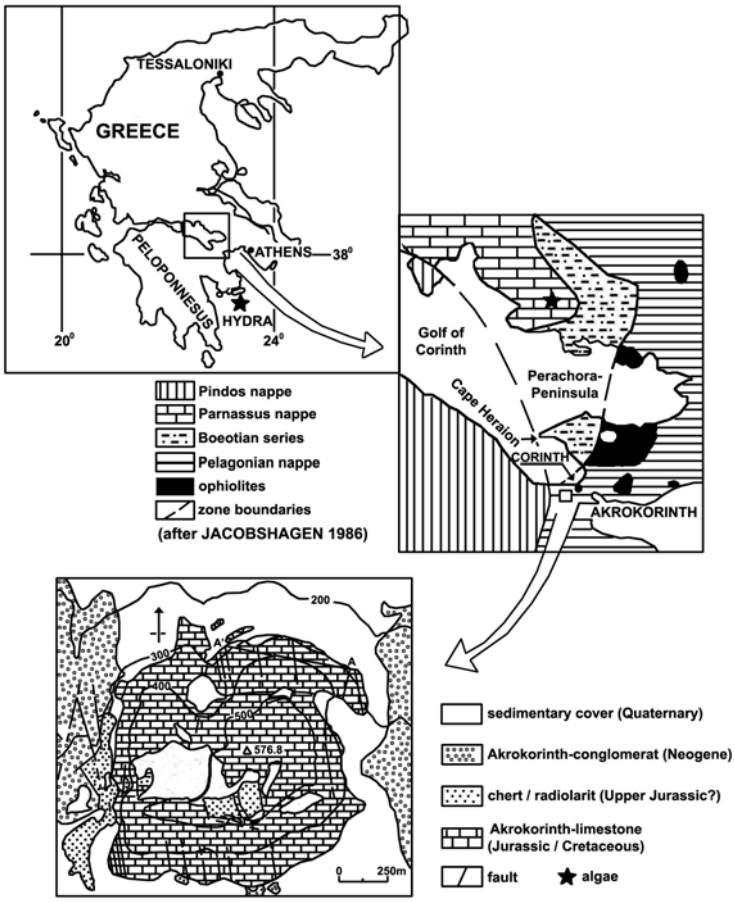

Fig. 5 -Sketch maps of the study area showing the isopic zones of Greece (middle graph), the samples from Akrokcorinth limestones and Hydra island (★) and occurences with *Protohalimedaceae* algae (from Richter, Dragastan & Gielisch, 1992).

METHANA AREA - The pile of limestone sequences Berriasian- Hauterivian in age are disposed in the south-eastern part of Methana peninsula (Text-Fig. 5). The lowermost Cretaceous limestones with algae are covered by rudist-limestones with *Offneria* sp., Barremian-Lower Aptian in age (Dragastan & Richter 2003).

The limestones from Methana area revealed a variety of protohalimedacean algae dominated by species of the genera *Felixporidium* and *Pinnatiporidium*. Besides *Felixporidium atanasiui* described first from Bicaz Gorges, Hăghimas Mts., Transylvanian carbonate platform (Romania), the following other new species of the genus *Felixporidium* were recorded: *F. renatae* (Early Valanginian), *F. balcanicus* (Late Valanginian - Hauterivian) and *F. flabelliforme* (Late Valanginian - Hauterivian).

In addition, two other taxa *Pinnatiporidium alpidicum* and *Margueritiella densa* from the Early Valanginian were found in the limestones of Methana (Greece), both species outside of their type – localities Bicaz Gorges, Hăghimas Mts., East Carpathians, Transylvanian carbonate platform, Romania.

HYDRA ISLAND – A Middle to Late Triassic reef basin complex dominates the geology of Hydra island, consisting of deep water carbonates on the southern thrust sheet, while in the northeastern part shallow water limestones appear (Richter 1999). In the area of Kap Kastello a brecciated level of uppermost Triassic to Early Jurassic age overlies lagoonal carbonates of Norian-Rhaetian age which cover a Carnian prograding reef complex.

In the Rhaetian limestones *Felixporidium triasicum* was found and described by Dragastan, Kube & Richter (2000), until now the oldest species of the protohalimedaceans algae during the Mesozoic stock of the genus *Felixporidium*.

Distribution of Mesozoic protohalimedaceans calcareous algae is strongly controlled by facies. The representatives of the Tethyan realm occur predominantly in back reef and open lagoon environments consisting of rudstones to packstones. Others like *F. triasicum* occur in lagoonal patch-reefs and in tidal flat environments.

The species *Cortiporidium calcareus* and *Akrokorinthiella furcata* are reported from restrictive lagoonal wackestones and mudstones of a tidal flat environment.

The use of these algae for biostratigraphy (Table 1) is restricted as marker at level of *Assemblage Zone*, mainly for the genera *Pinnatiporidium* and *Felixporidium*, well widespread in the different facies of carbonate platforms at the Jurassic /Cretaceous boundary. The whole stratigraphic ranges of selected taxa, however, are still poorly known.

The species *Felixporidium triasicum* could be a marker for the Rhaetian interval.

Some other taxa such as *Felixporidium renatae*, *F. balcanicus*, *F. flabelliforme*, and *Akrokorinthiella furcata* can be considered as

indicator for the Early Valanginian or Late Valanginian-Hauterivian. The species *Felixporidium atanasiui*, *Pinnatiporidium untersbergensis*, *P. cylindricus*, *P. alpidicum*, *P.toomeyi* and *Carpathocodium anae* were recorded frequently at the Jurassic / Cretaceous boundary.

The species which have an Upper Jurassic (Late Oxfordian-Tithonian) stratigraphic range are: *Cortiporidium calcareus*, *Tethysicodium elliotti*, *Palaeoporella tubulata*, *P. jurassica* , *Lowvillia paucipora* frequently reported during the Tithonian.

More rarely *Banatocodium surarui* and *Tethysicodium wrayi* appear during Lower Barremian – Early Aptian.

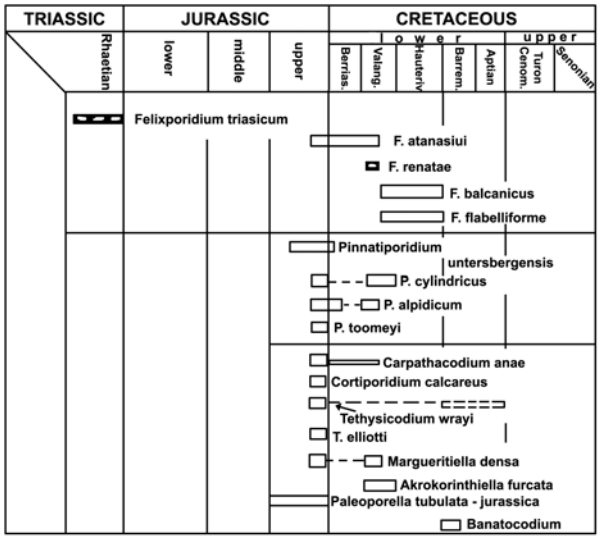

Table 1 – Stratigraphic range during Mesozoic of *Protohalimedaceae algae*

SYSTEMATIC PALEONTOLOGY

Due to many data achived recently (including molecular investigations), the systematic of green siphonous algae is controversely and sometimes confusingly debated.

CLASSIFICATION OF GREEN SIPHONOUS ALGAE, AN OVERVIEW

Taking into account the „historical" data, the ICBN rules, critical review (Silva 1982, Bassoullet *et al.* 1983, Hillis-Colinvaux 1984, Shuysky 1987, 1996, Dragastan *et al.* 1997, 2000, 2002, 2003, Herbig & Dragastan 2005), a new scheme for this group of algae is adopted using the followings ranks :

Phylum CHLOROPHYCOTA ENGLER 1903
Class SIPHONOPHYCEAE HAECKEL 1894
Order SIPHONALES KIRCHNER 1878
Suborder HALIMEDINEAE HILLIS – COLINVAUX 1984 (this name is non valid because the protologue lacked a Latin description, see Paul C. Silva commentaries, August 2005).
Family HALIMEDACEAE LINK 1832
Family PROTOHALIMEDACEAE DRAGASTAN, LITTLER & LITTLER 2002
Family DIMORPHOSIPHONACEAE SHUYSKY 1987
Family LANCICULACEAE SHUYSKY 1987
Family UDOTEACEAE ENDLICHER 1834 emend AGARDH 1887
Family PSEUDOUDOTEACEAE DRAGASTAN *et al.* 1997
Family AVRAINVILLEACEAE DRAGASTAN et al 1999 in DRAGASTAN & RICHTER 1999
Family RHIPILIACEAE DRAGASTAN *et al.*1999 in DRAGASTAN & RICHTER 1999
Suborder BRYOPSIDINEAE HILLIS-COLINVAUX 1984 the same non valid name.
Family CODIACEAE KÜTZING 1843
Family BRYOPSIDACEAE BORY 1924
Family PSEUDOCODIACEAE HILLIS-COLINVAUX 1984

According to Hillis - Colinvaux (1984), the family name *Halimedaceae* Link 1832 is synonymous with *Udoteaceae* Endlicher 1834 (see Senowbari-Daryan & Zamparelli 2005).

This assumption is not correct and cannot be accepted because in the opinion of Professor P. C. Silva (Berkeley University, pers. comm., August 2005) *Halimeda*, *Caulerpa* and *Codium* all have a such distinctive structure as to warrant separate families, *Udotea*, on the other hand, has a more general Bauplan and may be grouped with other genera with similar Bauplan in the *Udoteaceae*. The molecular data given by Kooistra (Phycologia 41: 456, fig. 1 2002) support the separation of *Udoteaceae* from *Halimedaceae* „.

Also, instead of Class *Bryopsidophyceae* Round 1963 and Order *Caulerpales* Schaffner 1922 ? - Order *Bryopsidales* Schaffner 1922 we propose to use the Order *Siphonales* Kirchner 1878 as a „*descriptive name*„ which does not contradict the ICBN rules, respectively the rules of priority as the same for Class *Siphonophyceae Haeckel 1878* .

In 1986 Hillis - Colinvaux wrote: „although present rules of nomenclature (Stafleu et al 1978) permit to use of a descriptive epithet such as *Siphonales*, they recommend that the ordinal epithet be based on the name of a genus within it, and that priority of names be recognized (16 B). Both *Bryopsidales* and *Caulerpales* are available as epithet. Of the valid descriptions available, that for the *Bryopsidales* Schaffner (1922) has priority over that of *Caulerpales* by Feldmann (1946), so I have chosen the former„.

The inclusion of Paleozoic taxa in the Family *Udoteaceae* by Bassoullet *et al.* (1983) and in the Order *Siphonales* Wille 1884 in Shuysky *et al.* (1996) is not correct to be followed. Instead, the genera *Dimorphosiphon*, *Dimorphosiphonoides*, *Lancicula* etc. belong to the Family *Dimorphosiphonaceae* Shuysky 1987 and to the

Family *Lanciculaceae* Shuysky 1987. The family *Anchicodiaceae* Shuysky 1987, does not correspond to green siphonous algae. After Mamet, 1976, Roux, 1985 and Bucur, 1994, this family could belong also to the green algae together with family Gymnocodiaceae.

Because the systematic of green siphonous algae was treated such diverse so from authors to authors, we will here take the opportunity to introduce the remarks and commentaries of Prof. Paul C. Silva (Berkeley University) famous taxonomist after the debating at XVII International Botanical Congress –Vienna 2005, in the framework of the Nomenclature Section.

Prof. Silva wrote: „In deciding of the classification of higher taxa, keep in mind that the priority does not have to be followed, but when names on generic names are used, it is recommended that priority be taken into account. When using descriptive names, it makes common sense to attribute such names to the earliest author. It is not easy, however, to be sure who this author is".

Phylum. At Vienna, the Nomenclature Section approved a recommendation that names of phyla of algae end in –phycota (parallel to the ending –mycota for phyla of fungi). These endings were proposed to satisfy phylogeneticists who remove most groups of algae and all fungi from Plant kingdom. Names of phyla of plants continue to end in –phyta.

Name of subphyla of algae should end in –phycotina, names of classes in –phyceae, names of subclasses in –phycides.

The first application of name based on Chlorophycota to a taxon of the rank of phylum or division was by Engler (Syllabus, ed. 3: pp. 11. 1903), who wrote „Abteilung Chlorophyceae". This spelling is correctable to Chlorophycota Engler 1903. Engler recognized three classes: Protococcales, Confervales, and Siphoneae. The earliest application of a Siphono–name to a taxon at the rank of phylum is that by Bessey (Nebraska Univ. Stud. 7: 285, 1907. Siphonophyceae). Siphono-descriptive names have fallen out of use in recent literature and it is not recommended using them any more.

Incidental information: The first use of Chlorophyta was that by Reichenbach (Pflanzenreich: pp. 5, 1934), who, however, applied the name to a class of the plant kingdom comprising orders Algae, Musci and Filices. The first use of the spelling Chlorophyta to apply to a taxon solely of algae was that by Pascher (Ber. Deutsch. Bot. Ges 32: pp. 158. 1914), but lacking any description. Pascher designated the taxon as „Stamm", corresponding to Engler's Abteilung.

Class. The earliest application of Siphono-name to a taxon of the class rank was that by Haeckel (Systematische Phylogenie der Protisten und Pflanzen, pp. 90, 91, 96,130,1894 „Siphoneae"). The citation of Siphonophyceae Kützing 1845, however, is an error. Kützing applied the name Coeloblasteae to the taxon comprising siphonous algae. The earlist typified class name equivalent to Siphonophyceae is Bryopsidophyceae Bessey (Nebraska Univ. Stud. 7: pp. 287.1907 Bryopsidoideae).

Order. The earlist application of Siphono -name to an order is that by Kirchner (Algen in Kryptogamen-Flora von Schlesien 2(1):81.1878 Siophoneae). The earlist typified ordinal name encompassing siphonous algae is Bryopsidales Schaffner (Ohio J.Sci. 22:133.1922). The citation Caulerpales Schaffner 1922 is a mistake, confusing Caulerpales with Bryopsidales.

Here are two options:

1. *Phylum Chlorophycota ENGLER 1903, Class Bryopsidophyceae BESSEY 1907, Order Bryopsidales SCHAFFNER 1922, Suborder Halimedineae HILLIS-COLINVAUX 1984, note: this name is non valid because the protologue lacked a Latin description and*
2. *Phylum Chlorophycota ENGLER 1903, Class Siphonophyceae HAECKEL 1894, Order Siphonales KIRCHNER 1878 and suborder Halimedineae non valid „*

Besides Paleozoic taxa included already in the Family Protohalimedaceae many other genera described past years by Mamet and collaborators that were included to Udoteaceae ?, must be reconsidered as taxa belonging to this family, like *Cummingsella lyoncrossi* Mamet & Roux 1980 (Namurian), *Loomisella petryki* Bergeron & Mamet 1992 (Carboniferous) and *Hortonella uttingi* Mamet 1995 (Early Carboniferous).

In the present paper we follow the second option proposed by Prof. Silva.

SYSTEMATIC

Phylum CHLOROPHYCOTA ENGLER 1903
Class SIPHONOPHYCEAE HAECKEL 1894
Order SIPHONALES KIRCHNER 1878
Family PROTOHALIMEDACEAE DRAGASTAN , LITTLER & LITTLER 2002
Genus *Felixporidium* DRAGASTAN 1999

Type species: *Cayeuxia atanasiui* Dragastan, designation of lectotype in 1978.

Felixporidium atanasiui (Dragastan 1978) Dragastan 1999
Pl.1, Figs.1-2; Pl. 2, Fig.1, Text-Fig. 6/2

1971 *Cayeuxia atanasiui* n. sp. Dragastan, p.184, Pl. IX, Figs. 4-10
1985 *Rivularia atanasiui* (Dragastan 1978 non 1971) Dragastan, p.112, Pl. XII, Figs.1-4.
1989 *Hedstroemia humili* n. sp. Dragastan, p. 419 only specimen from Pl. 1, Fig.1
1999 *Felixporidium atanasiui* (Dragastan 1978) Dragastan, p. 212, Pl. 5, Figs.1-5, Pl.7, Fig. 1.

Description: Thallus composed of hemisphaerical fan-shaped segments (= flabellae) bilaterally disposed along the axis. The thallus is

crossed by a main uniaxial, medullary siphon. Each segment is crossed by a primary simple cortical siphon followed by long, tubular secondary siphons dichotomously branched (Text-Fig. 6/2). The secondary siphons bear tubular tertiary siphons dichotomously branched and finally fourth tiny, simple siphons. The cortex of the segments is well calcified and the cortical siphons are disposed radially in each segment.

Remarks: The type species of genus *Felixporidium* was attributed successively to different genera, first to *Cayeuxia* and second to *Rivularia*. During the years new material with good preserved specimens lead to the introduction of the new taxon *Felixporidium*.

The bilateral disposition of the segments along the vertical axis represents the second level of thallus organisation in the family *Protohalimedaceae*. The first level and the oldest „step" of thalli organisation was the vertical axial superposed each-others segments crossed by uniaxial or multiaxial medullar siphons recorded at many taxa from Paleozoic but also during Mesozoic in frame of the same family.

Stratigraphic range: Tithonian – Berriasian – Early Valanginian .

Felixporidium renatae Dragastan & Richter 2003

Pl. 2, Figs. 2-5

2003 *Felixporidium renatae* n. sp. Dragastan & Richter, p. 82, Pl. 7, Figs. 2-5.

Description: Thallus composed of very narrow fan-shaped segments crossed by an uniaxial medullary siphon with an uneven constricted traject. The segment connections with the medullary siphon show an alternating position along the thallus. The segments are disposed bilaterally along the axis. In transverse sections, the thallus presents a more or less circular shape.

The cortex is crossed by primary, short and wide like vesiculiferous siphons continued with short cylindro-globuliferous secondary siphons dichotomously branched. Tertiary siphons are long, tubular, slightly increasing in diameter to the distal end. The fourth series are fine not so long, tubular and rarely dichtomous.

The biometric data for the species belonging to the genus *Felixporidium* are given in Table 2 .

Remarks: *Felixporidium renatae* was compared with *F. atanasiui* from which it differs by the shape of segments, narrow on the height and by the short penetration of the medullar siphon in the middle base of the segments. The segments show an alternating dense-set position along the axis of the thallus. From *F. balcanicus* and *F. flabelliforme* it differs by the shape of the segments and the inner structure of the cortex .

Stratigraphic range: Early Valanginian.

Felixporidium balcanicus Dragastan & Richter 2003

Pl. 2, Figs. 6-8

2003 *Felixporidium balcanicus* n. sp. Dragastan & Richter, p. 83, Pl. 7, Figs. 6-8.

Description: Thallus formed by hemisphaerical segments more wider and narrow on the vertical axis. The thallus is crossed by an uniaxial medullar siphon being very small in diameter with respect to the total thallus diameter.

The cortex is composed of short cylindro-subvesiculiferous primary siphons followed by short, tubular secondary siphons dichotomously branched. Tertiary siphons are long, tubular dichotomously branched and bear fourth orders siphons being long, tubular and very small in diameter.

Remarks: *Felixporidium balcanicus* differs from the other species of this genus by the shape of the segments more wider and narrow as high on the median axis of the segments and by the other morphology of the siphons crossing the cortex.

Stratigraphic range: Late Valanginian-Hauterivian.

Species Dimen in mm	F. triasicum	F. atanasiui	F. renatae	F. balcanicus	F. flabelliforme
Thallus length (L)	4.5-4.8	4.9-5.0	1.30-1.50	2.80-3.0	2.5-3.0
Diam. of the thallus at the base (Db)	3.0-3.2	1.20-1.50	0.90-1.0	1.0-1.80	1.60-1.85
Diam. of top thallus at the top (Dt)		2.40-3.0	1.40-1.60	1.80-2.0	——
Diameter of the segment - bush (Dbs)	0.40-1.0	1.0-1.5	0.30-0.60	0.60-1.0	0.30-0.35
Diam. of medullar siphon (dms)	0.060-0.080	0.30-0.50	0.15-0.17	0.10-0.12	0.20-0.25
Diam. of cortical siphons dc 1	0.040-0.080	0.10-0.15	0.070-0.085	0.10-0.11	0.08-0.013
dc 2	0.024-0.040	0.075-0.10	0.055-0.070	0.080-0.090	0.030-0.055
dc 3	0.012-0.020	0.060-0.090	0.020	0.030-0.040	0.016-0.030
dc 4	0.010-0.015	0.030	0.010	0.015	0.010-0.008

Table 2 – Biometric data for species of genus *Felixporidium*

Felixporidium flabelliforme Dragastan & Richter 2003

Pl. 2 , Figs. 9-10

2003 *Felixporidium flabelliforme* n. sp. Dragastan & Richter, p. 83, Pl. 7, Figs. 9-10.

Description: Thallus composed of a special shape of the segments bilaterally disposed along the axis. The segments have a more or less flabelliform shape, like a „bundle" very narrow to the base, where the uniaxial medullar siphon is in connection and after the segments become suddendly expanded towards the top. The cortex is crossed by long, tubular primary siphons continued by short, tubular secondary siphons dichotomously branched. The secondary siphons are also bearing short, tubular tertiary siphons, slightly claviform and fourth series, fine and tiny, very short.

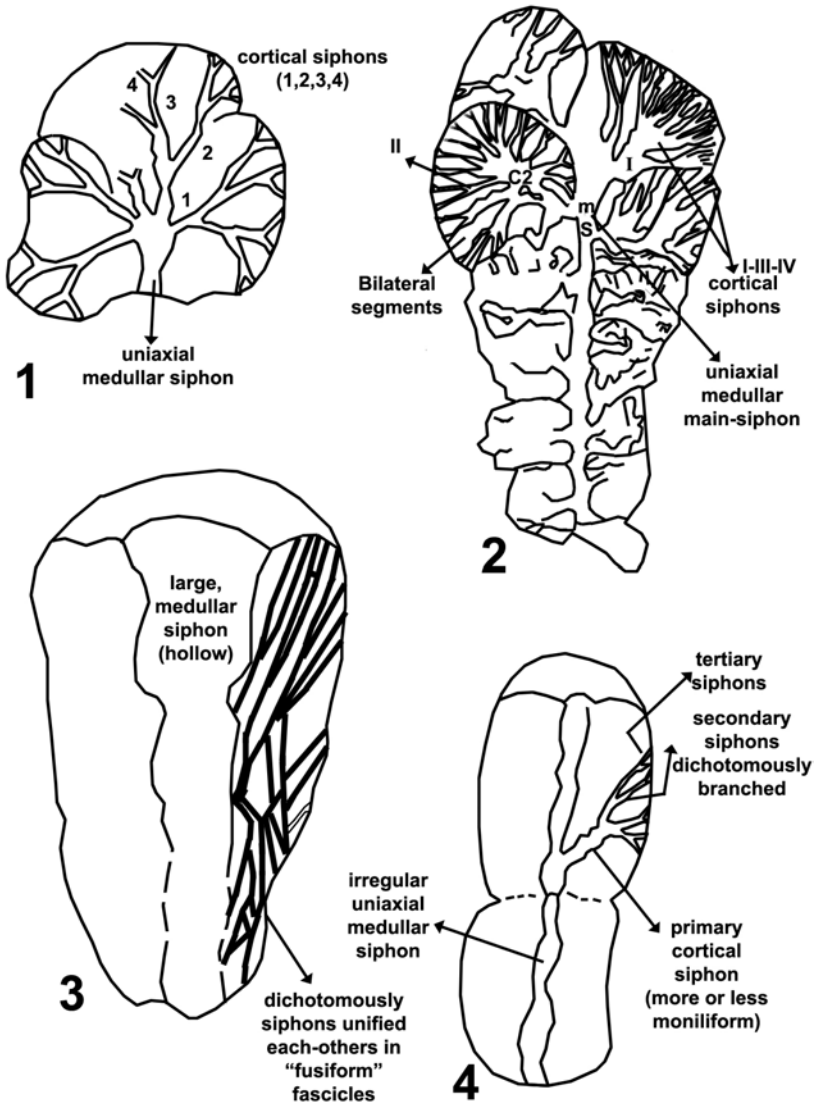

Fig. 6 -Reconstruction of thalli at: 1. *Felixporidium triasicum* Dragastan, Kube & Richter, 2000 (Late Triassic); 2. *F. atanasiui* (Dragastan, 1978) Dragastan, 1999 (Tithonian-Neocomian); 3. - *Carpathocodium anae* (Dragastan, 1971) Dragastan, 1985 (Tithonian-Neocomian); 4. *Tethysicodium wrayi* Dragastan, 1985 (Tithonian; Barremian - Early Aptian).

Remarks: *Felixporidium flabelliforme* differs from the other species of the genus *Felixporidium* by the characteristic shape of the segments and by the morphology of the cortical siphons.

Stratigraphic range: Late Valanginian-Hauterivian.

Felixporidium triasicum Dragastan, Kube & Richter 2000

Pl. 4, Fig. 2,Text-Fig. 6/1

2000 *Felixporidium triasicum* n. sp. Dragastan, Kube & Richter, p. 145, Pl. 4, Figs. 1-3

2005 *F. triasicum* Senowbari-Daryan & Zamparelli, p. 143,Table 1.

Description:Thallus built by ovoidal segments with bilateral disposition at the base becoming fan-shaped towards the top. The thallus is crossed by very narrow uniaxial medullar siphon (Pl. 4, Fig. 2 m). Each segment has a cylindrical connective medullar siphon from which the cortical series of siphons are continuing radially from the base to the top. The well calcified cortex is pierced by short tubular, slightly constricted primary siphons followed by long, tubular, uneven, distally claviform secondary siphons dichotomously branched (Text-Fig. 6/1).

The secondary siphons bear tertiary, long, tubular siphons dichotomously branched and finally fourth order siphons short and tiny (Pl. 4, Fig. 2).

Remarks: Until now, *Felixporidium triasicum* is the oldest taxon of Mesozoic protohalimedaceans algae. It is different by all stock of species of the genus *Felixporidium* by another disposition of the segments from the base and after to the top of the thallus. It is also distinguished by the characteristic morphology of the cortical siphons.

Stratigraphic range: Rhaetian.

Genus *Carpathocodium* Dragastan 1985

Type species: *Carpathocodium anae* (Dragastan 1971) Dragastan 1985

Carpathocodium anae (Dragastan 1971) Dragastan 1985

Pl. 3, Figs.1-3, Text-Fig. 6/3

1971 *Cayeuxia anae* n. sp. Dragastan, p. 183, Pl. 8, Figs. 5-6, Pl. 9, Figs.1-3

1985a *Carpathocodium anae* n. gen. n. sp (Dragastan 1971) Dragastan, p.121, Pl. 22, Figs.1-6, Pl. 23, Fig. 1.

The complete synonymy in Dragastan, 1985.

Description: Thallus formed by cylindrical segments crossed by a medium, large medullar siphon, like an empty hollow probably during the life having a multiaxial structure. The cortex crossed by dichotomic tubular siphons connected by a sytem of 2+1 or 2+2 forming „fusiform fascicles" (Text-Fig. 6/3). The cortical siphons are disposed more or less parallel to the axis of the segments. Because the medula and the cortex are not so well calcified and the vertical disposition of cortical dichotomously branched siphons are unified each-others in „fascicles", the cortex of the thallus breaks up easily into fragments in many cases (Pl. 3, Figs. 2-3). Due to the weak calcification of the cortex and the vertical position of the siphons, the thallus became fragile and presented only the fusiform cortical fasciles siphons after erosion, transport and sedimentation.

The biometric data for this taxon is presented in Table 4.

Remarks: *Carpathocodium anae* has a characteristic inner morphology especially for the cortex and was compared with Dinantian genus *Malakhovella* Mamet & Roux 1977 and with some species of genus „ *Arabicodium*". A halimediform algae with a typical micritic thallus structure and cortical siphons more oblique to the main axis was compared with *Carpathocodium anae*, figured from various Late Jurassic occurrences: the Northern Calcareous Alps of Austria (Schlagintweit and Ebli 1999), the Western Carpathians (Mišik 1979), Sicily (Senowbari-Daryan *et al.* 1994) and Morocco (Benzaggagh and Atrops 1997). The same species was illustrated by Dragastan (1990) as *Maslovina* sp. Although Senowbari-Daryan *et al.* (1994) stressed the wide morphological variability of *Carpathocodium anae*, Schlagintweit & Ebli (1999) assumed two different taxa (*C. anae* and another unknown species), but not yet well discriminated on the basis of the original description of the former.

However the large variability of thalli and more or less broken thalli suggested the presence of two diferent species (*C. anae* and *C*. n. sp.).

Stratigraphic range: Tithonian and Neocomian and rarely in Santonian after Radoicic 1960 in Dragastan 1985.

Genus *Pinnatiporidium* Dragastan 1990 emend Schlagintweit & Dragastan 2004

Type species: *Pinnatiporidium cylindricus* Dragastan 1990

Pinnatiporidium cylindricus Dragastan 1990
Pl. 4, Fig.1, Text –Fig. 7/1

1990 *Pinnatiporidium cylindricus* n. sp. Dragastan, p. 482, Pl. 1, Figs. 1-3, Pl. 2, Figs. 1-2

Description: Thallus isolate, cylindrical built by ovoidal – hemisphaerical segments overlapping each-others along the vertical axis. Segments fan-like, more or less equal as height and numerous along the thallus (Text-Fig.7/1).

Thallus crossed by a medium large, uneven, uniaxial medullar siphon which penetrates alternantely in the cortex. The cortex is formed by short primary siphons, swollen at the base after „leaving" the medullar siphon.The primary siphons are followed by short, tubular secondary siphons dichotomously branched. The secondary siphons bear tertiary long, tubular siphons dichotomously branched and support the fourth series of tubular, simple tiny siphons.

The biometric data for *Pinnatiporidium* species are presented in Table 3.

Remarks: *Pinnatiporidium cylindricus* was compared with species *Palaeoporella variabilis* Stolley 1893 (Ordovician) very well reconstructed by Mamet & Roux in Bourque *et al.* 1981, Text-Fig. 9) showing uniaxial medullar siphon and the cortical (1-4) siphons coming out from the medullary siphons in an alternately manner and with *P. recta* Gnilovskaja 1972 (Ordovician) and *P. lummatonensis* Elliott 1961 (Middle Devonian) from which it differs by the other morphology of cortical siphons.

Pinnatiporidium cylindricus was described from Tithonian limestones of Suhard Massif, Bicaz Gorges, Hăghimaş Mts., Transylvanian carbonate platform as an alga which often generated a reef-like consortium together with *Lithocodium – Bacinella* and microbolite, all together forming a framework crossed by large cavities and fenestral fabrics (Pl. 4, Fig.1).

Stratigraphic range: Tithonian; Valanginian-Early Hauterivian.

Species Dimen. in mm	P. cylindricus	P. alpidicum	P. untersbergensis	P. toomeyi
L	6.0-9.0	5.0-6.0	up to 6.2	3.0-6.0
Outer diam. (D)	3.0-3.2	1.25-2.30	1.60-1.85	3.0-3.80
Heigh of segments (HS)	1.5-2.5	1.20-1.50	2.0	——
dms	0.50-0.52	0.25-0.30	0.20-0.25	0.90-1.0
dc 1	0.15- (base) distal 0.060	0.030-0.060	0.080-0.13	0.075-0.090 claviform
dc 2	0.060-0.075	0.040-0.045	0.030-0.055	0.045-0.060
dc 3	about 0.030	0.010-0.020	0.016-0.030	——
dc 4	0.015-0.020	0.005-0.010	about 0.016	——

Table 3 – Biometric data for the species of genus *Pinnatiporidium*

Pinnatiporidium alpidicum (Dragastan 1999) Schlagintweit & Dragastan 2004
Pl. 5, Figs. 1-6

1991 *Rivularia atanasiui* – Darga & Schlagintweit, p. 211, Pl. 3, Fig. 1

1999 *Felixporidium alpidicum* n. sp. Dragastan, p. 213, Pl. 6, Figs.1 –4

2003 *Felixporidium alpidicum* Dragastan – Dragastan & Richter, p .81, Pl. 1, Fig. 9

2004 *Pinnatiporidium alpidicum* (Dragastan)-Schlagintweit & Dragastan, p. 456, Pl. 1, Fig. 5

2005 *Pinnatiporidium* cf.*alpidicum* (Dragastan)-Schlagintweit, Gawlick & Lein, p. 67, Fig. 59 a-b.

Description: Thallus isolate, cylindrical composed of ovoidal segments very narrow as

high, superposed each-others on the vertical axis. The thallus is crossed by an uniaxial medullar siphon. The cortex has primary long, tubular siphons continued by secondary tubular siphons dichotomously branched with a constant diameter (0.040 -0.050 mm). The tertiary siphons also tubular slightly claviform to the distal end dichotomously branched bear fourth tiny, short siphons.

Remarks: *Pinnatiporidium alpidicum* differs from *P. cylindricus* by the very narrow shape as high of the segments, many superposed on the vertical axis and by the different morphology of the primary and secondary cortical siphons. Both, *P. untersbergenis* and *P. toomeyi* have different shape of segments more cylindrical and long as high on the vertical axis and other morphology of cortical siphons and can thus be distinguished from *P. alpidicum*.

Stratigraphic range: Late Tithonian –Early Berriasian (Northern Calcareous Alps), Early Valanginian (Făgetul Ciucului Massif, Hăghimaş Mts., East Carpathians and in Mount Asprovouni, Methana region, Greece).

Pinnatiporidium untersbergensis Schlagintweit & Dragastan 2004

Pl. 5, Fig. 7

2004 *Pinnatiporidium untersbergensis* n. sp. Schlagintweit & Dragastan, p. 457, Pl. 1, Figs. 1-4, 6.

Description: Thallus cylindrical or subconical, built by elongate height segments not so numerous overlapping each-others along the vertical axis and separated from each others by a clear limit.

The segments are crossed by an uniaxial medullar siphon, smaller in diameter sometimes with constrictions between the segments.

The cortex is composed of siphons disposed in opposite manner, primary short with large diameter, secondary short dichotomously branched followed by tertiary long, also dichotomously branched and finally fourth fine, short, tiny siphons.

Remarks: *Pinnatiporidium untersbergensis* is different from the species *P. cylindricus* and *P. alpidicum* by another shape of the segment more elongate and subcylindrical and cortical siphons with other morphology.

Stratigraphic range: Late Kimmeridgian-Tithonian -? Lower Berriasian, Untersberg Mts., Northern Calcareous Alps.

Pinnatiporidium toomeyi (Dragastan 1985) nov. comb.

Pl. 9, Figs. 2-3, Text-Fig. 7/3

1985 *Bevocastria toomeyi* n. sp. Dragastan, p.126, Text-Figs. 4-5

Description: Thallus cylindrical composed of long cylindrical segments crossed by an uniaxial medullar siphon of medium size. The cortical system is only formed by primary and secondary siphons (Text-Fig.7/3). The primary siphons are long moniliform and claviform towards the distal end continued by short claviform secondary siphons dichotomously branched. Possible tertiary siphons not observed.

Remarks: *Pinnatiporidium toomeyi* was first assigned to the genus *Bevocastria* Garwood 1931, but is now reconsidered after the inner morphology of segments crossed by an uniaxial medullar siphon, the cortex only with primary and secondary siphons and a characteristic morphology which corresponds to the genus *Pinnatiporidium*.

Recently, Senowbari-Daryan & Link (2004) described well preserved thalli of the new species *Bevocastria magna* from the Late Triassic of the Taurus Mts./Turkey considering that the genus *Bevocastria* and some other species should belong to *Cyanophyceae* (= „Porostromata" Pia 1927), Family *Scytonemataceae*.

The inner morphology of thallus composed only by siphons dichotomously branched with „pearls-shaped morphology or moniliform at different grade of constrictions from slighty to deepest ones„, however, are in our opinion not characteristic features to assign this group of *Bevocastria* species to the Cyanophyceae.

Regarding *Bevocastria magna*, the nodular shape of thallus is real hemisphaerical (see in Senowbari-Daryan & Link, p.303, Fig. 2, 2004) and corresponds to a „blade" formed by a meshwork of moniliform siphons dichotomously branched. The authors remark that „the longitudinal sections exhibit a dichotomous branched tube with strangulations„.

In our opinion, such type of inner structure with moniliform siphons dichotomously branched and also the shape of the thallus corresponds well to green-siphonous algae of the Family *Avrainvilleaceae* including the genera *Mitcheldeania*, *Pseudomitcheldeania*, some *Bevocastria* species (like *B. magna*) and *Niteckiella* etc. (Dragastan *et al.*, 1997 and Dragastan & Richter 1999).

Stratigraphic range: Tithonian, Cetea Hill, Southern Apuseni, Transylvanian carbonate platform .

Genus *Tethysicodium* Dragastan 1985

Type species: *Tethysicodium wrayi* Dragastan 1985

Tethysicodium wrayi Dragastan 1985

Pl. 6, Fig. 1, Text-Fig. 6/4

1985 *Tethysicodium wrayi* n. sp. Dragastan, p. 125, Pl. 26, Figs. 1-4.

Description: Thallus shoe-like consisting of elongate segments superposed each-others along the vertical axis. The segments are crossed by a narrow, irregular uniaxial medullar siphon (Text-Fig. 6/4).

The cortex system is composed of short primary more or less moniliform siphons and long, tubular secondary siphons dichotomously branched. The secondary bears simple, medium long, fine, tubular tertiary siphons (Pl. 6, Fig.1).

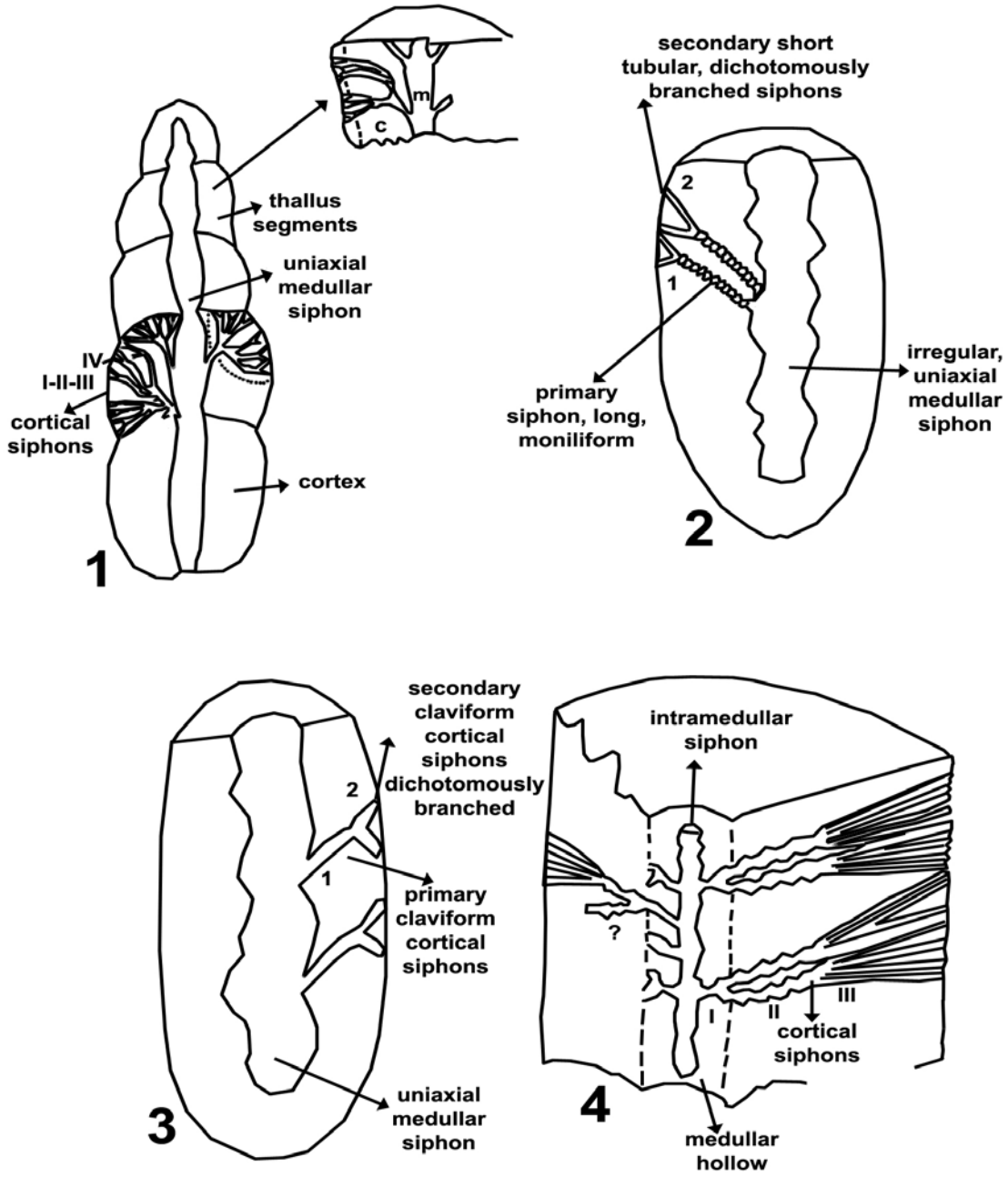

Fig. 7 - Reconstruction of thalli at: *1. Pinnatiporidium cylindricus* Dragastan, 1990 (Neocomian); 2. *Tethysicodium elliotti* (Dragastan, 1971) Dragastan & Schlagintweit nov. comb. (Tithonian*); 3. Pinnatiporidium toomeyi* (Dragastan, 1985) Dragastan & Schlagintweit nov. comb. (Tithonian); *4. Cortiporidium calcareus* Dragastan, 1990 (Tithonian).

Biometric data for the species of the genus *Tethysicodium* are shown in Table 4.

Remarks: *Tethysicodium wrayi* was compared with stock of species of the genus *Pinnatiporidium* from which it differs by its narrow, uneven constrictions of the uniaxial medullar siphon, primary cortical siphons moniliform and long secondary tubular siphons dichotomously branched as well as tertiary simple also tubular siphons.

Pinnatiporidium untersbergensis has an elongate thallus segments and fourth series of siphons with different morphology from those of *T. wrayi*.

Stratigraphic range: Tithonian, Făgetul Ciucului Massif, Bicaz Gorges, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform.

Tethysicodium elliotti (Dragastan 1971) nov.comb.
Pl. 6, Figs. 2-3,Text-Fig. 7/2

1971 *Cayeuxia elliotti* n. sp. Dragastan, p.187, Pl. 10, Fig. 3, not Figures 1, 2, 4.

1978 *C. elliotti* Dragastan –Bucur, Pl. 5, Fig. 4, Pl. 6, Fig. 3.

1985 *Bevocastria elliotti* (Dragastan 1971) - Dragastan, p.126, Pl. 27, Fig.4, Pl. 28, Figs. 1-4.

Description. Thallus cylindrical builts by cylindrical or oval –ellipsoidal segments. In the

oblique longitudinal section thallus showed a medium, large, irregular medullar siphon, possible multiaxial (Pl. 6, Fig. 2).

The cortex thick formed by primary long moniliform siphons (Text-Fig. 7/2) continued by short, tubular secondary siphons dichotomously branched. In transverse sections, the irregular shape of uniaxial medullar siphon and primary (1) and secondary (2) cortical siphons can be clearly seen (Pl. 6, Fig. 3).

No tertiary siphons observed.

Remarks. During the years, the specis *Tethysicodium elliotti* was assigned to both, the genera „*Cayeuxia* „ and *Bevocastria*.
Senowbari-Daryan & Link (2004) discussed the thallus morphologies of the two Jurassic taxa *Bevocastria elliotti* and *B*. *toomeyi* and correctly considered that the middle part of the thalli is presented by „a central medullar hollow" and thus, they cannot be assigned to the genus *Bevocastria*.

Stratigraphic range: Tithonian, Făgetul Ciucului Massif, Bicaz Gorges, Hăghimaş Mts. and Piatra Craiului Mts., East Carpathians, Transylvanian and Getic carbonate platforms.

Genus *Cortiporidium* Dragastan 1990 nov.comb.
Type species: *Cortiporidium calcareus* Dragastan 1990.

Cortiporidium calcareus Dragastan 1990
Text-Fig. 7/4

1990 *Cortiporidium calcareus* n. sp. Dragastan, p. 483, Pl. 3, Figs. 1-3, Pl. 4, Fig.1

Description. Thallus cylindrical formed by ovoidal –cylindrical segments, superposed each others along the vertical axis. The central area of the segments show a medullar hollow crossed by multiaxial medullar siphon (Pl. 1, Fig.1 in Dragastan 1990) . In the axis of the medullar zone we can observe an intramedullar, main tube siphon in direct connection with the cortical siphons (Text-Fig. 7/4). The intramedullar siphon is surrounded by normal medullar siphons. If this interpretation is correct, we suppose that intramedullar siphon could be in connection with normal medullar siphons and also with cortical siphons.

The cortex is pierced by short simple, tubular primary siphons continued by slightly moniliform medium, long siphons dichotomously branched. Tertiary siphons fine, small in diameter containing four to six tubular long not branched, grouped all together.

Remarks: *Cortiporidium calcareus* has a different inner structure of the segments with intramedullar and medullar siphons in the central area and also another morphology of the cortex system. It was compared with Permian species *Tauridium kurdistanensis* Elliott 1970 which has also ovoidal segments crossed by few weakly calcified medullar siphons and thick cortex crossed by primary, secondary and tertiary siphons that „bifurcate reapeatedly at angles from 30 to 60^{O}". The siphons are crowded by irregular banded zones „supposing each kind of siphons which corresponds to a zone „.

Taxa Dimen. in mm	C. anae	Cortiporidium calcareus	Tethysicodium		M.densa	A.furcata
			wrayi	elliotti		
L	4.4-5.0	3.0-3.20	6.0-8.0	4.0-4.8	H/Width 3.0/4.0	H/W 2.8/2.9
D	2.8-3.40	1.5-2.60	2.0-3.0	2.70-3.50	——	——
dbs	——	——	2.0-3.0	——	1.0/1.50	1.0-1.50
dms	1.0-1.50	0.15-0.20	0.90-1.50	0.60-0.90	0.90-1.20	moni-liform 0.060
c 1	0.020-0.060	short primary 0.090-0.10	monilif. 0.075-0.090	monilif. 0.030-0.040	0.12-0.15	0.060
c 2	2+1 or 2+2 0.060-0.080	long moniliform 0.060-0.075	0.030-0.040	0.015	0.060-0.090	0.040-0.050
c 3	——	in bundle 0.015-0.030	0.010	——	0.030-0.035	0.015-0.020
c 4	——	——	——	——	0.010	0.010

Table 4 – Biometric data for the species of genera *Carpathocodium*, *Cortiporidium*, *Tethysicodium*, *Margueritiella* and *Akrokorinthiella*

Some Mesozoic taxa like *Pinnatiporidium cylindricus* Dragastan 1990, *Maslovina* sp., *Palaeoporella tubulata* Dragastan 1990 and *P. jurassica* Dragastan 1990 are different by the structure of medullar zone and the construction of cortical system.

Stratigraphic range: Tithonian,Făgetul Ciucului Massif, Bicaz Gorges, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform (TCP).

Genus *Margueritiella* Dragastan 1990
Type species: *Margueritiella densa* Dragastan 1990

Margueritiella densa Dragastan 1990
Pl. 7, Fig. 1-2, Text-Fig. 8/1

1990 *Margueritiella densa* n. sp. Dragastan, p. 484-487, Pl. 4, Fig. 2

Description: Thallus hemisphaerical built by superposed fan-shaped segments with vertical and lateral growth (Text-Fig. 8/1). The thallus has a main uniaxial medullar siphon continuing with short medullar siphons which enter in each segment (Pl. 7, Fig.1). The segments are pierced by primary short, tubular large-sized cortical siphons followed by moniliform secondary and tertiary siphons of variable diameter (Table 4). The fourth kind of siphons, short , simple, fine tubular are not branched.

Remarks. *Margueritiella densa* could be compared with Recent *Halimeda cryptica* Colinvaux & Graham 1964 which has fan-shaped segments with uniaxial medullar siphon and cortex with three or four series of utricles, but some are not moniliform.

Stratigraphic range: Tithonian, Făgetul Ciucului Massif, Bicaz Gorges, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform.

Genus *Akrokorinthiella* Richter, Dragastan & Gielisch 1992
Type species: *Akrokorinthiella furcata* Richter, Dragastan & Gielisch 1992

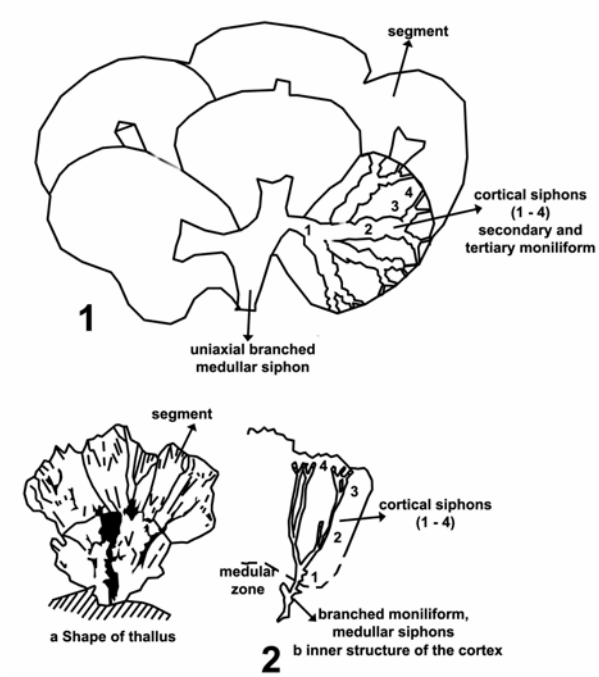

Fig. 8 - Reconstruction of thalli at: 1. *Margueritiella densa* Dragastan, 1990 (Tithonian); 2. *Akrokorinthiella furcata* Richter, Dragastan & Gielisch, 1992 (Neocomian), Greece.

Akrokorinthiella furcata Richter, Dragastan & Gielisch 1992

Pl. 8, Figs. 1-2, Text-Fig. 8/2

1992 *Akrokorinthiella furcata* n. gen. n. sp. Richter, Dragastan & Gielisch, p. 25-27, Pl. 5, Figs.1-2, Text–Fig. 7.

Description: Thallus hemisphaerical built by ovoidal segments with tendency of overlapping each-others and with a disposition more or less bilaterally. The segments are crossed by uniaxial simple, slightly moniliform medullar siphons.

The cortex of each segment has one up to four siphons (Text-Fig. 8/2). The primary cortical siphons are short, tubular with few constrictions. The primary bears secondary siphons dichotomously branched at an angle of 5 -10^{O} and continuing with short, tubular, dichotomously branched tertiary siphons of small diameter (Table 4). The fourth series of cortical siphons are small, fine tubular and very short.

Remarks: *Akrokorinthiella furcata* was compared with taxa *Suhardiella frolloae* Dragastan 1988 (Barremian – Lower Aptian) and *Hasmasiella aggregata* Dragastan 1990 (Tithonian), peudoudoteacean algae having fan-shaped thalli crossed by different kind of siphons in comparison with the inner structure of *A*. *furcata*.

Comparisons were made also with the protohalimedacean taxa *Fagetiella angulata* Dragastan 1988 (Tithonian), *Pinnatiporidium cylindricus* Dragastan 1990 (Tithonian-Neocomian) and with *Margueritiella densa* Dragastan 1990 (Tithonian; Early Valanginian). An inner structure similar to *A. furcata* was found in *Fagetiella angulata* which has a hemisphaerical thallus composed by superposed fan-shaped segments crossed by a small, tube-like uniaxial medullar siphon. The medullar tube continues in each segment in the central area and also the cortex. The latter is pierced by primary and secondary siphons last ones dichotomously branched.

Compared with *Margueritiella densa* Dragastan 1990, we can observe the close morphology of the thallus composed by superposed fan-shaped segments with vertical and lateral growth, but with another disposition and morphology of the cortical siphons.

Stratigraphic range: Neocomian (Valanginian), Akrokorinth limestones, Parnassus Zone, NE Peloponnese, Greece.

Genus *Palaeoporella* Stolley 1893

Type species: *Palaeoporella variabilis* Stolley 1893

Palaeoporella tubulata Dragastan 1990 emend.

Pl. 9, Fig. 1

1990 *Palaeoporella tubulata* n. sp. Dragastan, p. 492, Pl. 6, Figs. 1-3.

Description: Thallus built by cylindrical segments round in shape in transverse section. The segments crossed by a large medullar hollow multiaxial filled by coarsely crystalline calcite (Pl. 9 Fig. 1, arrow).

The cortex is crossed by simple, long sinuous tubular primary siphons, large in diameter (Table 5).

The primary bear long secondary siphons dichotomously branched. Tertiary siphons tubular, of medium length also dichotomously branched continued with fourth series siphons, fine and small in diameter.

Remarks: *Palaeoporella tubulata* was compared with *P*. *variabilis* Stolley (Ordovician) having a similar inner structure. This species has cylindrical segments crossed by a large medullar zone and a cortex with long primary siphons, slightly calviform to the distal end. The primary bear long tubular secondary siphons, dichotomously branched at an angle of 20-30^{O} The tertiary siphons are also dichotomic branching; fourth order siphons simple, and very small in diameter. The other species such as *P*. *opuntiformis* Saltovskaia 1975 (Ordovician) presents a thallus with cylindrical segments and cortex with primary, secondary and tertiary siphons strongly claviform, the fourth series are simple, short and tubular.

Palaeoporella recta Gnilovskaia 1972 (Late Ordovician) is a species with thallus composed of cylindrical segments. The latter are crossed by an uniaxial medullar siphon, small in diameter and with denticulate excrescenses. The cortex contains primary club-shaped siphons. The primary siphons disposed after an acute angle against axis continue with secondary elongate and club-shaped siphons. The secondaries bear a cluster of shorter and thinner elongate club-shaped tertiary siphons continued with fourth cupula shaped and very small siphons.

All these features found at Paleozoic species are more or less different from the shape of the inner morphology of *Palaeporella tubulata*.

P. tubulata (Late Jurassic) was found in micro-reef environment dominated by consortium of *Lithocodium-Bacinella* and microbolitic crusts crossed by large cavities and laminoid fenestral fabrics. (Pl. 9, Fig.1).

Stratigraphic range: Tithonian, Făgetul Ciucului Massif, Bicaz Gorges, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform.

Palaeoporella jurassica Dragastan 1990 emend.
Original figures in Dragastan, 1990a

1990 *Palaeoporella jurassica* n. sp. Dragastan, p. 495, Pl. 7, Figs. 1-2

Description. Thallus built by cylindrical segments, round in transverse section. The segments have a central medullar siphon (possible uniaxial ?) medium size in diameter.

The cortical system constructed by short, ovoidal to claviform primary siphons continued with secondary long, claviform siphons dichotomously branched large in diameter (Table 5). The secondary siphons bear small tertiary siphons short, ovoidal and finally fourth series siphons possible present, but not observed.

Remarks: *Palaeoporella jurassica* has a close inner structure morphology with Jurassic species *P. tubulata*. It differs from the latter by different morphologies of primary and secondary cortical siphons. From the stock of Paleozoic species only *P. opuntiformis* Saltovskaia 1975 has some structural affinities regarding the shape of primary and secondary cortical siphons, more claviform in shape.

Stratigraphic range: Tithonian, Vînturariţa Massif, Southern Carpathians, Getic carbonate platform.

Genus *Lowvillia* Guibault & Mamet 1976

Type species: *Lowvillia raripora* Guilbault & Mamet 1976

Lowvillia paucipora Dragastan 1990
Pl. 10, Fig. 2

1990 *Lowvillia paucipora* n. sp. Dragastan, p. 495, Pl. 7, Figs. 3-4

Description: Thallus built by ovoidal compressed segments emphasized constrictions and lateral expansions. The thallus may take the form of a string of joined subsphaeres. The segments crossed by narrow medullar siphon composed by few medullar siphons of small diameter. (Pl. 10, Fig. 2).

The cortex contains primary (1) tubular, claviform siphons bearing secondary (2) also slightly claviform dichotomously branched siphons disposed in „tufts".

Remarks: *Lowvillia paucipora* was compared with some Ordovician species: *L. grandis* Guilbault & Mamet 1976, *L. multipora* Guilbault & Mamet 1976 and *L. raripora* Guilbault & Mamet 1976.

L. paucipora is different owing to its reduced medullary siphons and a cortex with primary and secondary siphons disposed in „tufts". The Paleozoic species are different by having only primary cortical „tubes", which increase slightly in diameter towards the edges„ from the original description of Guilbault & Mamet 1976 (in Bassoullet et al . 1983).

Stratigraphic range: Tithonian, Giuvala Massif, Dâmbovicioara Basin and Upper Oxfordian-Kimmeridgian, Ghimbav Massif, Getic carbonate platform.

Genus *Banatocodium* Bucur 1994

Type species: *Banatocodium surarui* n. gen. n. sp. Bucur 1994

Banatocodium surarui Bucur 1994 emend
Pl. 11, Fig. 1, Pl. 12, Fig. 1

1994 *Banatocodium surarui* n. sp. Bucur, p. 18, Pl. 5, Figs. 1-7

Description: Thallus built by cylindrical segments crossed by a large medullar hollow (Pl. 11, Fig.1m). The medullar zone we suppose that was multiaxial.

The cortex system (Pl. 12, Fig. 1) constructed by medium long, cylindrical claviform toward the distal end primary (1) siphons continued with secondary (2) long cylindrical siphons, slightly inflated distally, dichotomously branched. Possible secondary siphons bearing also tertiary siphons. Fourth series of siphons not observed. The new morphological features regarding the clear description of the shape of the cortical siphons imposed the emendation of this taxon.

Remarks: *Banatocodium surarui* can be compared with Jurassic species *Palaeoporella tubulata* Dragastan and *P. jurassica* Dragastan .

B. surarui is different by possessing a large medullar hollow (probably multiaxial) and the other morphology of primary , secondary and tertiary cortical siphons.

Palaeoporella tubulata has only cylindrical, tubular cortical siphons which are close but not identical with those of *B. surarui*. *Palaeoporella jurassica* differs by having tubular slightly claviform primary cortical siphons continued with long, claviform secondary siphons. The tertiary are short tubular, also different.

Stratigraphic range: Lower Barremian, Caraşova, Banat, Southern Carpathians, Getic carbonate platform.

SPECIES / Dimens. in mm	Palaeoporella tubulata	P. jurasica	B. surarui
L	——	——	——
D	2.80-3.60	2.20-2.20	3.72-5.58
dbs	——	——	——
dms	0.090-1.20	0.18-0.20	1.0-3.10
c 1	0.090-0.10	0.070-0.090	0.075-0.14
c 2	0.060-0.075	0.040-0.075	0.030-0.039
c 3	0.030	0.020	—?—
c 4	0.010-0.015	——	——

Table 5 - Biometric data for the species of genera *Palaeoporella* and *Banatocodium*

CONCLUSIONS

- The protohalimedacean algae comprise a group of primitive calcareous algae with thalli segmented or constricted, uniaxial medullar zone, primary and secondary cortical siphons mostly during Paleozoic and more advanced morphology with multiaxial medullar zone, multiseries (1-4) cortical siphons in taxa crossing the Late Paleozoic and Mesozoic time-span;
- The calcareous algae of the family *Protohalimedaceae* represent a stock of genera and species, which have transitional morpho-structures from uniaxial to multiaxial medullar zone and also from uniaxial medullar siphon not branched to main uniaxial siphon branched.
- In case of hemisphaerical thalli formed by fan-shaped segments superposed each-others vertical and lateral , there is a main medullar siphon which entered in each segments and after is connected bilateral with cortical siphons ;
- The transitional character of these algae is emphasized also by the multiseries cortical system and by various shapes of the primary, secondary cortical siphons (cylindrical, claviform, moniliform) with different degree of constrictions and also of tertiary and fourth series siphons more or less tubular or cylindrical;
- The family *Protohalimedaceae* represents an evolutive link-line between Paleozoic families *Dimorphosiphonaceae* and *Lanciculaceae* and the Mesozoic to Recent family *Halimedaceae*. The family *Halimedaceae* originated during the Permian-Triassic time and continued with a spectacular diversification of species crossing the Cretaceous-Paleocene boundary and afterwards during the Cenozoic (Herbig & Dragastan, 2005) until Recent with a „high-speciation speed";
- The inner thallus morphology of representatives of the family *Protohalimedaceae* is characterized by three kind of segments: cylindrical, ovoidal - elongate – sphaeroidal and hemisphaerical multiserial fan-shaped compressed or not;
- The majority of thalli were constructed mainly by *cylindrical* segments with various shape and diameter, each-others superposed along the vertical axis (*Pinnatiporidium*, *Palaeoporella*, *Banato-codium*) and rarely cylindrical with small branches (*Tethysicodium*); by *cylindrical* or *ovoidal elongate* to *sphaeroidal* segments disposed bilaterally along the vertical axis (*Felixporidium*) and *hemisphaerical fan-shaped* segments superposed each-others along the axis growing vertically and laterally (*Margueritiella*, *Akrokorinthiella*, *Fagetiella*). If the cylindrical thallus formed by uniaxial, cylindrical or by different variant of sphaeroidal-ovoidal segments disposed along the vertical axis were found very frequent during the Paleozoic and Mesozoic , the same thallus structure, but with bilateral arrangement of the segments along the vertical axis was rarely described during the Paleozoic (see thallus reconstruction of *Palaeoporella variabilis* provided by Mamet & Roux in Bourque *et al.*1981). During the Mesozoic this disposition was very often recorded from many species of the genus *Felixporidium*.
- The hemisphaerical thalli built by fan-shaped segments overlapping each-others and growing vertically and laterally is a morpho-construction orginated during Triassic continuing during the Jurassic – Cretaceous time (*Margueritiella*, *Akrokorinthiella*, *Fagetiella*).

We suppose that from the stock of genera with hemisphaerical thalli (*Margueritiella*, *Fagetiella*) represented by fan-shaped segments of family *Protohalimedaceae* could be the „source" from which the families *Pseudoudoteaceae* and later *Udoteaceae* originated;

- It was pointed out, that the calcareous fossils of order *Siphonales* originated in Early Cambrian from a simple siphonous alga *Kordesiphon princeps* n. gen., n. sp. represented by a cylindrical thallus built by cylindrical segments crossed by uniaxial medullar hollow and with cortex pierced by primary and probably secondary siphons (?).

Starting from the Early Cambrian ancestor *Kordesiphon,* the Ordovician-Devonian family *Dimorphosiphonaceae* evolved.

From this family, two evolutive lines were separated, the family *Protohalimedaceae* (Silurian- Cretaceous) and the family *Lanciculaceae* (Devonian).

The *Protohalimedaceae* algae correspond to the „source" from which the family *Halimedaceae* originated during Permian-Triassic time and also the family *Pseudoudoteaceae* and later family *Udoteaceae* in Mesozoic times.

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EXPLANATION OF PLATES

PLATE 1

Figs. 1-2. *Felixporidium atanasiui* (DRAGASTAN 1978 non 1971) DRAGASTAN 1999: 1. axial longitudinal section with bilateral disposed segments, uniaxial medullary siphon (ms) and 1, 2, 3, 4 cortical siphons; 2. a part of the thallus enlarged,Tithonian, Bicajel Massif, Bicaz Gorges, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform, Scale bar = 0.25 mm.

PLATE 2

Fig. 1. *Felixporidium atanasiui* (DRAGASTAN 1978 non 1971) DRAGASTAN 1999, oblique longitudinal section, uniaxial medullar siphon (m) and cortex(c).
Figs. 2-5. *F.renatae* DRAGASTAN & RICHTER 2003, longitudinal and transverse sections.
Figs. 6-8. *F. balcanicus* DRAGASTAN & RICHTER 2003, longitudinal and transverse sections.
Figs. 9-10. *F. flabelliforme* DRAGASTAN & RICHTER 2003, longitudinal and tangential sections, Neocomian, Asprovouni Mts., Methana, Subpelagonian carbonate platform, Scale bar = 1.0 mm.

PLATE 3

Figs. 1-3. *Carpathocodium anae* (DRAGASTAN 1971) DRAGASTAN 1985, axial longitudinal section, thallus crossed by large uniaxial medullar siphon and cortex with dichotomously branched siphons, unified in fusiform fasciles. In the left side corner *Clypeina sulcata* (ALTH) (c); 2-3 - Broken thalli from the cortex area and typical disposition of the siphons (arrows), Tithonian – Berriasian, Făgetul Ciucului Massif, Bicaz Gorges, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform, Scale bar = 0.35 mm.

PLATE 4

Fig. 1. Reef consortium built by *Lithocodium-Bacinella–microbolite* (l, lm, arrows) and *Pinnatiporidium cylindricus* DRAGASTAN 1990, the consortium reef crossed by large cavities (c) and fenestral fabrics (f)., Tithonian, Suhard Massif, Bicaz Gorges, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform, Scale bar = 1.5 mm.
Fig. 2. *Felixporidium triasicum* DRAGASTAN, KUBE & RICHTER 2000, oblique longitudinal section, segments bilaterally disposed, uniaxial medullar siphon (m) and cortical primary siphons, subvesiculiferous (1), secondary (2), tertiary (3) and fourth (4) series siphons cylindrical and dichotomously branched, Rhaetian, Hydra Island, Greece, Scale bar = 0.25 mm.

PLATE 5

Figs. 1-6. *Pinnatiporidium alpidicum* (DRAGASTAN 1999) SCHLAGINTWEIT & DRAGASTAN 2004, Fig.4, *Holotype*, longitudinal and oblique sections, Tithonian-Berriasian, Dietrichshorns, Northern Calcareous Alps, Scale bar: Figs.1-2, 4-6 = 1.0 mm and Fig. 3 = 0.50 mm.
Fig. 7-*Pinnatiporidium untersbergensis* SCHLAGINTWEIT & DRAGASTAN 2004, longitudinal oblique section, *Holotype*, Upper Kimmeridgian - Tithonian, Veitel quarry, Untersberg, Northern Calcareous Alps, Scale bar = 1.0 mm.

PLATE 6

Fig. 1. *Tethysicodium wrayi* DRAGASTAN 1985, oblique longitudinal section, thallus segments crossed by uniaxial medullar siphon (m) and cortex (arrow) with primary moniliform (1) and 2-3 tubular long and short.
Figs. 2-3. *Tethysicodium elliotti* (DRAGASTAN 1971) DRAGASTAN & SCHLAGINTWEIT nov. comb. 2. oblique longitudinal section, uniaxial (m) and cortex with primary moniliform, long(1) and secondary medium long, dichotomously branched (2), 3. transverse section, showing uniaxial medullar siphon (m) and the cortex with primary and secondary siphons (2). Tithonian, Făgetul Ciucului Massif, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform, Scale bar = 0.50 mm.

PLATE 7

Figs.1-2. *Margueritiella densa* DRAGASTAN 1990, axial longitudinal section in thallus constructed by superposed segments (fan-shaped or fabellae) crossed by main medullar siphon (mm) and cortical siphons (1-4) primary short claviform, secondary slightly moniliform, tertiary moniliform dichotomously branched (2-3) and fourth serires short, tubular(4), see arrows and in Fig. 2. reconstruction of cortical siphons.Tithonian, Făgetul Ciucului Massif, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform, Scale bar = 0.25 mm.

PLATE 8

Figs. 1-2. *Akrokorinthiella furcata* RICHTER, DRAGASTAN & GIELISCH 1992, oblique longitudinal sections, thallus composed by segments crossed by uniaxial branched medullar siphon (m) and primary short cortical (1), long secondary siphons dichotomously branched (2) tertiary short (3) and fourth series (4) tubular. Neocomian, Valanginian, Akrokorinth limestone, Parnassus Nappe, Greece, Scale bar = 0.50 mm.

PLATE 9

Fig.1. Micro-reef consortium composed by *Lithocodium* – *Bacinella* – microbolite crusts (L), crossed by large cavities (c) and transverse section in *Palaeoporella tubulata* DRAGASTAN 1990 (arrow).
Tithonian, Făgetul Ciucului Massif, Hăghimaş Mts., East Carpathians, Transylvanian carbonate platform.
Figs. 2-3. *Pinnatiporidium toomeyi* (DRAGASTAN 1985) DRAGASTAN & SCHLAGINTWEIT nov. comb., oblique longitudinal and transverse sections, Tithonian, Cetea Hill, southern Apuseni, Scale bar = 0.40 mm.

PLATE 10

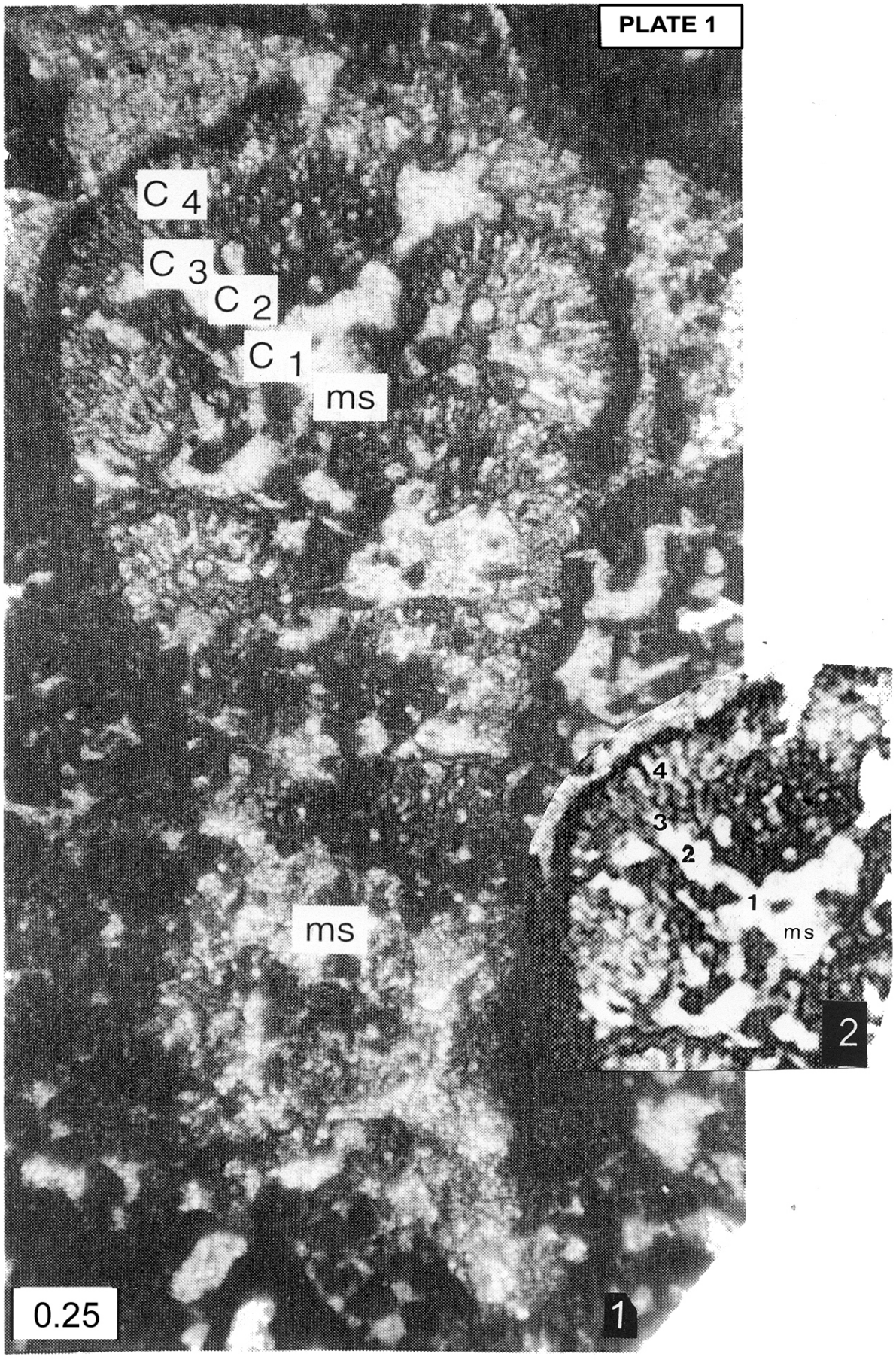
Fig. 1. *Kordesiphon princeps* n. gen. n. sp. (from original of Korde 1973, Pl.XVII, Fig. 4), Coll. Pin, No.1761/37, oblique longitudinal section in cylindrical thallus with large medullar zone (m) and cortex with ovoidal – claviform primary siphon (1 arrow) and probably secondary? (2 arrows) tubular slightly claviform, simple not branched. Early Cambrian, Tuva.
Fig. 2. *Lowvillia paucipora* DRAGASTAN 1990, oblique transverse section in a segment crossed by narrow medullar with few siphons (m) and cortex with primary (1) and secondary (2) siphons (see arrows).
Tithonian, Giuvala Massif, Dîmbovicioara Basin, Getic carbonate platform, Scale bar = 0.10 mm .

PLATE 11

Fig. 1. *Banatocodium surarui* BUCUR 1994 emend, unfortunately piling thalli segments cut by oblique transverse sections showing the cylindrical shape (round in section) of thalli crossed by large medullar zone (m) and thick cortex. Early Barremian, Caraşova, Nera Valley Limestone, Banat, Southern Carpathians, Getic carbonate platform, Scale bar = 1.0 mm.

PLATE 12

Fig. 1. *Banatocodium surarui* BUCUR 1994 emend, thallus more enlarged showing the large medullar zone (m) and the cortex crossed by primary long, cylindro-claviform to distal (arrows) and secondary (2 arrows), long, claviform or cylindro-conical dichotomously branched. Scale bar = 0.050 mm.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C 2
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2
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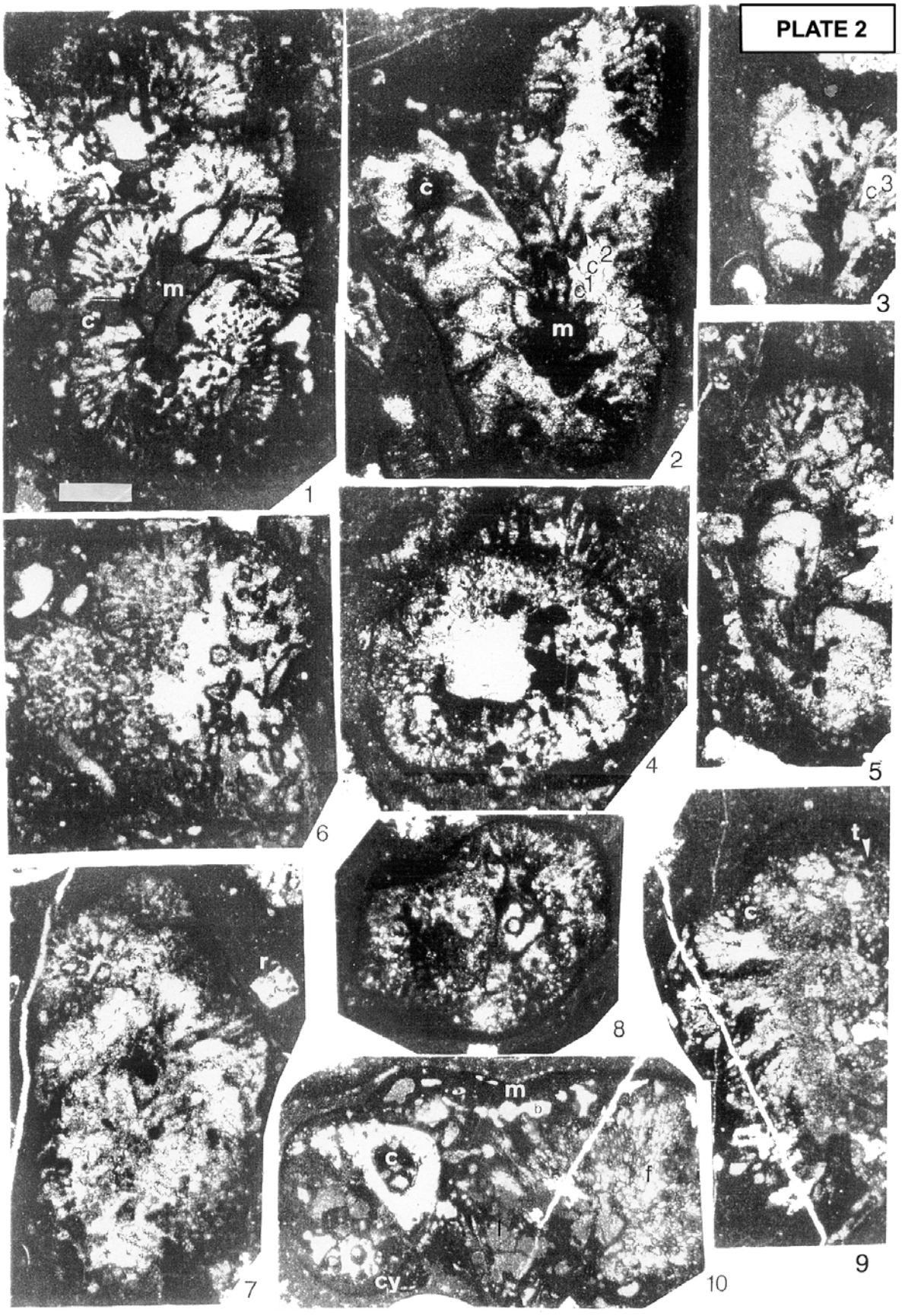
1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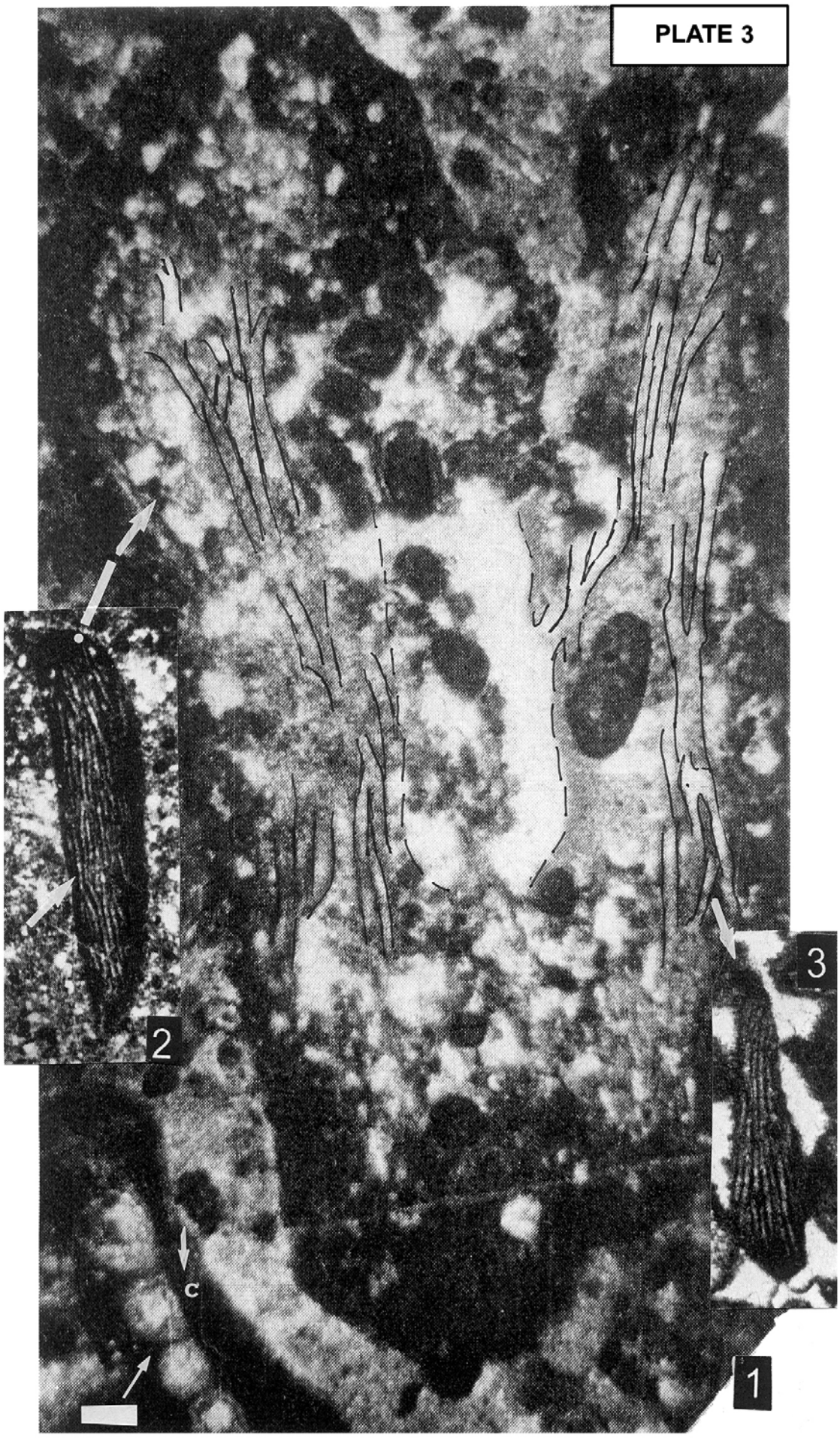
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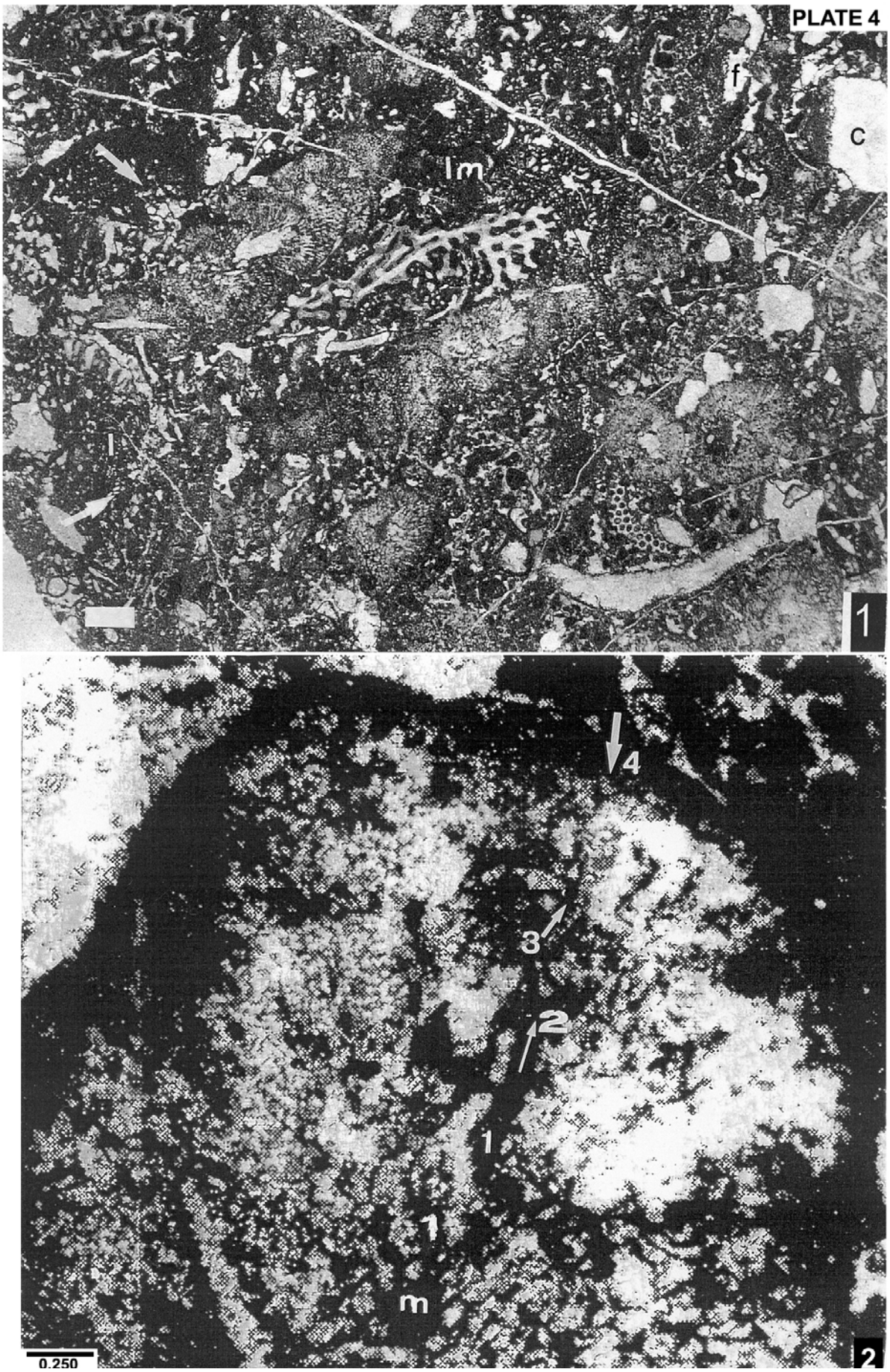
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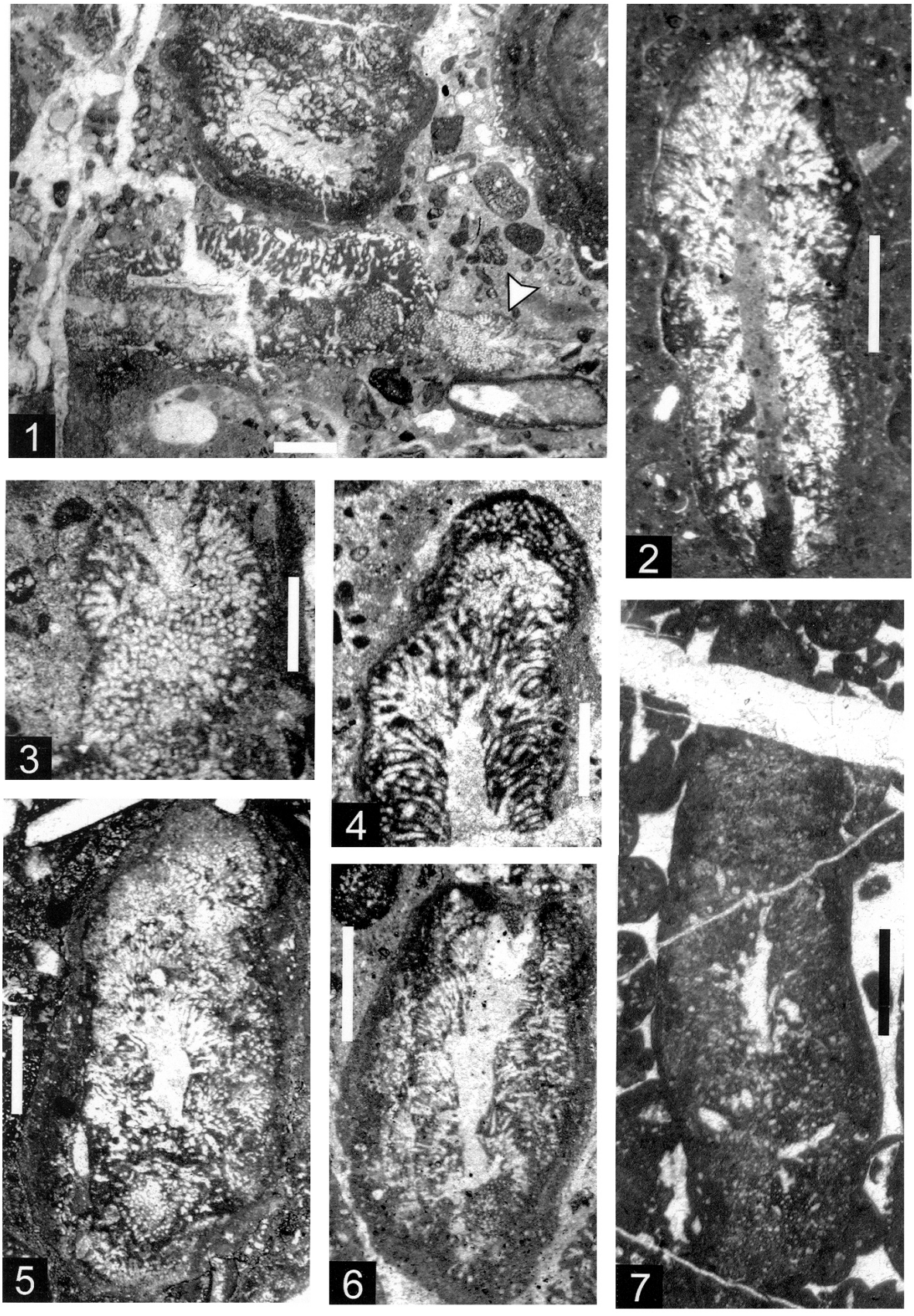
PLATE 5



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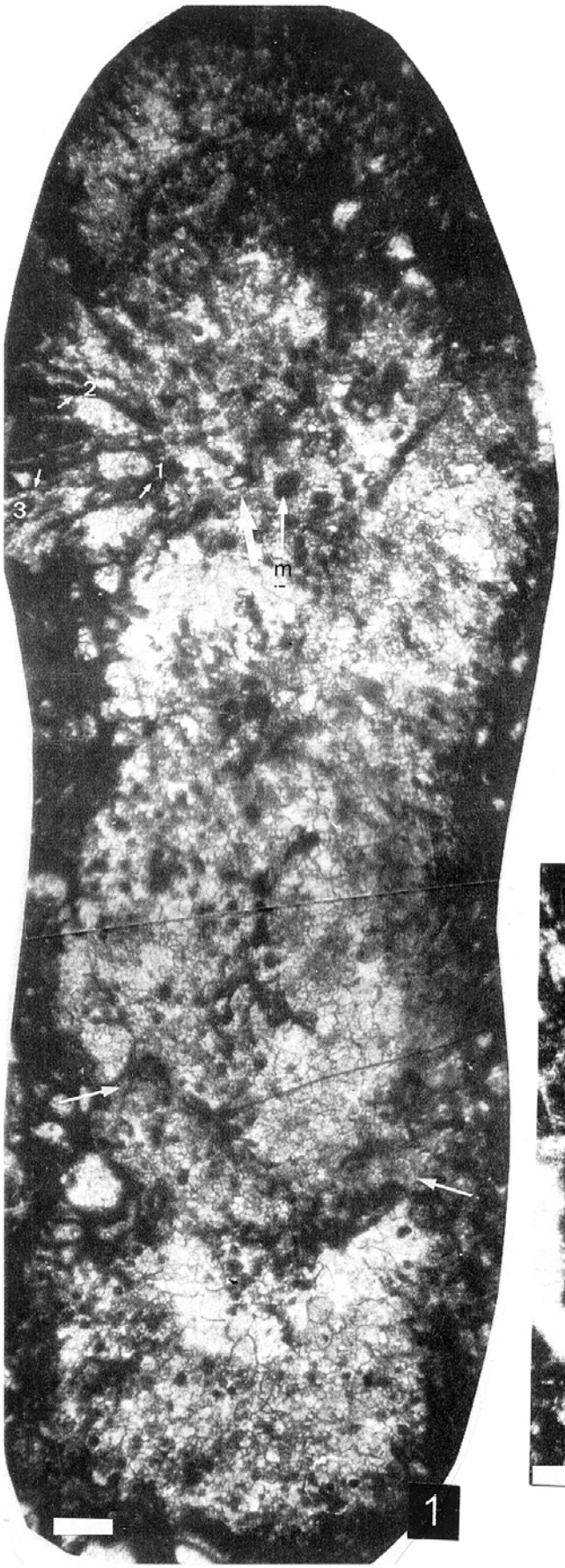

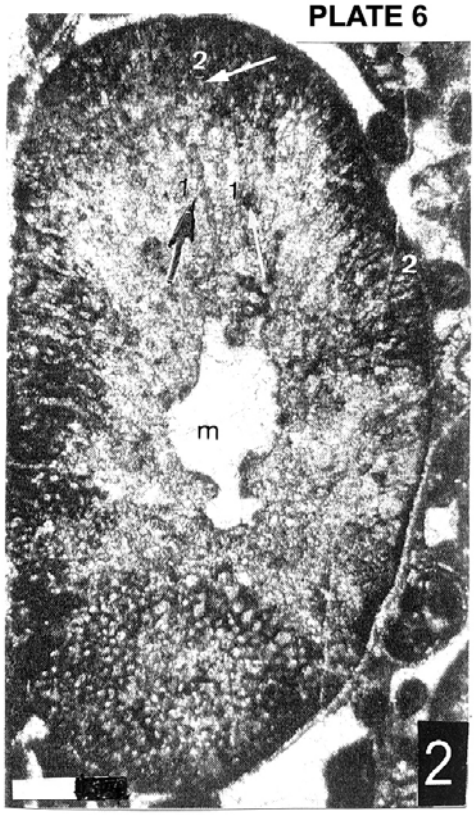

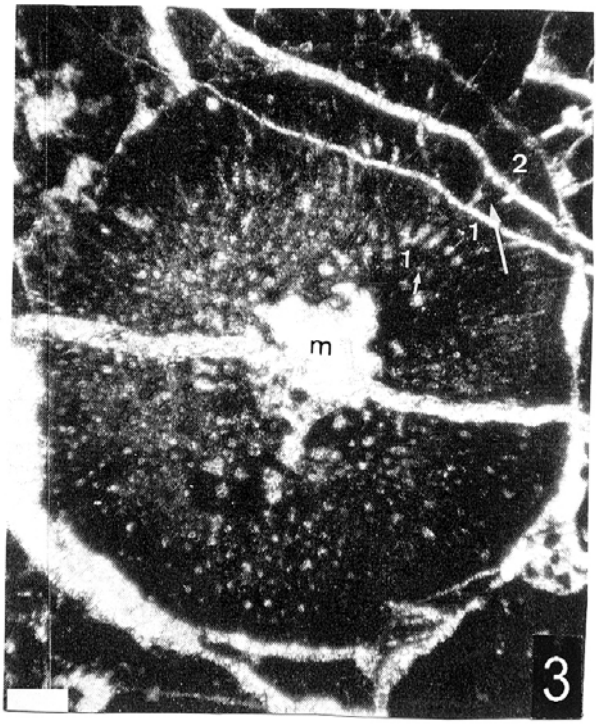

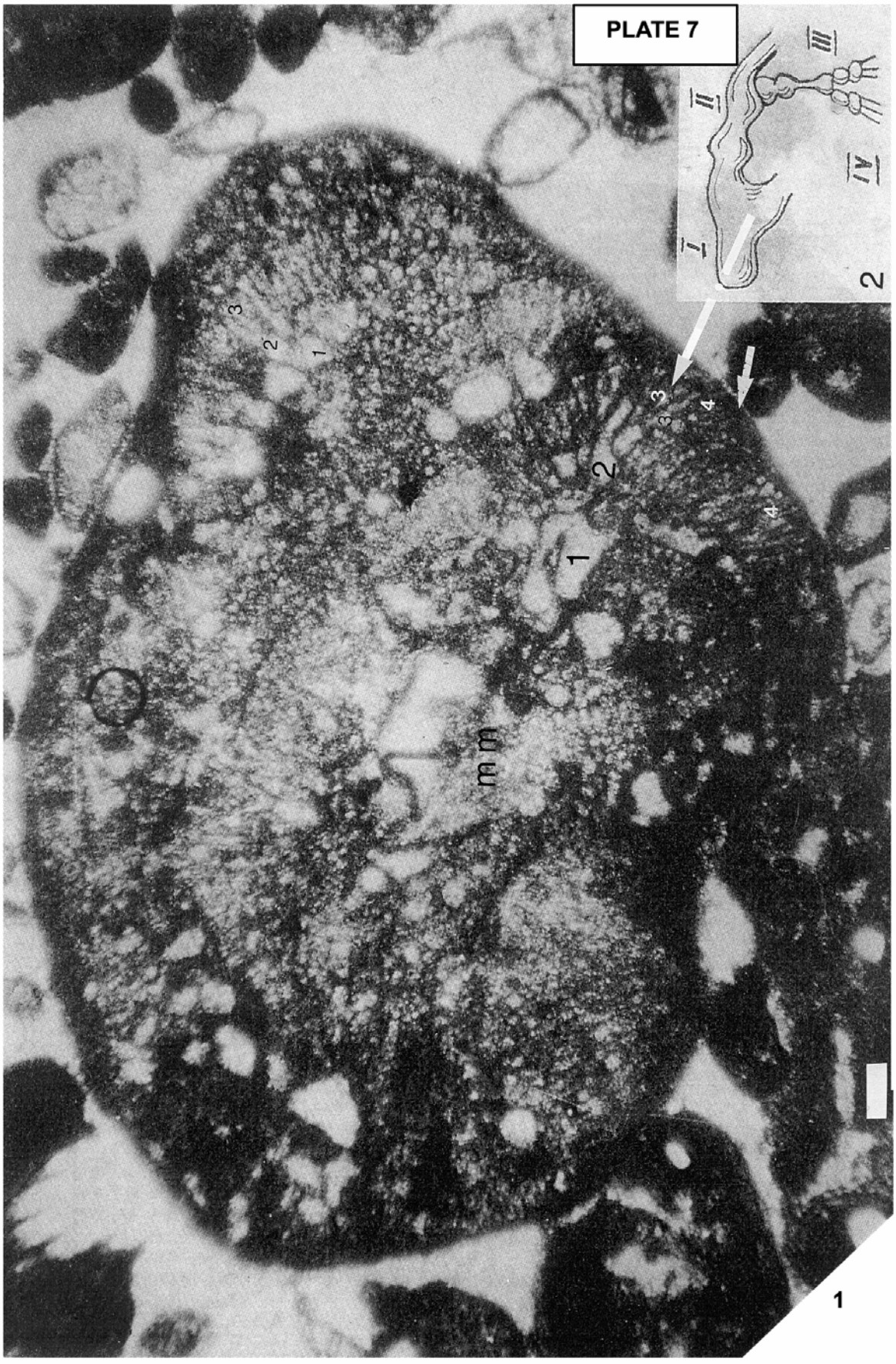
PLATE 7
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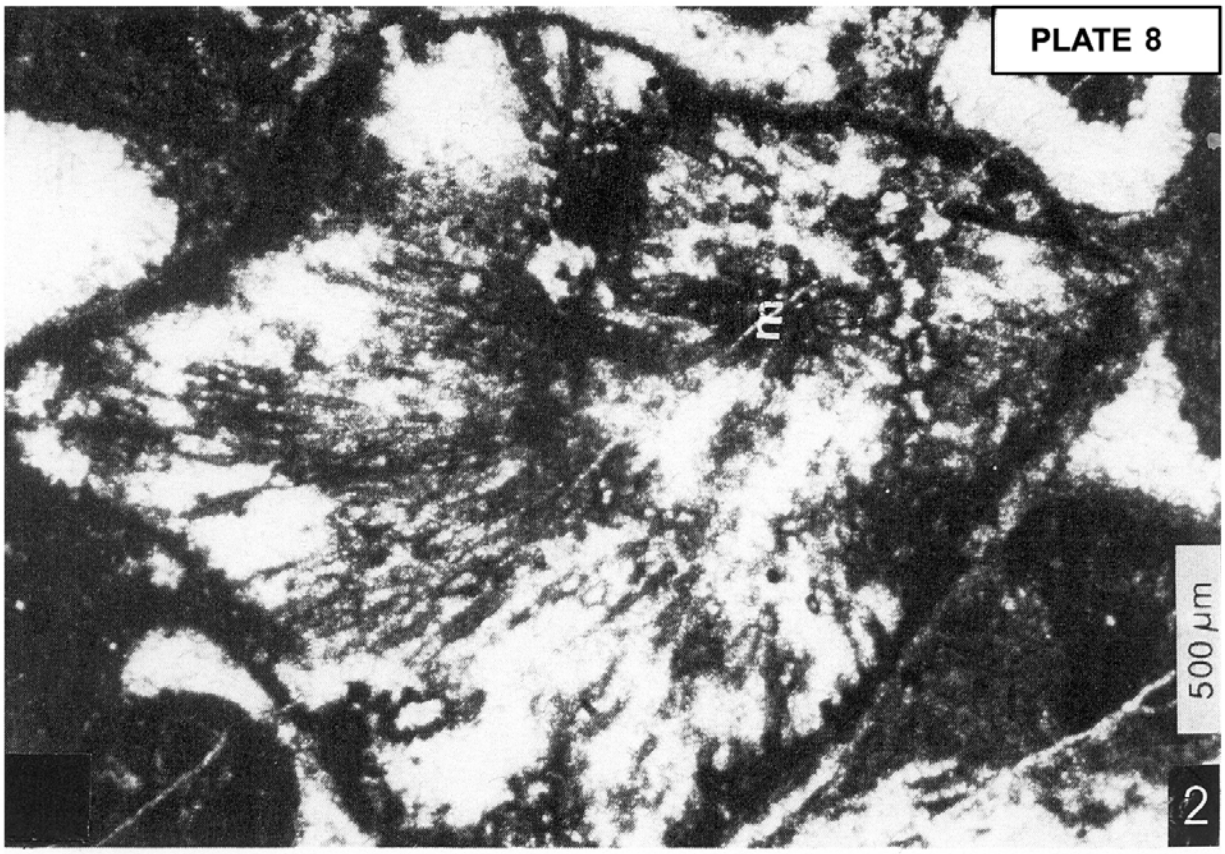
PLATE 8
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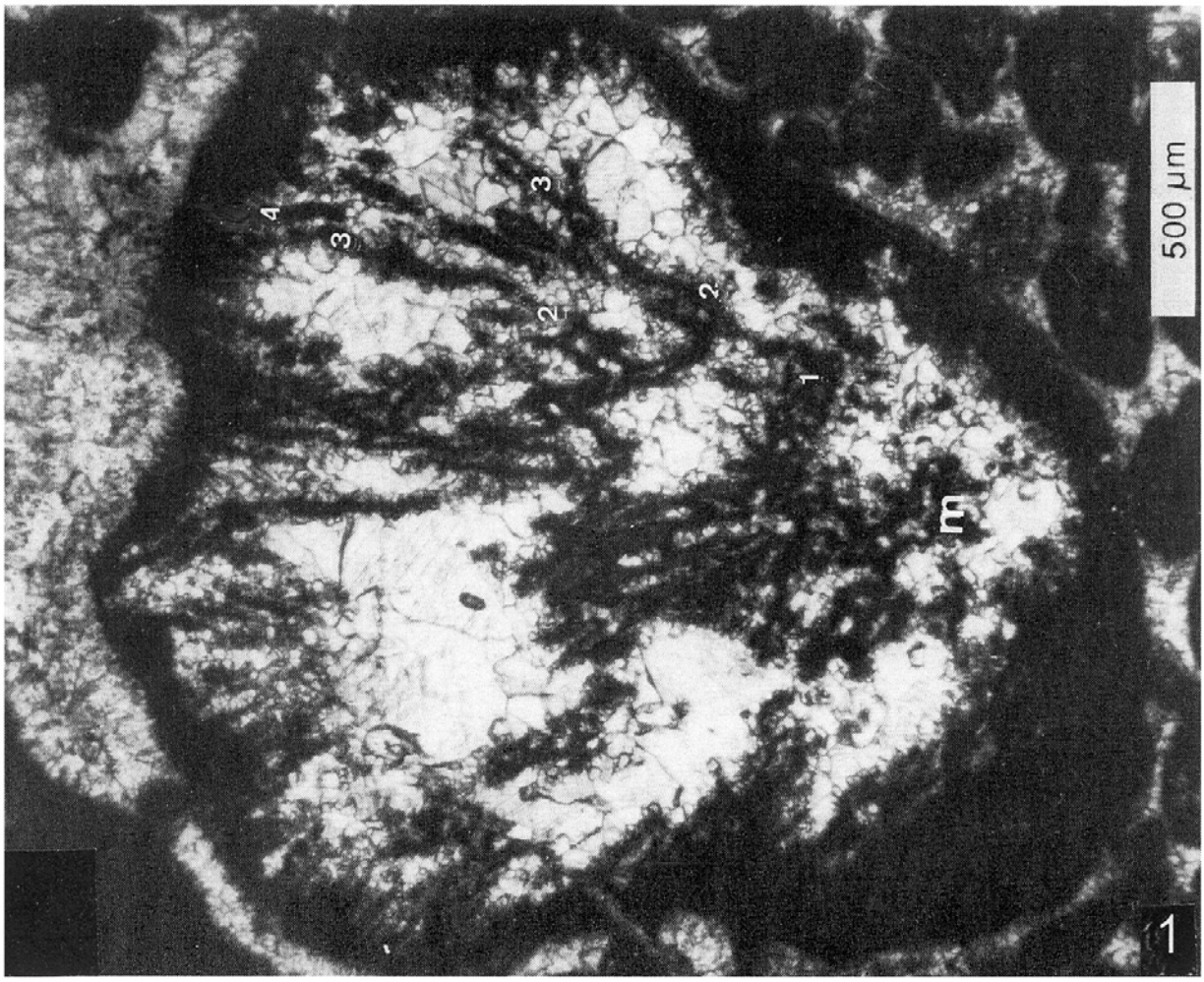
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PLATE 9
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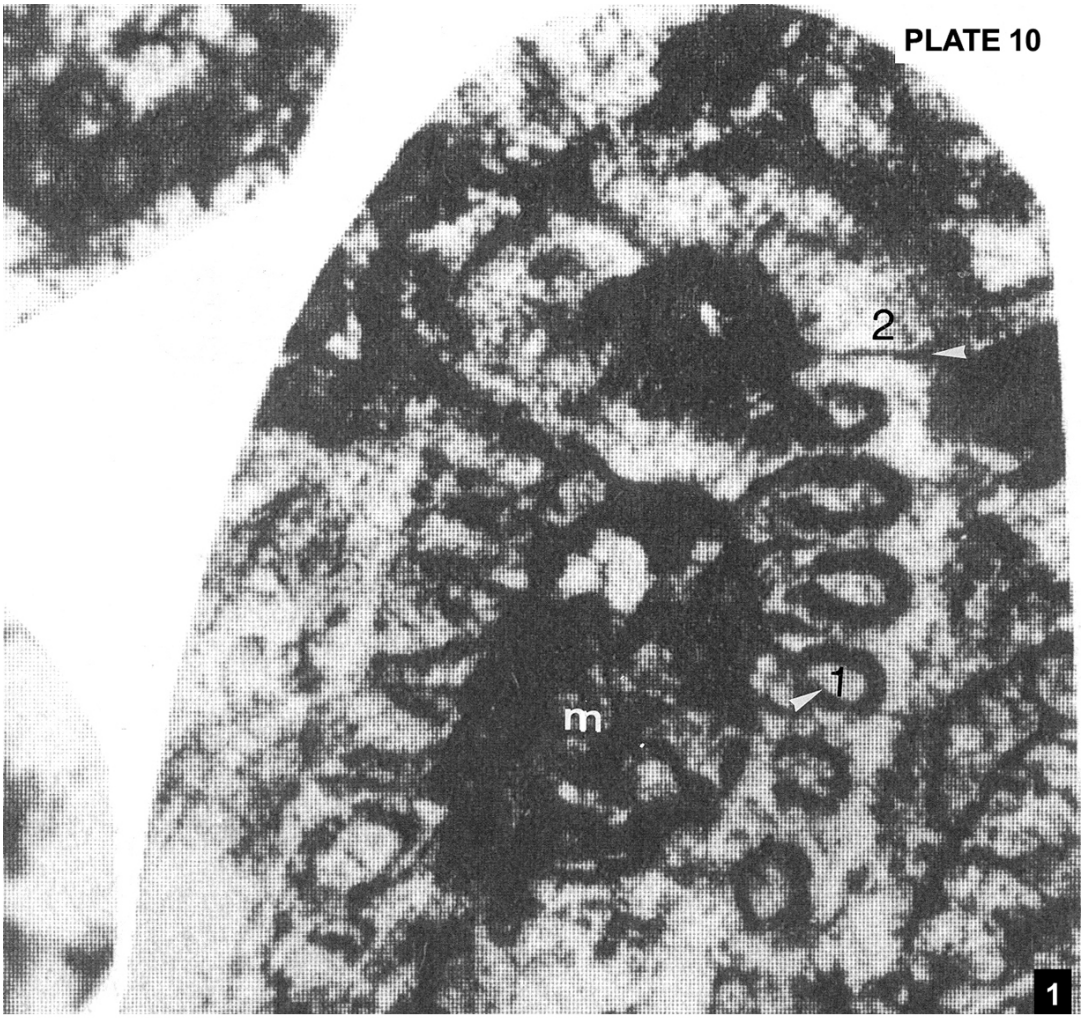
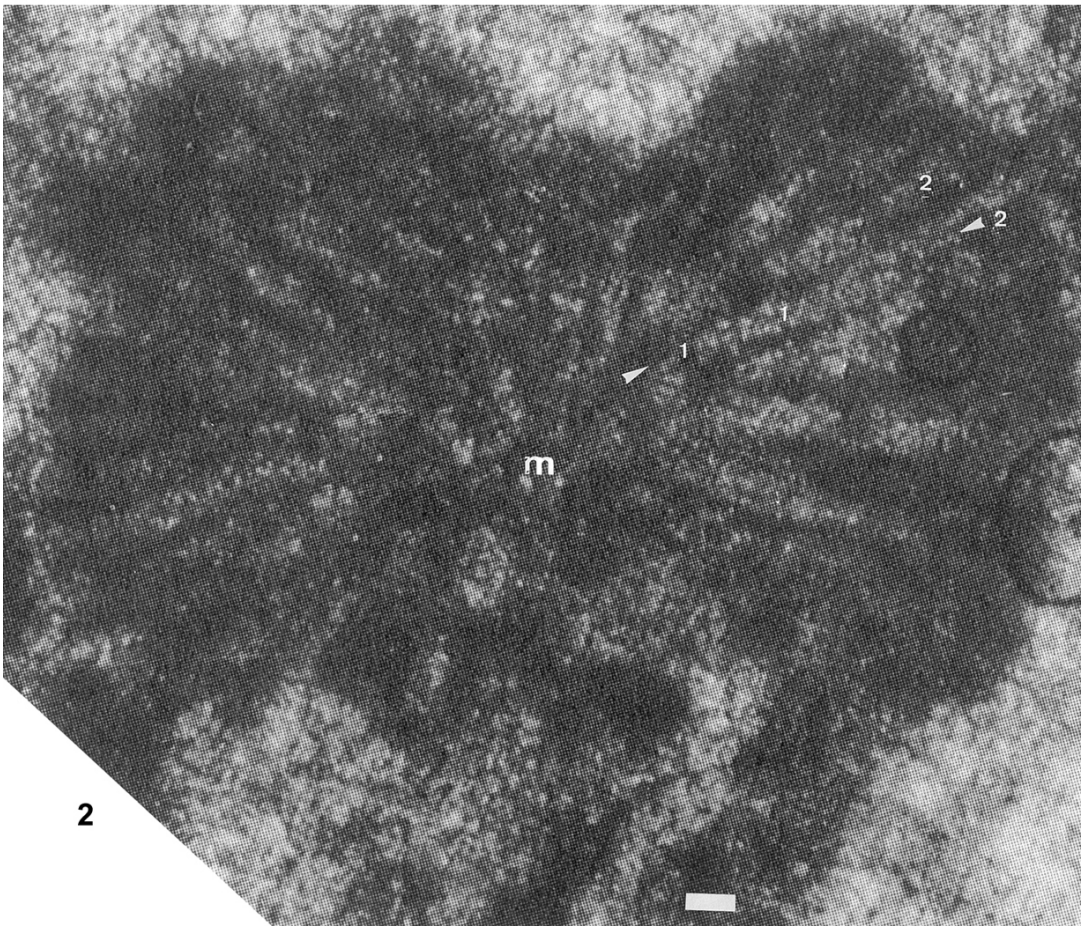
PLATE 10





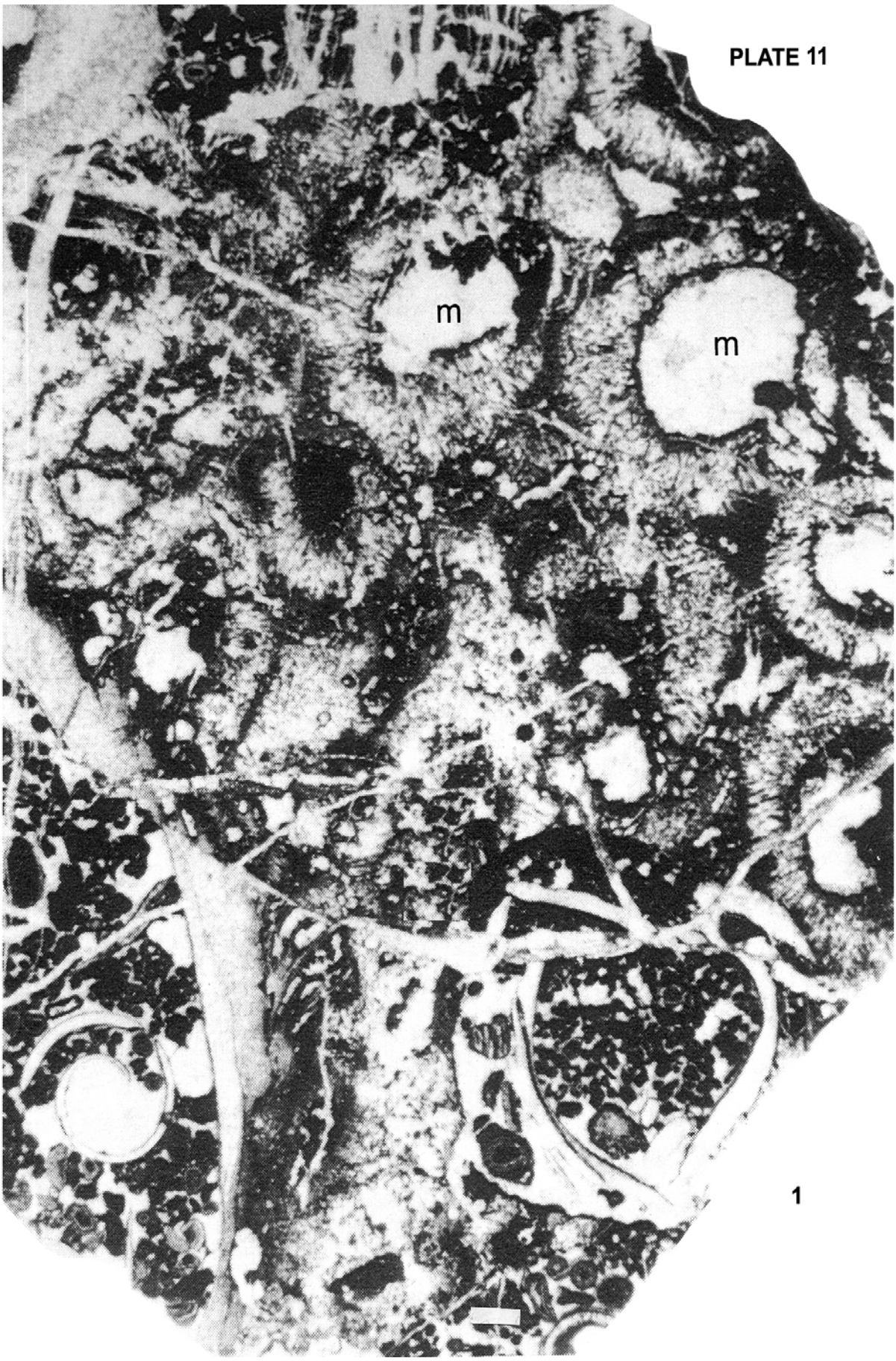


PLATE 11
m
m
1

PLATE 12