CALCAREOUS ALGAE

Algae are a large group of diverse non-vascular, mostly chlorophyll-bearing plants with the lowest and the simplest organization of the thallus — the plant body is not differentiated into true roots, true stems and true leaves. They range in size from a few microns to tens of metres in length and vary from simple unicellular to very complex multicellular types.

Those members of the algal subdivisions which display — the majority, today, donot—internal and/or external calcification (Pl. 19, fig. 1) are commonly known as the calcareous algae. (Johnson, 1961 and Bray, 1977 provide comprehensive introductions on the subject of fossil calcareous algae). In the skeletal calcareous algae the precipitated skeletal calcareous material represents direct/indirect evidence of the plant body or tissue. Non-skeletal calcareous algae, such as the stromatolites are, on the other hand, primarily sedimentary structures produced through algal agency. (The present study concerns the skeletal calcareous algae).

Except for the small planktonic coccolithophores,
calcareous algae are attached bottom dwellers—the sessile benthos.

Geographically the distribution of calcareous algae varies, today, as a function of the amount of CaCO$_3$ dissolved in sea water. The warmer water-temperature, lower CO$_2$-partial pressure and normal marine salinity of the tropical low latitudes favour the maximum precipitation of CaCO$_3$ and, hence, also favour the maximum abundance and variety of present-day calcareous algal growth. (Comparably the carbonate rocks are the principal store-houses for the fossil calcareous algae).

Fossil algae have been recorded from rocks of all ages from the Precambrian (vide Berghoorn and Tyler, 1965; Berghoorn and Schoff, 1965; Cobulic and Berghoorn, 1977) up to the Recent. Moreover, they are known as prolific rock-builders of Late Palaeozoic, Triassic, Jurassic, Late Cretaceous and Cenozoic times (Johnson, 1961).

A knowledge of calcareous algae may be utilized geologically in carbonate sedimentology, age and environment interpretations, and also in petroleum and mineral exploration—algal-rich facies have served as hosts for hydrocarbon accumulation in the Pennsylvanian of South-West U.S. and Palaeocene of Libya and for ore mineralisation in the Cambrian of Missouri and Precambrian of Russia.
Classification

The spectrum of criteria considered in formulating phylogenetic classification of algae is constantly broadening in the light of overwhelmingly large amount of new data and continually affecting algal classifications. Under the circumstances, the classification of algae differs with the classifier. Current systems of classification mostly recognize between 3 (e.g. Chadeau, 1960; Christensen, 1962; Feldmann, 1963; Bourrelly, 1963) and 10 (e.g. Chapman and Chapman, 1973) which is more or less similar to the classifications favoured by Papenfuss, 1959; Smith, 1959; Fott, 1959; Round, 1965; Dawson, 1966; Prescott, 1968) divisions. Bold and Wynne (1979) tentatively recognize the following divisions:

- Ochrochloronta (blue green algae), Chlorophycophyta (green algae), Charophycophyta (stapworts), Euglenophycophyta (euglenoids), Phaeophycophyta (brown algae), Chrysophycophyta (golden and yellow-green algae, including diatoms), Pyrrophyycophyta (dinoflagellates), Cryptophycophyta (cryptomonads) and Rhodophycophyta (red algae).

The schemes of classification referred to above and their further subdivisions are based upon characters and processes observed in the living algae. This presents something of a problem in case of the classification of
fossil calcareous algae, primarily because the fossil algae are identified by studying incompletely preserved morphology only. Moreover, the older the fossils are, the less are they like the extant forms. Faced with this situation the author recalls Johnson (1961) who, while considering the problem of classifying fossil algae, remarked, "... one does not have to worry too much about the system (of classification) used as long as it will work for most of the specimens studied".

Wray (1977) provides a classification of fossil benthonic skeletal calcareous algae relying on the morphological characteristics used in the classification schemes of analogous living forms. This sufficiently suits the present study as a starting point because of its simplicity and will be followed here with slight modifications in appropriate places in the sequel.

**Check List of the Algal Taxa Described**

The systematic part of the present study includes the description and illustration of sixty species of calcareous algae representing five algal families. The following is the check list of the forms identified:

(a) The Red Algae

Family: **Solemaceraceae** Pia, 1927

Genus: **Solemamia** Douville, 1924
Solenomaria o'gormani Bouville, 1924
Solenomaria (?) sp.

Genus: Marialia Pfender, 1939 ammd.
Marialia lueconi Pfender, 1939

Family: SCUAMARIACEAE Zanardini, 1941

Genus: Pseudolithothamnium Pfender, 1936
Pseudolithothamnium album Pfender, 1936

Family: CORALLINACEAE Harvey, 1853

Subfamily: HELOBESIOTIDAE Mason, 1939

Genus: Archaeolithothamnium Rothpletz, 1991
Archaeolithothamnium tawarii n. sp.
Archaeolithothamnium poroleum Johnson, 1964
Archaeolithothamnium stenereoni (Schwager, 1983)
Archaeolithothamnium cf. A. conoastilensis (Rao, 1943)
Archaeolithothamnium consorarcisac n. sp.
Archaeolithothamnium lueconi Pfender, 1926
Archaeolithothamnium quentai n. sp.

Genus: Lithothamnium Philippi, 1937
Lithothamnium cf. L. bofili Lemoine, 1920
Lithothamnium carienses Johnson, 1957
Lithothamnium cf. L. morati Lemoine, 1927
Lithothamnium mince Lemoine, 1939
Lithothamnium poroleum Johnson, 1955
Lithothamnium lunchnoniensis n.sp.
Lithothamnium spinosum n. sp.
Lithothamnium cf. L. diagramaticum
Johnson and Kaska, 1965
Lithothamnium ghosai n. sp.
Lithothamnium sp. A
Lithothamnium sp. B

Subgenus 1 Paleothamnium Segonzac, 1969
Lithothamnium (Paleothamnium) ivaal Maslov, 1962

Genus 1 Mesophyllum Lemoine, 1929
Mesophyllum (?) sp. A
Mesophyllum (?) sp. B

Genus 1 Lithophyllum Philippi, 1937
Lithophyllum simplex Lemoine, 1927
Lithophyllum cf. L. monspurnum Johnson and Ferris, 1948

Genus 1 Lithonorella Foslie, 1909
Lithonorella calophanidens (Foslie, 1903)
Lithonorella minus Johnson, 1964

Genus 1 Litholania Foslie, 1909
Litholania (?) sp.

Genus 1 Distichonella Foslie, 1934
Distichonella biserialis (Dietrich, 1927)

Subfamily 1 CORALLINACEAE Mason, 1953

Genus 1 Amphiroa Lamouroux, 1812
Amphiroa sp.
Genus : Corallina Linnaeus, 1758
  Corallina cf. C. prisma Johnson, 1957
  Corallina cf. C. natans Johnson, 1957
  Corallina sp.

Genus : Jania Lamouroux, 1812
  Jania jauntiensis n. sp.

Genus : Calliergon Menzies, 1937
  Calliergon (?) sp.

Genus : Metacnoniolithon Weber van Bosse, 1904
  Metacnoniolithon (?) nachalovensis n. sp.

(b) The Green Algae

Family : UDOTEACEAE Feldmann, 1946

Genus : Ovulites Lamarck, 1816
  Ovulites baroculata Lamarck, 1801
  Ovulites morletti Elliott, 1955
  Ovulites elonque Lamarck, 1816
  Ovulites caillolensia Massieux, 1966

Genus : Halimeda Lamouroux, 1812
  Halimeda praemontana Morelet, 1940
  Halimeda sp.

Family : DASYCLADACEAE Ruttig orth. mut. Stizenberger, 1860

Subfamily : DASYCLADOIDEAE Valot, 1968

Genus : Acrocoralla (Fratilic, 1964)
  Acrocoralla anguina Segonzia, 1976
Genus 1 Dissociadella (Pia, 1936)
          Dissociadella eliottii n. sp.
          Dissociadella sp. A
          Dissociadella sp. B
Genus 1 Trioplanosa Raines, 1922
          Trioplanosa sp.
Genus 1 Sarafiella Conrad and Peybernes, 1973
          Sarafiella rupicrasci n. sp.
Genus 1 Trioplanrella (Steinmann, 1891)
          Trioplanrella sp.
Genus 1 Angiorollia Masse, Conrad and Raboisie, 1973
          Angiorollia (?) sp.
Subfamily 1 BORNETTELLIDAE Valet, 1969
Genus 1 Termesella Munier-Chalmas, 1877
          Termesella sp.
          Termesella cf. T. lenticularia Pia, Rao and Rao, 1937
Subfamily 1 NEOMERIDIDAE Valet, 1969
Genus 1 Nomeria (Lomoureu, 1916)
          Nomeria cf. N. pianaensis Beloffre, 1970
Subfamily 1 UNCERTAIN
Genus 1 Furcoperella Pia, 1919
          Furcoperella diplonora Pia, 1919
Genus 1 Namanella Elliott, 1978
          Namanella cf. N. analalanaensis Elliott, 1978
Family: ACETABULARIAEAE Velet, 1968
Subfamily: ACETABULARIAEAE Decaism, 1942
Genus: Clionea (Michelin, 1945)
    Clionea elliotri Beckmann and Beckmann, 1966
Genus: Acicularia d'Archiac, 1943
    Acicularia sp. A
    Acicularia sp. B

The presentation of algal descriptions in this chapter follows the order of arrangement of the taxa in the above list, beginning at the top.

Repository:

The figured specimens of the algae listed above have been catalogued and deposited in the Museum of the Centre of Advanced Study in Geology, Panjab University, Chandigarh under slide Nos. CASTMF 1867 to 1915.
SYSTEMATIC DESCRIPTION

More than 209 systematically collected field samples from the nine field sections of the Sylhet Limestone Formation have been used in this study. Petrographic thin sections of these samples have been critically analyzed for their algal content. Informations of a general nature used in this chapter and the mode of presentation of the algal descriptions have been synthesized from a multitude of existing publications.

Taxonomic treatment including the identification of the algal fossils have been based on considerations of external morphology including growth habit (Plates 10 and 11 shows a few examples of different growth habits) and shape, size and arrangement of internal structural elements such as the preserved tissue, reproductive organs etc. With the available information it has been possible to provide a few taxonomic keys in this thesis in appropriate places.

In the present collections both the red and the green algae are abundantly represented. Consequent upon the almost inevitable diagnosis of the original skeletal carbonates, the red corallines, in particular, have a fine grained, dark coloured appearance under the microscope.
and the greens a clear, coarse grained sparry appearance.

The red and the green algae are described below in two parts, (a) and (b) respectively:

(a) The Red Algae

Division RHODOPHYTA Neettstein, 1901
(Syn. RHODOPHYCOPHYTA Papenfuss, 1946)

The red algae are a large group of marine plants biologically appearing to be intermediate between the blue-green and the green algae. Most rhodophytes are characterized by complex thalli. Fossil red algae can be distinguished on the basis of the external morphology, the texture of the cellular tissue and the structure of the reproductive organs. The group is represented by about fifty to sixty genera in the fossil record which dates back to the Middle Cambrian times.

Class RHODOPHYCEAE Sprecht, 1851
Subclass FLORIDEAE Hylin in Fitseh, 1935
Order CRYPTOSPHERIALES Schmitz in Engler, 1992
Family SOLENOPOREACEAE Pia, 1927

The members of the extinct family of solenoporaceans grew as round to nodular masses and thin crusts. Their cellular tissue is usually undifferentiated. Cells are large, rectangular in longitudinal sections and polygonal in
transversal sections. Reproductive organs are not known definitely. About ten to twelve genera have been assigned to this extinct family, of which most are widely distributed in the marine Palaeozoic and Mesozoic rocks and only a few are known from the Tertiary.

Genus- *Polonomoria* Douville, 1924

Type species- *Polonomoria o’connelli* Douville, 1924

Diagnosis (after Gray, 1977):

The genus is characterized by a marked irregularity of its cellular tissue. Cells are polygonal in transverse sections, averaging 40-60 microns in diameter. In vertical sections also the individual cells appear to be irregular in shape; cell partitions being alternate in position in adjacent rows to give a zig-zag effect. The thallus varies in shape from nodular forms to thin encrusting species. Reproductive organs were probably external and uncalcified, although internal conceptacles have been described.

Remarks:

Pfender (1926a) compared the general aspect of the tissue of *Polonomoria* with that of some hydroses (genera *Clathrodictyon*; *Parallelopora*). Johnson (1965, 1968) too had considerable doubt as to whether the organisms described
by him as Solanomaria were truly algae. Rao and Varma (1953) described Solanomaria douvillei Rao and Varma, non Pfender, with alleged conceptacles from the Lower Eocene of Pakistan and classified it under Melobesiales on grounds of cell dimensions and the alleged reproductive structures. On the other hand, Elliott (1965), from his study of Solanomaria from the Middle East has presented data showing that the genus is truly a solanoporacean alga. In recent years Boulanger and Poignant (1969) and Poignant and Chaffaut (1970) have reported "sporangia" in Solanomaria from France.

The genus is known to range from the Late Cretaceous to the Early Oligocene.

*Solanomaria o'conmani* Douville, 1924

*(Pl. 22, fig. 1-2)*

1924-*Solanomaria o'conmani* Douville, p. 168-170, fig. 1-5
1960-*Solanomaria o'conmani* Douville-Elliott, p. 225
1965-*Solanomaria o'conmani* Douville-Elliott, p. 697, pl. 108, fig. 1-3, pl. 106, fig. 1-3, pl. 107, fig. 1-2, pl. 108, fig. 3
1969-*Solanomaria o'conmani* Douville-Boulanger and Poignant, p.109
1970-*Solanomaria o'conmani* Douville-Poignant and Chaffaut, p. 205-207

Description:

Thallus encrusting on other crustose algae such as

3337 20
Lithoxarella, Lithothamnium or Foraminifera such as Discoyclina. Fragments up to 1.375 mm thick and up to 5.625 mm long have been noticed. Rather weakly banded growth zones are suggested by variations in cell size. Cells appear as polygonal in both vertical and cross sections; in vertical sections they are very frequently hexagonal; horizontal cell walls very thin, vertical walls much thicker. Transverse septa straight to somewhat convex upwards. Cells in adjacent vertical rows alternating, giving a zig-zag effect. In vertical sections, cells measure 0.0313–0.0625 mm in width and 0.0125–0.0563 mm in height. No conceptacles are seen.

Remarks:

In general appearance and cellular structure these specimens are almost identical with those figured by Elliott (1965) for S. percentii from the Paleocene-Lower Eocene of the Middle East (Pl. 106, fig. 3 of Elliott may, however, be showing S. douvillei Pflender, according to Segonzac, 1966, p. 417). The measurements and the hexagonal shape of the cells in vertical sections also indicate similarity of the present form with the type species of Solenomeris originally described from the Lower Eocene of French Pyrenees.
Associations and Microfacies:

Numerous superposed and interstratified crusts of *Solenopora o'connorii* occur in the biolithites containing abundant crustose corallines and *Pseudolithothamnium album* with infrequent fragments of *Dictyonema bicornis*. Associated fauna are *Discocyclina* (common), badly preserved *Nummulites*, *Miscellaneous* and rare bryozoans.

Horizon and Locality:

Mainly in Subzone IID, Lakadong Limestone Member, Upper Paleocene, Section G, Lashmangong vicinity.

Stratigraphic and Geographic Distribution:

- Paleocene of France (Peignat and Chaffaut, 1970),
- Paleocene-Lower Eocene of Italy (Fraturian, 1966),
- Paleocene-Lower Eocene of the Middle East (Elliott, 1960, 1965),
- Lower Eocene of French Pyrenees (Couville, 1924),
- Middle Eocene (Upper Lutetian) of France (Boulenger and Peignat, 1969).

Figured Specimen:

Slide C5053F 1896.
Solenomeris (?) sp.

(Pl. 13, fig. 1; Pl. 22, fig. 3-4)

Description:

Thallus consisting of rather coarse individual tubular filaments (up to 0.400 mm in length and 0.013-0.081 mm in diameter) or colonies (up to 1.5 mm long and up to 0.275 mm wide) of irregularly tangled filaments. Colonial thalli form irregular masses or nodules often encrusting upon other objects/organisms such as Corallites or Foraminifera. The encrusting filaments start growing parallel to the surface of attachment but become irregularly disposed further away. Single isolated filaments have been seen to pass gradually into tangles of filaments at one end and to acutely taper at the other end. In cross sections the filaments are circular, subcircular, oval or bluntly polygonal. Dichotomous branching of filaments has been noticed occasionally (Pl. 13, fig. 1; Pl. 22, fig. 4). Ovoidal cavities (0.265 mm x 0.158 mm) or circular cavities (0.160 mm in diameter) seen within the colonies may possibly be conceptacular in some cases.

Remarks:

The growth habit, tubular structure and large cells of the specimens point to their solenoporellid affinity,
recalling probably certain oblique sections of Solanomaria.
But a typical Solanomaria aspect usually seen in vertical
sections is missing here and other characters described
above are apparently different from those of a Solanomaria.
However, till more information is available the identity
of the present fossils remains enigmatic.

Associations and Microfacies:

Noticed mainly in the biosparites of the Umlatdoh
Limestone Member in association with frequent Qualites,
rare Furconocrella diplomata, Ternamella, cf. L. lenticularis,
Alveolina, miliolids, tentularids and echinoid spines.

Horizon and Locality:

Mainly in zone IV, Umlatdoh Limestone Member,
Lower Eocene, Section G, Lumbanong vicinity.

Figured Specimens:

Slides CASMF 1999, 1912.

Genus Marinella Pfender, 1939 emend.

Type species Marinella lugaeoni Pfender, 1939

Diagnosis:

Algae characterised by more or less rounded or
meandrinform masses with a thick-set aspect, growing irregularly
in diverse directions and at times giving a digitated appearance to the thallus. The compact tissue which may show pronounced growth zones is constituted of closely packed fine tubular, sometimes sinuous, filaments. The filaments, which are more often only locally constricted, may at once show both constrictions and cross partitions. Incipient hypothallus is occasionally suggested by oblique basal cells turning up and merging into the main parithallic structure. Definite sporangia not known.

Remarks:

Whereas Pfender (1939), Johnson (1961b, 1964c), Beckmann and Beckmann (1966), Bourouilles and Deloffre (1968) and Masse and Poignant (1971), for example, have described Marinella under Codiaceae, Pla and Andrusov (in Pfender, 1939, p. 215) would like to associate this genus with the solenoporaceans or at least with the red algae.

The present study has revealed the presence in Marinella of horizontal partitions along with constrictions in the filaments (Pl. 13, fig. 3; Pl. 23, fig. 7) and incipient basal hypothallus consisting of oblique cells (Pl. 13, fig. 2; Pl. 23, fig. 6; cf. Elliott, 1965, Pl. 109, fig. 2 for Neosolenopora catarrini Mastrorilli, 1955).

These characters together with the growth form and general
appearance of the alga points towards its place among the Solanoporidae as visualised by Pla and Andrusev. Aegonser (personal communication) agrees with this assignment of Marinella to the family Solanoporidae on the basis of above mentioned new findings.

The genus is known from the Jurassic of Europe, the Middle East and the U.S.A., Lower Cretaceous of Angola, Guatemala, Cuba, Hungary and Bulgaria, Upper Cretaceous of Portugal, and Palaeocene-Middle Eocene of Cuba and France. The present discovery of the genus in the Upper Palaeocene of Meghalaya is the first record of its occurrence in India.

*Marinella luzononi* Pfender, 1939

(*) Pl. 13, fig. 2-3; Pl. 23, fig. 1-7(*)

1939—*Marinella luzononi* Pfender, p. 3, pl. 2, fig. 1-2

1961b—*Marinella luzononi* Pfender-Johnson, p. 147, pl. 31, fig. 1-2

1965—*Marinella luzononi* Pfender-Johnson and Hasha, p. 74, pl. 6, fig. 2

1966—*Marinella luzononi* Pfender-Beckman and Beckman, p. 35, 36, pl. 10, figs. 150-152

1968—*Marinella luzononi* Pfender-Poignant, p. 271, pl. 1, fig. 4

1968—*Marinella luzononi* Pfender-Sourouille and Deloffre, p. 218-219, pl. 1, fig. 7-9

1969—*Marinella luzononi* Pfender-Poignant, p. 234
1969—

**Marinella lunesoni** Pfender-Boulangier and Poignant, p. 159

1969—

**Marinella lunesoni** Pfender-Berthou and Poignant, p. 2544

1971—

**Marinella lunesoni** Pfender-Masse and Poignant, p. 259.

Description:

Irregular, more or less rounded, cauliflower-like lobate and also digitate masses consisting of closely packed, occasionally slightly sinuous, tubular filaments with both local constrictions and cross partitions. In longitudinal sections, the filaments show a divergent fan-like arrangement. Growth zones very distinct in many cases. Basal part of the filaments suggests in some well preserved specimens an incipient hypothallus of oblique cells which turn up and merge with the main perithallial structure. Fragments of thallus up to 3.75 mm long and up to 5.00 mm wide. Individual filaments very fine, circular or very bluntly polygonal in cross sections, with diameters ranging from 0.0063 to 0.0132 mm (0.0066-0.0099 mm common).

Remarks:

A distinctive deep brown tint is characteristically present in the fossil fragments. The size values of the present specimens are similar to those given for *M. lunesoni* by different authors from time to time, and the cellular diameters closely agree with Pfender's original values.
(0.006-0.010 mm) for the filaments of this widely distributed species. The discovery of incipient basal hypothallus and horizontal partitions in the filaments of the present specimens of the species has been taken indicate its place in the family Solenoporaceae.

Associations and Microfacies:

Bionomicites and biomicrosparites, sometimes rich in intracrysts and pellets, with some Ovulites, rare Furcocoralla diplonera, frequent Teromolla sp. Foraminifers such as frequent rotalids, miliolids and small Operculina along with occasional echinoid spines are also present.

Horizon and Locality:

Zone III, Lakadong Limestone Member, Upper Paleocene, Sections B, C, D, E, F and G, Lunseng and vicinity.

Stratigraphic and Geographic Distribution:

Lower Jurassic of Yugoslavia, Syria, Japan (Pflender, 1939)
Upper Jurassic of Gulf Coast, Texas (Johnson, 1961b)
Lower Cretaceous of Guatemala, Cuba, France, Hungary, Bulgaria (Johnson and Paska, 1965; Beckmann and Beckmann, 1966; Bourouiller and Deloffre, 1968; Poignant, 1966)
Upper Cretaceous of France, Portugal (Poignant, 1969; Berthou and Poignant, 1969)
Palaocene-Middle Eocene of Cuba (Beckmann and Beckmann, 1966)

Middle Eocene (Lutetian) of France (Boulanger and Poignant, 1969).

Figured Specimens:

Slides CASMF 1868,1974.

Family SQUAMARIACEAE Zenardini, 1941

These algae occur as simple flattened crusts or as complex, undulating foliace forms with a variable internal structure. The external cells are smaller than the internal cells; cells oval, also rectangular. Reproductive organs are not known, probably external, uncalcified and hence not preserved. The altered aragonite mineralogy gives a distinctive glassy yellow-brown tint to the fossils. This is an extinct family whose fossil representatives are particularly known in the Lower Cenozoic reefoid limestones.

Genus PSEUDOLITHOTHAMNION Pflender, 1936

Type species PSEUDOLITHOTHAMNION ALBUM Pflender, 1936

Diagnosis:

Thallus encrusting, with a median hypothallus (mesothallus) constituted of files of cells which ramify towards the upper and lower parts, and with an upper and a lower perithallus. Organs of reproduction not seen,
probably external, uncalcified and not preserved.

Remarks:

A pale yellow-brown tint with a somewhat glassy lustre is distinctive for the Squamariaceae including *Pseudolithothamnium* (cf. Gray et al., 1973; Ginsberg and James, 1976; Gray, 1977).

Massieux and Denizot (1962, 1964) compared *Pseudolithothamnium* with the recent genus *Rhalius Weber van Bosse, 1913* and concluded that the former is a junior synonym of the latter. This view was accepted by Elliott (1965), Johnson and Kasha (1965) and Pretorius (1966), but not by Segonzac (1963) and Beckmann and Beckmann (1966).

In 1965, Denizot introduced further modifications by rejecting the family name Squamariaceae and replacing it by Peyssoconeliaceae, under which *Pseudolithothamnium album* became now *Polystrata alba*.

However, the question of the validity of one name or the other is still under dispute and for the present the author follows Poignant (1974, 1978 in Deloffre and Poignant, 1978) and retains *Pseudolithothamnium* as a valid genus on the ground that the fossil genus *Pseudolithothamnium* has not been found above Miocene and its unknown reproductive organs may be different from those of the comparable living genera.
Known range of the genus *Pseudolithothamnium* is from the Lower Cretaceous to the Miocene. The genus is being reported from India for the first time.

*Pseudolithothamnium album* Pfender, 1936

(Pl. 22, fig. 5-6)

1916—*Lithothamnium torulsum* Cambel-Trauth (pars), p. 213, pl. 1, figs 7-10

1936—*Pseudolithothamnium album* Pfender, p. 303, pl. 19, fig. 1-5

1938—*Pseudolithothamnium album* Pfender-Andrusov, p. 20, pl. 5, fig. 3

1956—*Parachetetes kehotii* Haslov?—Haslov, p. 112, text-fig. 41

1961—*Pseudolithothamnium album* Pfender-Sagonzar, p. 445, text—pl. fig. 15, pl.13a, fig. 1-2

1962—*Pseudolithothamnium kehotii* (Haslov) comb. nov?—Haslov, p. 68-69, text—fig. 4, pl. 7, fig. 1-2

1962—*Ethelia alba* (Pfender) Massieux and Denizot comb. nov—Massieux and Denizot, p. 262-26, fig. 1-2

1963—*Ethelia alba* (Pfender) Elliott, p. 293, pl. 47, fig. 1-3

1963—*Pseudolithothamnium album* Pfender-Sagonzar, p. 233, text—fig. 1-9

1964—*Ethelia alba* (Pfender, 1936) Massieux and Denizot, p. 31-42, pl. 1, fig. 1-10, pl. 2, fig. 1-9

1965—*Ethelia alba* (Pfender) Massieux and Denizot-Johnson and Fasska, p. 69-70, pl. 15, fig. 1-2

1966—*Pseudolithothamnium album* Pfender—Beckmann and Beckmann, p. 30-31, pl. 3, fig. 113-117

1966—*Ethelia alba* (Pfender)—Presutlron, p. 185, 186, fig. 13-14
1969—*Phelia alba* (Pfender) Massieux and Peninot-Poignant, p. 234

1969—*Pseudolithothamnium album* Pfender-Boulanger and Poignant, p. 199

1970—*Pseudolithothamnium album* Pfender-Poignant and Chaffaut, p. 206

1977—*Pseudolithothamnium album* Pfender-Poignant, p. 55, 59, pl. 2, fig. 6.

Description:

Crusts ribbon-like, simple (0.3–0.7 mm thick) or superposed (up to 5 mm thick), with a pale, glassy yellow-brown tint. Good specimens in the present collections are transversal sections cut parallel to the elongation of the mesothallial cells, showing the typical plumose structure described by Pfender (1936). In sections, this structure appears either symmetric or asymmetric. The large, closely packed, rounded-elongate, axial cells are arranged in arcuate files in opposing layers on either side of the median axis. Towards the outer margin the cells become gradually smaller. The overall range of cell size varies from 0.012 to 0.040 mm in length and from 0.008 to 0.020 mm in width in the more distinct parts of the thalli.

Remarks:

This is a very easily recognizable species. Depending upon the angle of cut the internal structure appears to vary
considerably. The growth habit, appearance and size values given above are similar to those described by other workers. The species is found mostly associated with reef-like environments of the Paleocene-Eocene (cf. Praturlon, 1966).

Associations and Microfacies:

Predominantly biolithites with interstratified crusts of Solenomorpha o'connori, Archasolithamnion luceoni, Lithocorallia selachica, Lithothamnion cf. L. balfilli and fragments of Distichopora biserialis. Important associated Foraminifera are Ranikothalia, Miscellanea miscella, Discoraphis (abundant). Also noticed in this microfacies are abundant corals and some fragments of bryozoa.

Horizon and Locality:

Abundant in Subzone IIIb, Lakadong Limestone Member, Upper Paleocene, Section G, Lunshnong vicinity.

Stratigraphic and Geographic Distribution:

Ranging from Upper Barremian-Lower Aptian to Burdigalian, it is widely distributed in Central and Southern Europe, Mediterranean basin, Middle East, Madagascar, Cuba and Guatemala (vide Massieux and Penizot, 1964; Praturlon, 1966; Beckmann and Beckmann, 1966).

Figured Specimen 1

Slide CASEMF 1907.

Family CORALLINACEAE Harvey, 1853

This is one of the largest and most important families of red algae comprising strongly calcified genera and species whose thalli may be crustose or articulated. The cellular tissue is more often differentiated into hypothallus and perithallus and is constituted of longitudinal files or transversal rows of quadrate to rectangular cells usually less than 0.050 mm in size. Reproductive organs are preserved within the tissue. The family is easily fossilisable because of the strong calcification of its members. This extant family originated in the Carboniferous and virtually exploded in the Lower Cretaceous. About forty genera are known from the fossil record.

The classification of the fossil corallines in the present collection has been based on the classical palaeontological works of Lemoine (1911, 1917), Conti (1950) and Johnson (1961) which take into account only the anatomical structures and characters of reproductive organs.
Subfamily MELOBESIOIDEAE Mason, 1951
(The Crustose Corallines)

The Melobesioidae form simple or ramified crusts and
nODULES of varying forms and sizes. Their cellular tissue
is differentiated into a hypothallus and a perithallus.
Basal hypothallus of encrusting specimens may be single-or
multi-layered. Perithallus develops upon the basal hypothallus
of crusts and around the medullary hypothallus of the branched
forms. Reproductive organs are buried within the tissue.
Plate 12 illustrates the characteristic internal structures
of some crustose coralline genera. Out of about twenty
living genera about ten are known also from the fossil record.
Some extinct genera are also known. The more common Genomic
genera may be distinguished with the help of the following
key (after Johnson, 1961a; 1961c; Adey, 1970; Adey and
Macintyre, 1973; Poignant, in Pelofre and Poignant, 1978,
and others).

Key 1:

1. Sporangia isolated
   - Sporangia isolated
   - Sporangia in conceptacles

2. Thallus pluristratified; basal hypothallus
   non-coaxial with cells in multiple files;
   perithallus and medullary hypothallus in
   multiple rows
   - Archaeolithothamnion

3. Conceptacles single-pored
   - Conceptacles single-pored
   - Conceptacles multi-pored

4

7
4. -Thallus monostromatic; or locally pluristematomotic and tissue badly differentiated
   ... ... 5
   -Thallus pluristematomotic, tissue clearly differentiated ... ... 6

5. -Hypothallus with cells vertically or obliquely elongated; perithallus absent; thalli loosely and capriciously superposed ... •Lithophyllum

   -Hypothallus with cells obliquely elongated; perithallus reduced to a single or several layers of cells in regular horizontal rows; cells nearly equidimensional ... •Permetolithon

6. -Hypothallus commonly coaxial; perithallus in rows; tissue homogeneous ... •Lithophyllum

7. -Thallus monostromatic; or partly pluristematomotic with tissue badly differentiated; hypothallus a single layer of square or horizontally elongated rectangular cells; perithallus, if present, reduced to a few layers of small cells; thallus not stratified ... •Moselasia

   -Thallus pluristematomotic ... ... 8

8. -Hypothallus coaxial; perithallus of cells in rows; strong growth zones ... •Mesophyllum

   -Hypothallus non-coaxial, with cells in multiple files; perithallus of cells in multiple files; often monostated ... •Lithothamnium
Genus - *Archeolithothamnium* Rothpletz, 1891

Type Species - *Archeolithothamnium canumunicum* Rothpletz, 1891

Diagnosis:

Crustose or branching plants, up to several centimetres across, sometimes free; basal hypothallus multilayered, with cells in files that start parallel to the substrate and then gradually curve upward into the perithallus; perithallus and medullary hypothallus of branches compact, with regular rows of cells; sporangia characteristic- cally occur in loose sori.

Remarks:

While the reproductive bodies are usually distinctive for this genus, the tissue of *Archeolithothamnium* may strongly resemble that of *Lithothamnium*. In many cases the infertile crusts of the two genera can not be distinguished from each other. Also, as Johnson (1963) points out, the infertile fragments of the branches of *Archeolithothamnium* and *Lithothamnium* may not be easily distinguishable sometimes, when coaxial medullary tissue is present in both. And again, the cystocarpic conceptacles in the former have single apical pores like the sporangial conceptacles in the latter.

The extensive review of this genus by Johnson (1963) with a list of fossil species has been of immense help in the
present study.

Ranging from the Late Jurassic to the Recent, the
genus reached the zenith of its development during the
Late Cretaceous and Pliocene.

**Archaeolithothamnium tovarii**
*(Pl. 14, figs.3-5; pl. 24, fig. 1-4)*

**Derivation of Name :**

In honour of Prof. B.S. Tovari, Department of
Geology, Panjab University, Chandigarh.

**Description :**

Crusts, 0.038 to 1.125 mm thick, with numerous
knobby lobes upto 3.375 mm across. Crusts often superposed.
Basal hypothallus 0.050 to 0.125 mm thick and made up of
loosely packed rectangular cells arranged in horizontal
to up-curved files, transverse partitions discontinuous;
cells measure 0.009-0.025 mm x 0.009-0.013 mm. Recurrent
hypothallus frequent. Perithallus is a regular, compact
lattice of very small rectangular to quadrate cells;
horizontal walls of cells thicker and more continuous than
the vertical walls, giving better defined horizontal rows.
Cells measure 0.006-0.022 mm x 0.006-0.013 mm. Isolated sporangial sori seen only in one knobby portion of the thallus are ovoid to rectangular-ovoid, rather loosely arranged in successive concentric rows. They are 0.050-0.088 mm x 0.038-0.050 mm in size. Also present are numerous conical flask- or gram- shaped sexual conceptacles with long necks and large apical pores. Such conceptacles measure 0.100-0.325 mm x 0.150-0.375 mm with necks up to 0.100 mm x 0.063 mm in size.

Remarks:

The most distinctive characters of the present form are the very compact, regular and finely textured tissue of the perithallus and the abundance of the sexual conceptacles. In the absence of the sporangial sori it would have been difficult to distinguish the tissue from that of some Lithothamnium. The combination of characters shown by the present specimens does not fit any previously described species known to the author. A. fomenti Johnson, 1964, described originally from the Rocane of Ishigaki has longer average hypothallial and perithallial cells.

Associations and Microfacies:

Bioolithites with crusts of Lithothamnium cf. L. bofilli, Lithoporella melobesicida and Distichopsis.
biseriata and some *Pseudolithothamnium album*. Foraminifera such as *Muscoclypea, Miscallance,* and *Panikothalia* have been recognized.

**Type Level:**

Subzone IIb, Lakedong Limestone Member, Upper Paleocene.

**Type Locality:**

Section C, Lumshnong vicinity, Jaintia Hills, Meghalaya.

**Figured Specimens:**

*Holotype, Slide CASCNF 1875*
*Paratypes 1, 2, Slide CASCNF 1875.*

*Archeoolithothamnium perplexum* Johnson, 1964

*(Pl. 24, fig. 5-6)*

1964a-*Archeoolithothamnium perplexum* Johnson, p.209, pl. 2, figs 2,3,7

**Description:**

Vertical section through a thick warty protuberance. Hypothallus not seen; parithallic tissue composed of arched layers of cells; horizontal partitions of cells thicker,
more conspicuous, and form continuous lines; vertical partitions between cells thinner, straight, but not distinctly continuous. An apparent alternation of cell rows of darker and lighter colours suggests an alternation of long and short cells. Sporangia elongated-elliptical to ovoid and spherico-ovoid, arranged in gently arched rows and in groups of 3 to 15. The cells are 0.013–0.025 mm x 0.006–0.012 mm in size and the sporangia 0.035–0.056 mm x 0.050–0.081 mm.

Remarks:

The growth form, appearance and size values are nearly identical with those of *Archeolithothamnium* described originally from the Palaeocene of Northern Iraq by Johnson (1964a).

Associations and Microfacies:

Bioclastosparites with *Archeolithothamnium lunae*, undetermined *Lithothamnium*, articulated coralline (*Jania*?), *Pseudolithothamnium album*, *Distiocladus biserialis*, and rare *Coralites* and *Halimeda* fragments. Associated faunas are abundant Foraminifera such as *Opuculina* including *Q. cf. Q. canalifera*, rotalids and miliolids, and rare *Discocyclina*. 
Horizon and Locality:

Subzone IIb, Lakadong Limestone Member, Upper Paleocene, Section G, Luschnong vicinity.

Stratigraphic and Geographic Distribution:

Paleocene of Northern Iraq (Johnson, 1964a).

Figured Specimen:

Slide CAGMV 1888.

Archaeolithothamniun aschersoni (Schwager, 1863) (Pl. 15, figs. 1-2; Pl. 25, figs. 1-2)

1863—Lithothamnum aschersoni Schwager, p. 147, pl. 29, fig. 25
1868—Archaeolithothamniun aschersoni Schwager—Poselie, p. 4
1961—Archaeolithothamniun aschersoni (Schwager)—Segonzac, p. 437
1964a—Archaeolithothamniun aschersoni (Schwager)—Johnson, p. 200, pl. 1, fig. 3
1966—Archaeolithothamniun aschersoni (Schwager)—Johnson, p. 251, pl. 1, fig. 3-4
1966—Archaeolithothamniun aschersoni (Schwager)—Segonzac, p. 431, pl. 1, fig. 1.

Description:

Thallus encrusting with small assimilated protuberances. Fragments of crust 1.062-1.937 mm x 0.750-0.813 mm in size and
protuberances 1.120 x 0.93 mm in size are known. Tissue may or may not show hypothallus; hypothallus, when present, up to 0.006 mm thick. Perithallus, by contrast, is more prominently developed; transversal partitions well developed, thicker, widely undulating in crusts; vertical partitions thinner but distinct. Hypothallic cells squarish to rectangular, arranged irregularly or in upcurved rows; both longitudinal and transverse walls are of similar thickness; cells measure 0.013-0.039 mm x 0.008-0.017 mm. Perithallic cells mostly squarish, also rectangular, 0.009-0.012 (0.023) mm x 0.006 (0.007)-0.013 mm in size.

Sexual conceptacles only are seen; they are long conical with single large apical pore. They measure 0.113-0.163 mm x 0.080-0.075 mm with necks up to 0.099 mm in height and 0.025-0.050 mm in diameter.

Remarks:

In the absence of the usual isolated sporangial sori, the character of the basal hypothallus has made possible the assignment of the present specimen to *Archeolithothamniun* (cf. Johnson, 1963). Within this genus the tissue characters and dimensional values fit best those given by various authors for *A. archersonii*. The conceptacular measurements given by Segonzac (1966) for some specimens of this species are
0.135-0.192-0.200 mm x 0.068-0.090 mm with a neck measuring
0.060-0.125mm x 0.022-0.030 mm. The minor discrepancies
between Segonzac’s and the present values are not believed
to be of taxonomic significance.

Associations and Microfacies:

Bicentrosparites with other badly preserved crustose
corallines, including Lithophyllum minus, and Qoylita.
Associated Foraminifera include common miliolids, Alvania,
Helapultites and Discorviina.

Horizon and Locality:

Zone IV, Unistichi Limestone Member, Lower Eocene,
Sections A, C, Lumshong vicinity.

Stratigraphic and Geographic Distribution:

Post-Montian (?) of Morocco (Pfender, 1936)
Paleocene of Iraq (Elliott, 1956)
Paleocene of Iraq (Johnson, 1964a)
Paleocene and Lower Eocene of Guatemala
(Johnson and Raska, 1965)
Paleocene of Borneo (Johnson, 1966)
Paleocene of France (Poignant and Chaffaut, 1970)
Thetian of Pyrenees (Segonzac, 1961)
Lower Eocene of Libya (Schwager, 1983).
Figured Specimens:

Slides CASGIF 1884, 1896.

Archaeolithothamnium cf. A. noncostainensis Rao, 1943

(Pl. 25, fig. 6)

cf. 1943- Archaeolithothamnium noncostainensis Rao, p. 270-271
   pl. 1, figs. 1, 2, text-fig. 2

cf. 1970- Archaeolithothamnium noncostainensis Rao-Poignant and
         Chaffaut, p. 209.

Description:

A single worn fragmental specimen shows only the
perithallic tissue consisting of compact regularly arranged,
arched cell rows. Cells squarish to rectangular, small,
0.008-0.012 mm x 0.008-0.011 mm. Sporangia absent, small,
in well defined parallel rows, separated by about 9 to 12
rows of perithallic cells. They measure 0.030 mm x 0.025-
0.037 mm.

Remarks:

The general aspect of the crust and the small size
of the sporangia are similar to those of A. noncostainensis.
However, the cells in the available fragment of tissue being
more quadrate than rectangular and smaller than those of
Rao's original specimens the comparison is inconclusive.
Association and Microfacies:

Biosparites teeming with fragments of Opylitia including O. morganite, O. morleti and O. elongata. Associated algae are rare O. asillocapsa, infrequent Halimeda praemoinia and Sarcotella oconoci. Common Alveolina, miliolids and rare rotulids constitute the foraminiferal association.

Horizon and Locality:

Zone IV, Maletshoh Limestone Member, Lower Eocene, Section A, Lushnong vicinity.

Stratigraphic and Geographic Distribution:

-Lower Eocene? (probably Palaeocene) of Meghalaya (Nao, 1943)
Palaeocene of France (Poignant and Chaffaut, 1970)

Figured Specimen:

Slide CASCHF 1881.

Archaeolithothamnium conspuracens n. sp.

(Pl. 14, figs. 1-2; Pl. 25, figs. 3-5)

Derivation of Name:

Characteristic conical shape of the sporangia seen in this form.
Description:

Fragments of simple crusts, 0.500 mm - 1.063 mm in thickness. Bnal hypothallus thin, up to 0.063 mm across, made up of irregularly and loosely arranged cells about 0.013 mm in average diameter. A lenticular area of secondary hypothallus indistinctly observed. Perithallus is a lattice-work of squarish to rectangular cells with both vertical and horizontal partitions continuous and equally strong, but horizontal partitions show wide undulation. Cells measure (0.006)0.009-0.018 (0.023) mm x (0.006)0.009-0.013 (0.016) mm in size. Sporangia closely packed in small lenticular areas only slightly separated from each other. In each cluster there are 4 to 7 sporangia, varying in shape from thin elongated or irregularly elliptical and tapering to short conical and pointed types. Sporangial dimensions are 0.063-0.094 mm x 0.020-0.050 mm.

Remarks:

The present form has no resemblance with any of the previously described species of Archaeolithothamnium from the Tylhet Limestone Formation. A. lugosii Pfenner, 1926 and A. socchiile Lemoine, 1939 have comparable growth form, cellular and sporangial dimensions but not the sporangial characters of the present specimens. A. lugosii Segonsar, 1966
has sporangia pointed towards the base as in the present case, but it is characterized otherwise by numerous irregularities in the perithallus and shows a cellular disorder in spite of the continuity of the longitudinal partitions.

Associations and Microfacies:

Biomicrite with abundant Gyrolites, particularly G. moreleti and with Halimeda fragments, Lithothamnium(?), Lithophyllum minus and Corallina(?). Foraminifers present in association include Discocyclina, Hapalolites, rotalids, miliolids, textularids and Avesolina.

Type Level:

Zone IV, Błatodoh Limestone Member, Lower Eocene.

Type Locality:

Section D, Luschnong, Jointia Hills, Meghalaya.

Figured Specimens:

Holotype, Slide CASOMP 1071
Paratype, Slide CASOMP 1071.
Archeolithothamnium luceoni Pfender, 1926

(Pl. 26, fig. 1-3)

1926 - *Archeolithothamnium luceoni* Pfender, p. 324, pl. 9, 13
1936 - *Archeolithothamnium luceoni* Pfender-Sae and Pia, p. 35, pl. 4
1939 - *Archeolithothamnium luceoni* Pfender-Lewine, p. 52-53
1961 - *Archeolithothamnium luceoni* Pfender-Seegers, p. 437-439
1962 - *Archeolithothamnium luceoni* Pfender-Maelov, p. 48, pl. 13, fig. 3; Text-fig. 23
1966 - *Archeolithothamnium luceoni* Pfender-Johnson, p. 263, pl. 1, fig. 2
1966 - *Archeolithothamnium luceoni* Pfender-Seegers, p. 408-409, pl. 1, fig. 6.

Description:

Thalli consist of numerous crusts averaging 0.300 mm in thickness, frequently superposed; protuberances up to 3.1 mm long and up to 2.4 mm in diameter are also seen. Basal hypothallus poorly to well developed, 0.025 to 0.250 mm thick; cells in rather loosely arranged upcurved files, with irregularly placed transverse walls; they measure 0.012-0.031 mm x 0.007-0.019 mm. Recurrent hypothallus seen in many specimens. Perithallic cells rectangular to quadrate arranged in fairly regular to very regular horizontal rows and vertical files and measure 0.007-0.026 mm x 0.008-0.017 mm. Sporangia ovoid to nearly subspherical, closely
packed in long regular rows; in most cases they measure
0.051–0.080 (0.100) mm x 0.032–0.054 mm.

Remarks:

The above form seems to dominate the
Archaeolithothamnium population in the present collection
of samples. The form while going close to A. johnsoni
Mastrorilli, 1959 described from the Paleocene-Eocene of
West Indies, Spain and Italy in growth form and Sporangial
dimensions, very well fits A. lugens in all respects.

Associations and Microfacies:

Mostly in the biolithites but also in other
biomicrites and biomicrasterites with mainly crustose
coralines such as Archaeolithothamnium corniculum, un-
determined Archaeolithothamnium, Lithothamnium simplex,
Lithothamnium cf. L. bofilli, undetermined Lithothamnium,
Lithocodium melovesicoides, Distichocora bissariae,
Pseudolithothamnium album and minute fragments of rare
ovulites and Halimeda and Foraminifera including encrusting
forms.

Horizon and Locality:

Subzone IIIb, Lakadong Limestone Member, Upper
Paleocene, Section G, Zone IV, Unialgal Limestone Member,
Lower Eocene, Sections D, G, Zone V, Prang Limestone Member,
Middle to Upper Eocene, Section I.

Stratigraphic and Geographic Distribution:

Maastrichtian of Cuba (Deeley and Deeley, 1966)
Ranian of South India (Keo & Pia, 1936)
Thanetian of Pyrenees (Segonzac, 1961)
Palaeocene of Borneo (Johnson, 1966)
Palaeocene of Ukraine (Maslov, 1962)
Palaeocene of Czechoslovakia (Schalekova, 1963)
Palaeocene of Iraq (Elliott, 1956)
Eocene of France (Segonzac, 1966)
Ypresian of Algeria (Masieux, 1961)
Eocene of Trinidad, Sarawak (Johnson, 1955, 1962)
Lutetian of Italy (Mastrorilli, 1936)
Middle Eocene of Algeria (Pfender, 1926a; Lemoine, 1927, 1939)
Upper Eocene of Peru (Johnson and Tafur, 1952)
Oligocene of Spain (Miranda, 1935)
Lower Miocene of Saipan (Johnson, 1957a).

Figured Specimens:

Slides CASOMP 1889, 1916.
Archaeolithothamnium guptai n. sp.
(C1. 26, fig. 4-5 )

Derivation of Name:

In honour of Prof. V.J. Gupta, Department of Geology, Panjab University, Chandigarh.

Description:

Vertical sections of fragmental crusts up to 0.438 mm thick and longitudinal sections of protuberance, 3.1 mm long and 2.37 mm across observed in the collection. Basal hypothallus, 0.063 to 0.075 (0.088) mm in thickness, is made up of long and short rectangular cells arranged in loose files mostly parallel to the substrate; upper files very gradually curve upwards and ultimately almost perpendicularly merge into the vertical perithallial files; cross partitions of the cells are irregular and poorly defined; cells measure (0.019) 0.025-0.038 (0.046) mm x 0.009-0.013 (0.019) mm. Perithallial tissue consists of regular areolate and undulating cell rows; an alternation of thick and thin rows are seen in parts of the tissue; cells rectangular, 0.006-0.031 (0.038) mm x 0.006-0.013 mm in size; their heights may vary even in the same row. Sporangia grow together in rows, mostly 4 to 7 sori in a group; successive sporangial rows are separated by 7 to 10 cellular rows. They are elongated elliptical to
ovoid, and 0.050–0.080 (0.100) mm x 0.025–0.050 mm in size.

Remarks:

Amongst the previously described species, A. *johnsoni* Mastrorilli, 1959 has smaller ranges of cell dimensions than the present form and *A. lucasoni* Pfender does not show characters of hypothalial and perithallial tissue as described above. *A. aff. provincialis* Pfender described and illustrated by Pia (in Rao and Pia, 1936) from the Taranian of South India comes very close to present specimens in growth habit and aspects of the perithallial tissue and sporangia. However, in Pia’s specimens hypothallus was unknown and the perithallus showed more distinct alternation in the heights of cell rows.

Associations and Microfacies:

Biolithites with abundant crustose corallines like *Lithothamnium paraleuca*, *Lithocorella minus*, *L. melobesicola* and some *Corallina* sp. Associated microfauna are abundant *Terebratulina*, *Himantella* and encrusting Foraminifera.

Type Level:

Upper part of Zone V, Prang Limestone Member, Upper Eocene.
Type Locality:

Section 2, Lunshnoor vicinity, Jaintia Hills, Meghalaya.

Figured Specimen:

Holotype, Slide CASQMF 1995

Genus—Lithothamnium Phillippi, 1837
Type species—Lithothamnium gamulosum Phillippi, 1837

Diagnosis:

Crustose and branching plants, sometimes free; hypothallus parallel to the substrate, multilayered, but non-coaxial, cells in files; perithallus thick, with cells in files, often sunken; conceptacles multipored.

Remarks:

Lithothamnium has been used as an 'umbrella' terminology for informal designations of many kinds of crustose corallines, as Newell (1956), Johnson (1961), Adie and MacIntyre (1973) and Gray (1977) amongst others will bear out. According to Adie and McKibbin (1970) and Adie and MacIntyre (1973), the existence of typical cover cells characterize living Lithothamnium specimens. However, in the fossil
materials this feature is usually not observable. The classical works of Lemoine (1911, 1917), Conti (1950) and Johnson (1961) provide the basis for the generic discrimination of fossil corallines taking into account only the structure of the thallus and characteristics of the asexual conceptacles. Johnson (1962) has reviewed the fossil species of Lithothamnium. The genus ranges from the Upper Jurassic or Lower Cretaceous to the Recent.

*Lithothamnium* cf. *L. kofillii* Lemoine, 1929
(pl. 27, fig. 6-7)

*cf. 1929*-Lithothamnium kofillii* Lemoine, p.96-97, figs. 5-6

*cf. 1939*-Lithothamnium kofillii* Lemoine-Lemoine, p.70-71, pl. 1, figs. 1,7

*cf. 1965*-Lithothamnium kofillii* Lemoine-Johnson, p.807, pl. 97, fig. 5

Description:

Thin crusts, 0.088 to 1.562 mm in thickness, developing branches up to 3.800 mm in height and 2.789 mm in diameter. Texture of both crusts and branches shows faint growth zones. Basal hypothallus thin, 0.050-0.075 mm across with cells in files showing uncurved to plumose arrangements; cells measure 0.013-0.024 (0.045?) mm x 0.007-0.009 mm.

Medullary and perithallic tissue of regular compact rows of
small, squarish to subquadrature cells. Medullary cells measure 0.006-0.013 mm x 0.006-0.010 mm and perithallic cells measure 0.004-0.009 mm x 0.004-0.006 mm. Conceptacles numerous, elongated-oval, arranged in parallel rectilinear rows in the crust, and in parallel arched rows in the branch. Traces of ovoid to rectangular-ovoid sporangia can be seen in some of the conceptacles which are otherwise filled with cellular tissue. Conceptacles measure (0.125)0.166-0.250 (0.475) mm x (0.075)0.080-0.090 (0.125) mm in size, and the sporangia about 0.052 mm x 0.032 mm.

Remarks:

The present form is comparable to L. bopilli Lemoine described from the Eocene of Spain and Algeria and from the Middle Eocene of Greece. However, the perithallic cells and the conceptacles in the present case are somewhat smaller. L. aff. bopilli (?) Lemoine described by Rao (1943) from the limestones of Cherrapunji area does not compare with the present form either in growth habit or in dimensional data. Pal and Dutta's (1979) illustrated specimens of L. aff. bopilli Lemoine from the Prang Limestone Member of Jaintia Hills do not show the fountain like files in the hypothallus or the hemispherical conceptacles described by them, but show only squarish perithallic cells.
Associations and Microfacies:

Biolithites with *Archaeolithothamnion tawari* n. sp. and the flora and fauna listed with this species.

Horizon and Locality:

Subzone IIb, Lakadong Limestone Member, Upper Palaeocene, section G, Lushnong vicinity.

Figured specimen:

SLIDE CASGMP 1875.

*Lithothamnium marianae* Johnson, 1957

(Pl. 27, fig. 3-4)

1957a - *Lithothamnium marianae* Johnson, p. 226, pl. 41, fig. 1-3

1978 - *Lithothamnium marianae* Johnson-Ishijima, p. 172, pl. 24, fig. 1

Description:

An oblique longitudinal section through a marginally worn branch and part of the basal hypothallus. Branch 2.743mm x 1.688 mm in size with strong lens shaped growth zones; each zone about 0.055 to 0.150 mm thick at the middle. Basal hypothallus 0.050-0.075 mm thick, well developed; cells rectangular and arranged in files gently curving up and down,
and measure 0.008-0.016 mm x 0.006-0.009 mm. Medullary hypothallus of rectangular cells arranged in longitudinal files; horizontal partitions slightly stepped; the regular cells measure 0.018-0.026 mm x 0.006-0.015 mm and the intercalary cells 0.007-0.009 mm x 0.007-0.009 mm. Perithallus thin, made of more regular rows; cells mostly squarish, 0.007-0.016 mm x 0.006-0.008 mm in size. Conceptacles not seen.

Remarks:

The specimen strongly resembles _G. marisnae_ Johnson, although in the latter the hypothallic cells are taller and slightly wider.

Associations and Microfacies:

Bioticites with _Distichosolen biserialis_, _Archeolithothamnites tavarii_, n. sp., _Amphiroa_ sp., _Metacnicolithon_ (? _mochalenensis_, n. sp. and abundant Foraminifera including _Tubulites_, and corals.

Horizon and Locality:

Subzone IIb, Lakadong Limestone Member, Upper Palaeocene, Section G, Lammnong vicinity.

Figured Specimen:

_Slide CASOMF 1906._
Lithothamnium cf. L. moreti Lemoine, 1927
(Pl. 27, fig. 5)

cf. 1927-Lithothamnium moreti Lemoine, p. 547, fig. 2-3

cf. 1939-Lithothamnium moreti Lemoine-Lemoine, p. 71, 73

cf. 1965-Lithothamnium moreti Lemoine-Johnson, p. 907-908

cf. 1966-Lithothamnium moreti Lemoine-Regensber, p. 412-413, pl. 1, fig. 3

Description:

Funiculated crust, 1.188 mm x 0.875 mm in section; hypothallus not seen; perithallus compact, tissue not disposed in regular rows; zonation suggested by alternate dark and light coloured bands; cells in more distinct areas squarish in vertical sections, irregular in oblique sections and rounded to polygonal in transversal sections; vertical partitions more distinct and continuous than the horizontal partitions. Cells measure 0.006-0.009mm x 0.006-0.009mm. Conceptacles crowded together, somewhat irregularly disposed, and measure 0.125-0.188mm x 0.075-0.088mm; orifices not seen.

Remarks:

The growth form, internal structure and also the perithallic cell dimensions are similar to those of L. moreti Lemoine. However, the hypothallus is not known.
and the conceptacular size ranges are incompletely known.

**Associations and Microfacies**

Bomicrites with fragments of undetermined
Lithothamnium, Nummulites and other undetermined Foraminifera.

**Horizon and Locality**

Zone V, Prang Limestone Member, Middle to Upper
Eocene, Section I, Lamshong vicinity.

**Figured Specimen**

Slide CASCHF 1093.

*Lithothamnium minee* Lemoine, 1939

(Pl. 20, fig. 1)

1939-*Lithothamnium minee* Lemoine, p. 69, text-fig. 29

1949-*Lithothamnium minee* Lemoine-Johnson and Ferris,
  p. 194, pl. 37, fig. 3

1979-*Lithothamnium minee* Lemoine-Ishijima,
  p. 172-173, pl. 26, fig. 1

**Description**

Thin superposed crusts, up to 0.375 mm thick, with
mamillary protuberances 0.638 mm across, and a very finely
cellular tissue; hypothallus missing or with indistinct and
poorly defined cells 0.009-0.016mm x 0.004-0.006(0.009)mm in size. Perithallus unusually irregular, cell rows obscurely defined; cells very small, subquadrate, 0.004-0.007(0.009)mm x 0.003-0.004(0.007)mm in size.

A conceptacle seen measures 0.135 mm x 0.067 mm.

Remarks:

The specimens closely fit the description of L. minae Lemoine by other workers.

Associations and Microfacies:

Biolithites with Lithoporella melobesioides, undetermined Archaeolithothamnium and thoroughly fragmented and altered larger Foraminifera.

Horizon and Locality:

Zone V, Frang Limestone Member, Middle to Upper Eocene, Section I, Lunshnong vicinity.

Stratigraphic and Geographic Distribution:

Ypresian-Lutetian of France (Segonzac, 1966, 1974)
Eocene of Malaysia (Ishijima, 1978)
Middle Eocene and Oligocene of Algeria (Lemoine, 1939)
Miocene of Dutch East Indies (Johnson, and Peris, 1949)
Figured Specimen

Slide CASOMF 1995.

*Lithothamnium perplexum* Johnson, 1955

(Pl. 16, fig. 3; Pl. 28, fig. 5-9)

1955-*Lithothamnium perplexum* Johnson, p. 71, pl. 9, fig. 3

1966-*Lithothamnium perplexum* Johnson-Beckmann and Beckmann, p. 17, pl. 1, fig. 33-34

1967-*Lithothamnium perplexum* Johnson-Mastrovilli, p. 261, pl. 8, fig. 1

Description:

Crustose thalli eamillated to strongly branched. Crusts up to 0.938 mm in thickness, sometimes superposed; branches upto 3.7 mm in length and about 2 mm in diameter. Basal hypothallus thin, 0.063 to 0.175 mm across, composed of cells in upcurved files; cells measure (0.013) 0.018-0.027 mm x (0.006) 0.010-0.015 (0.017) mm. Recurrent hypothallus is seen in several instances with somewhat longer and narrower cells which measure 0.020-0.030 mm x 0.007-0.010 mm. Perithallus of crust and medullary tissue of the branches generally show weak but distinct, growth zones; zones more visible in the branches where each
zone is 0.100 to 0.300mm thick; zone boundaries marked by small and irregular intercalary cells. Perithallial cells in the crust measure 0.021-0.027mm x 0.008-0.021mm (big cells) and 0.012-0.018mm x 0.006-0.001mm (small cells). Medullary cells in the branches measure 0.015-0.049mm x 0.009-0.016mm (big cells) and 0.007-0.013mm x 0.006-0.012mm, 0.010mm (small cells). Perithallial cells in the branches are 0.012-0.016mm x 0.009-0.013mm in size. The vertical partitions of cells in the crusts and branches are thinner and often discontinuous or even lacking in some portions of the thallus giving the cells an wider appearance. Conceptacles measure 0.285mm x 0.100mm, 0.200mm x 0.133mm, 0.675mm x 0.125mm. One conceptacle shows multiple pores in the roof.

Remarks:

The specimens have the same internal structure as shown by the tissue of L. perplexum described from Trinidad (Johnson, 1955), and Cuba (Beckmann and Beckmann, 1966) and Italy (Mastrorilli, 1967). However, whereas the present form is strongly branched, the other previously described specimens of L. perplexum were only crusts. To the present author it seems logical to add branches to the definition of L. perplexum and to assign his specimen to it because of the strong similarity of the internal structures
of the crusts and the branches.

Associations and Microfacies:

Biomicroites with Lithothamnium diagrammaticum, L. spinosum n. sp., undetermined Lithothamnium, Lithoporella minus and L. malolescioides and Corallina sp. Associated Foraminifera include fragmented Discocyclina, Nummulites and also Callistiosira.

Horizon and Locality:

Zone V, Prang Limestone Member Middle to Upper Eocene, Section I, Lunshnong vicinity.

Stratigraphic and Geographic Distribution:

Oligocene of Italy (Mastrorilli, 1967)
Oligocene and Aquitanian (Burdigalian) of Cuba (Beckmann and Beckmann, 1966)
Aptian of Trinidad (Johnson, 1955).

Figured Specimens:


Lithothamnium lunshnongianus n. sp.

(Pl. 17, fig. 1; Pl. 20, fig. 2-4)
Derivation of Name:

Village of Lumshnong in the Jaintia Hills of Meghalaya.

Description:

Strongly branching thallus; branches generally cylindrical, mostly 1.750-1.938 mm long and 1.250 - 1.938 mm in diameter. Tissue may consist only of a medullary hypothallus or of both medullary hypothallus and marginal perithallus (0.375 - 0.625 mm thick). Both medullary hypothallus and marginal perithallus are strongly constricted. In each zone of medullary hypothallus there are 3 to 8 concentric rows of cells; and in each zone of the marginal perithallus there are 3 to 5 rows of cells. Individual rows in both medulla and the perithallus are mostly of uniform thickness. Cells in the outermost layers in a zone are markedly stunted; regular cells rectangular to quadrate, stunted cells squarish. Horizontal partitions thicker and may show zig-zagging in the medulla; vertical partitions thinner and may be discontinuous from row to row. Cellular measurements are as follows:

Medullary cells (regular): 0.019-0.038 mm x 0.009-0.025 (0.018) mm
Medullary cells (stunted): 0.006-0.009-0.019 mm x (0.006) 0.009-0.013 mm
Perithallial cells (regular): (0.013) 0.019-0.031 x 0.009-0.025 (0.018) mm
Perithallial cells (stunted): (0.006) 0.009-0.013 x 0.009-0.013 mm
Recurrent hypothallus has been seen in some specimens; they are 0.037–0.050 mm thick and show an irregular to plumose arrangements cells. Conceptacular cavities seen measure 0.412 mm x 0.163 mm, 0.188 mm x 0.063 mm, 0.413 mm x 0.150 mm.

Remarks:

This form is distinguishable from all previously described branched Lithothamnium by its growth form and the internal structure as also by its measurements. It is distinguishable from the branches of L. perplaxum Johnson as described in this thesis by its very strong poration and mostly larger regular cells.

Associations and Microfacies:

Biomicrotes with Lithothamnium perplaxum, L. spinosum, L. diagrammaticum and associated flora and fauna listed under these species.

Type Level:

Zone V, Prang Limestone Member, Middle to Upper Eocene.

Type Locality:

Section I, Tawshnong vicinity, Jaintia Hills, Meghalaya.
Figured Specimens:

Holotype, Slide CASCHF 1992
Paratype 1,2, Slide CASCHF 1992.

*Lithothamnium spinosum* n.sp.
(P1. 15, fig.3-5; Pl. 29, fig.1-2)

Derivation of Name:

Spinose character of the branches seen in this form.

Description:

Vertical section through a ramified branch; ramification tapering, sharply pointed like spines, bent at about $120^\circ$ to main branch. The main branch is 2.375 mm long and 1.875 mm in maximum diameter and the spinose ramification is 1.212 mm long and 0.699 mm in maximum diameter. Tissue consist largely of medullary hypothallus in the main branch and only of medullary hypothallus in the ramification; medullary hypothallus of branch shows thick, conspicuous, slightly undulating horizontal rows and much thinner and less conspicuous vertical files; medullary tissue of ramification, on the other hand, shows relatively more conspicuous continuous
vertical partitions giving a fountain-like aspect; horizontal walls are not obvious. Tissue shows no motonion.

Medullary cells measure $0.010-0.031$ mm x $0.009-0.013$ mm.

Marginal Perithallus of branch only about $0.100-0.313$ mm thick and consist of slightly shorter cells compared to the medullal cells measure $0.009-0.025$ mm x $0.009-0.011$ mm.

Two definite well preserved conceptacles with flat bases and arched roofs with multiple pores. They are thinner and drawn out at one end and measure $0.350$ x $0.125$ mm and $0.600$ x $0.313$ mm respectively.

Remarks:

This branched Lithothamnum is easily distinguishable from L. carapazanum as described in this thesis by the spinose ramification, characters of tissue and the shape of the conceptacles. L. fauriei Lemoine, 1927 and L. cavernosum Capeder, 1909 which are also branched forms are distinguishable by the same characters as mentioned above.

Moreover, the large sized cells in the present specimens are also distinctive. L. diagramaticum is distinguished in having 'water-jet' arrangement of medullary cells in the branches.
Associations and Microfacies:

Biomicrites with *Lithothamnium coroleum*,
*L. diagrammaticum*, other undetermined *Lithothamnium*,
*Lithoporella minus* and much altered and worn Foraminifera
including *Discocyclina* and *Hemmulites*.

**Type Level:**

Zone V, Prang Limestone Member, Middle to Upper
Eocene.

**Type Locality:**

Section I, Barshong vicinity, Jaintia Hills,
Meghalaya.

**Figured Specimen:**

Holotype, Slide CASGRS 1894.

*Lithothamnium* cf. *L. diagrammaticum* Johnson and Kaska, 1965
(Pl. 29, fig. 3)

1965- *Lithothamnium diagrammaticum* Johnson and Kaska,
pp. 34-35, pl. 34, fig. 3-4.

**Description:**

Strongly branching form, occurring as isolated
longitudinal sections; length (incompletely known) varies from 1.100 to 4.125 mm and diameter (maximum) from 0.875 to 0.877 mm. The tissue consists mostly of medullary hypothallus with long plumose or 'water-jet' arrangement of vertical filaments with better defined and continuous longitudinal partitions; horizontal partitions mostly discontinuous. Medullary cells elongated, rectangular, 0.013-0.031 (0.018)mm x 0.009-0.013mm in size. Marginal perithallus, when present, is narrow consisting of 7-10 rows irregularly varying in thickness; but in most cases a marginal perithallus cannot either be distinguished from the medullary hypothallus or is absent; perithallie cells measure 0.013-0.031 (0.018)mm x 0.009-0.013mm. Two irregular shaped cavities seen in one specimen could be conceptacles; they measure 0.100 mm x 0.0250 mm and 0.063 mm x 0.075 mm respectively.

Remarks:

Lithothamnium malthi, a branched form described and illustrated by Rao (1943) from the limestones of Cherrapunji area has much smaller and slenderer branches and cells; its perithallus, when present, is relatively thicker compared to its medullary hypothallus. The present form most closely resembles the description and
Illustration of *L. diagrammaticum* Johnson and Kaska known from the ?Palaeocene-Lower Eocene of Guatemala. However, branches in the present case are stouter, and sometimes terminally widened as against tapering in the Guatemalan specimens. Also, the perithalic cells are longer and wider in the present specimens.

Associations and Microfossils:

Dinocrites with fragments of *Lithothamnium complexum*, *L. spinosum* and much altered *Lithocodium minus* and *L. colochrooides*. The abundant fragmentary Foraminifera associated with the algae include *Discocyclina, Nummulites*, and *Orbitalites*.

Horizon and Locality:

Zone V, Prang Limestone Member, Middle to Upper Eocene, Section I, Lushnong vicinity.

Figured Specimen:

*Slide CASGMF 1894.*

*Lithothamnium chosei* n.sp.

*(Pl. 16, fig. 1; Pl. 29, fig. 4-5)*

Derivation of Name:

In honour of Dr. D.K. Chose, Indian Institute of Technology, Kharagpur.
Description:

Thin curving and bifurcating crusts, often superposed. Hypothallus well developed, (0.008-0.250 mm across), may exist alone or may support a thin and unevenly developed parithallus, only 1 to 7 cell rows thick, sometimes up to 0.150 mm thick. Hypothallus plumose, cells rectangular, 0.013-0.022 mm x 0.008-0.013 mm in size. Parithallus, where sufficiently developed, faintly but distinctly zonated into horizontal layers; cells sub-quadrate with strong horizontal partitions, 0.010-0.017 mm x 0.006-0.012 mm in size. One good conceptacular cavity seen measures 0.313 mm x 0.106 mm; apertures not seen.

Lithothamnium species of the kind described above are not numerous in literature. A comparison with previously described species suggest that the present form resembles *L. toltecensis* Johnson and Kaska, 1965 in thickness and structure of the hypothallus and in general appearance as illustrated by Johnson and Kaska (1965), pl. 21, fig. 3) but not in cellular dimensions. The comparable species are tabulated below which shows that the present form should be described as a new species of *Lithothamnium*:
<table>
<thead>
<tr>
<th>Species</th>
<th>Hypothallus</th>
<th>Perithallus</th>
<th>Conceptacles</th>
<th>Originally described from (age)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height</td>
<td>Width</td>
<td>Height</td>
<td>Width</td>
</tr>
<tr>
<td>L. andrusovi</td>
<td>0.010</td>
<td>0.008</td>
<td>0.007</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td></td>
<td>(0.015)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L. crinophillus</td>
<td>0.009</td>
<td>0.009</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>Johnson, 1967a</td>
<td>0.015</td>
<td>0.013</td>
<td>0.016</td>
</tr>
<tr>
<td>L. guatemalense</td>
<td>0.012</td>
<td>0.006</td>
<td>0.008</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>Johnson and</td>
<td>0.054</td>
<td>0.013</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>Naska, 1965</td>
<td></td>
<td>(0.023)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. ledronicium</td>
<td>0.020</td>
<td>0.009</td>
<td>0.009</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>Johnson, 1967a</td>
<td>0.023</td>
<td>0.013</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>L. mazagonense</td>
<td>0.014</td>
<td>0.011</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>Johnson, 1964b</td>
<td>0.025</td>
<td>0.015</td>
<td>0.011</td>
</tr>
<tr>
<td>L. toltecanum</td>
<td>0.014</td>
<td>0.011</td>
<td>0.009</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>Johnson and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Naska, 1965</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. sp. Johnson,</td>
<td>0.010</td>
<td>0.009</td>
<td>0.009</td>
<td>0.009</td>
</tr>
<tr>
<td>1964a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. ghossi n.sp.</td>
<td>0.013</td>
<td>0.009</td>
<td>0.010</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associations and Microfacies:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomicroites and bimicrosporites with crusts and branches and nodular superposed crusts of Lithothamnium.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
*perplexum*, *Lithoporella melobesicida*, *L. minus* and  
bundant larger Foraminifera consisting mainly of *Puellispira*  
and *Himunites*.

**Type Level:**

Zone V, Prang Limestone Member, Middle to Upper Eocene.

**Type Locality:**

Section 1, Lumphong vicinity, Jaintia Hills, Meghalaya.

**Figured Specimens:**

Holotype, Slide CASGMP 1991  
Paratype, Slide CASGMP 1991

**Lithothamnium sp. A**

(Pl. 27, fig. 1-2)

**Description:**

A single crust 0.6-0.8 mm thick; the basal hypothallus  
where present is thin, 0.075-0.1 cm across, and made up  
of small indistinct cells showing an irregularly plurose  
to uncurred arrangement. Perithallus regular, with  
distinct, very gently undulating rows. Tissue very compact;  
faintly but distinctly stratified due to the more accentuated
horizontal partitions; only 3 to 4 rows of cells in each zone; cells mostly square, also rectangular, very small, 0.006-0.009 mm x 0.006-0.009 mm in size. One elongated oval cavity in the thallus has a smoothly concave base and an irregular roof. It measures 0.475 mm x 0.100 mm (0.112%).

Remarks:

In structure of the perithallial tissue this specimen compares very closely with *Mesophyllum* sp. 4 described and illustrated by Segonnet(1966), although the latter form has slightly larger perithallial cells and a thicker hypothallus.

However, the present specimen is assigned to *Lithothamnia*, because of the character of the hypothallus. But a specific nomenclature is not attempted because of the incomplete data available from the solitary specimen.

Associations and Microfacies:

Biosparite with fragments of *O. auriculata* and *Neanogia* and Foraminifera such as *Disocyclus*, *Alveolina*, *Hemulinia*, ciliolids and textularids.
Horizon and Locality:

Zone IV, Oulstchot Limestone Member, Lower Eocene, Section A, Lumphong vicinity.

Figured Specimen:

Slide CASOMF 1879.

Lithothamnium sp. B

(Pl. 16, fig. 2; Pl. 39, fig. 1-3)

Description:

Thallus epizoic on a larger Foraminifera (Hemmulites?) and consists of a very thin crust, up to 0.125 mm thick, from which abruptly grows an erect protuberance. The encrusting part may consist only of a simple to plumose hypothallus, 0.063-0.089 mm thick, or of a thin hypothallus, 0.025-0.075 mm across, and a 3-to-4-cell-row-thick parathallus. Hypothallic cells indistinct, rectangular with rather dark and thick walls; cells 0.006-0.012 mm x 0.006-0.009 mm in size. The protuberant portion is 1.500 mm long and 0.963 mm in diameter; tissue strongly moneted; 5 or 6 rows of small regular cells measuring 0.0045-0.0165 mm x 0.0045-0.0099 are followed by 1 or 2 darker rows of much smaller and indistinct cells. One curved lenticular conceptacle
measures 0.350 mm x 0.125 mm; apertures not known.

Remarks:

Apparently, the growth habit, internal structure, shape of conceptacles and the cell sizes together set this form apart from any earlier described species. However, a specific name is not assigned because of the indistinct nature of the hypothallic tissue.

Associations and Microfacies:

Biomicroites with Lithothamnella melobesioidea, L. minus, and fragment of Lithothamnium (Paleothamnium) torii Maslov and undetermined crustose corallines. Associated fauna include robust larger Foraminifera like abundant Discocyclina, some Nummulites and echinoid fragments. Many of such Foraminifera are seen to be encrusted all around by the crustose corallines.

Figured Specimen:

Slide CAS007 1996.

Subgenus-Paleothamnium Segonzac, 1969

Remarks:

Paleothamnium which includes fossils intermediate
between *Archaolithothamnium* and *Lithothamnium* was created as a genus by Conti (1945) to designate a Miocene *Melobesioideas* from Austria which showed a particular stage of evolution of the asexual reproductive organs. He has been followed in this use of the term in the same sense by Maslov (1962) and Mastrorilli (1967). But Segonzac (1969) after a careful consideration of the structure of *Paleolithothamnium* interpreted it as a subgenus of *Lithothamnium*. The principal characters of the subgenus are: (i) a crustose or branched thallus, (ii) basal hypothallus in files, (iii) medullary hypothallus and perithallus in rows and may be zonated, (iv) organs of asexual reproduction show intermediate stages of maturity of sporangia.

*Paleolithothamnium* is known from Paleocene to Miocene

*Lithothamnium* (*Paleolithothamnium*) *lortii* Maslov, 1962  
(Pl. 30, fig. 4-5)

1956- *Lithothamnium*? *lortii* Maslov, p. 115-116, pl. 33, fig. 3
1970- *Paleolithothamnium* *lortii* Maslov-Poignant and Chaffaut,  
  p. 203, pl. 1, fig. 2-3.
1977- *Lithothamnium* (*Paleolithothamnium*) *lortii* Maslov-Poignant,  
  p. 58

Description:

A very well preserved and interesting fragment of crust showing a basal hypothallus, 0.075-0.088 mm across,
with cells in creeping files; the more distinct cells mostly rectangular, 0.013-0.017 mm x 0.007-0.010 mm in size. Perithallus very regular; conspicuous horizontal rows and distinct partitions give a clear, grilled aspect; cells rectangular, measuring 0.008-0.018 mm x 0.006-0.012 mm in size. A zonated appearance is discernible in the tissue primarily because of the nature of arrangement of the reproductive organs. Conceptacles lenticular, measuring 0.200 mm x 0.063 mm, 0.275 mm x 0.075 mm, 0.325 mm x 0.100 mm and 0.375 mm x 0.100 mm respectively. These conceptacles are occupied by vertically elongated rectangular to elongated ovoid sporangia at intermediate stages of maturity. Sporangial sori measure 0.072-0.082 mm x 0.020-0.039 mm. Some conceptacular cavities appear as being gradually filled up by secondary hypothallial tissue.

Remarks:

The characters of tissue, reproductive organs and the measurements fit those of *L. (2)* forii Meslov described and illustrated by other workers (e.g. Poignant and Chaffaut, 1970).

Associations and Microfacies:

Bionomicrites with *L.*, sp. B and other associated flora and fauna listed under this species.
Horizon and Locality:

Zone V, Prang Limestone Member, Middle to Upper Eocene, Section II, Lumshnong vicinity.

Stratigraphic and Geographic Distribution:

Paleocene of Russia (Kaslov, 1962)
Paleocene of France (Poignant, 1977)
Ypresian of France (Poignant and Chassignet, 1970).

Figured Specimen:

Slide CASCMF 1896.

Genus—Menophyllum Lemoine, 1928
Type species—Menophyllum lichanoides Lemoine, 1928

Diagnosis:

Mostly crustose, also branched, forms; basal hypothallus parallel to the substrata, multilayered and characteristically coaxial; perithallus thick, in rows, and distinctly sunated. Branched forms with pronounced irregular growth zones of the tissue. Conceptacles relatively large, multipored.

Remarks:

The genus shows a structure intermediate between that of
Lithothamnion and Lithophyllum, possessing conceptacles and sponges similar to those in the former and tissue similar to that in the latter. Some Mesophyllum, however, may have a hypothallus which is not necessarily coaxial (Aday, in Buchbinder, 1977).

Under the above circumstances generic assignment of specimens lacking significant combinations of anatomical characters may depend upon the experience and judgment of the individual observer. The queried recognition of Mesophyllum in this thesis reflects absence of good specimens in the present collections.

This living genus dates back to the Paleocene or probably to Lower Cretaceous (vide Poignant, 1974).

Mesophyllum (?) sp. A

(Pl. 31, fig. 3)

Description:

A fragmental crust, 0.575 mm in thickness; hypothallus not preserved; perithallus shows irregular growth zones dividing the tissue into lenticular areas; perithallial cells squareish to rectangular, 0.007-0.018 mm x 0.006-0.012 mm in size, and arranged in vertical rows, often with less conspicuous and less continuous horizontal partitions.
Conceptacles not known.

Remarks:

The solitary specimen lacking the hypothallus as well as the conceptacles cannot be properly compared with previously described species. M. sp(?) described by Rao (1943) from the limestones of Cherrapunji area in Meghaleya does not show lenticular growth zones.

M. meghalevansis described (without measurements) and illustrated by Pel and Dutta (1979) from the Lakadong Member of the Jaintia Hills, Meghaleya shows characters resembling those in Metackoniolithon(?) meghalevansis n. sp. as pointed out under the latter in this chapter.

Associations and Microfacies:

Biostratigraphites, partially recrystallised to a coarsely crystalline calcite mosaic, with small crustose coralline fragments including Lithophorella mineral and Cylindracea coralliforme. Miliolida, Belemnites, Discocyclina and other unrecognizable foraminiferal fragments constitute the associated faunal elements.

Horizon and Locality:

Zone IV, Umshnong Limestone Member, Lower Eocene.

Section 7, Umshnong vicinity.
Figured Specimen:

Slide CASEMPF 1880.

*Mesophyllum (?)* sp. B

(Pl. 10, fig. 1; Pl. 31, fig. 5-7)

Description:

Longitudinal, oblique longitudinal and transversal sections of a strongly branching thallus are seen. Branches long and slender and tapering towards the top (spinose); some spinose branches have a bulbous tip due to the localized accretion of perithallic tissue. Observed incomplete lengths vary from 1.075 mm to 2.00 mm, and the diameters from 0.750 mm to 0.763 mm at the widest parts, and from 0.250mm to 0.313mm at the spinose parts; the bulbous tip is 0.400mm in diameter in one specimen. Medullary hypothallus is strongly constricted with 5 to 7 (or 8) rows of cells per zone; the outer-most rows are thinner and darker coloured; cells rectangular in regular rows and quadrates in stunted rows, vertical partitions continuous, horizontal zig-zagging. In transversal sections cells appear as rounded-polygonal. The regular cells measure 0.0186-0.043 (0.050)mm x 0.009-0.013 (0.0188)mm and the stunted cells (0.006) 0.009-0.013 (0.0188)mm x (0.006) 0.009-0.013 mm in size. Marginal perithallus absent or very much localized and thin,
0.063–0.0100 mm across, consisting of 3 to 4 rows of rectangular to subquadrature cells; cells (0.006)0.009–0.025 mm x 0.009–0.013 mm in size. Two conceptacle spaces with irregular roofs measure 0.075–0.088 mm x 0.163–0.263 mm; definite orifices not seen.

Remarks:

The form and the structure of the thallus are very distinctive. Among the many species of *Mesophyllum* described in the literature, *M. cf. pflanzheimii* (Lemoine) described from the Paleocene of Borneo (Johnson, 1966) has certain similarity with the present form in growth habit and cell sizes. However, the present branches are thinner and spinose and conceptacles are much smaller. They may possibly belong to an undescribed species.

Associations and Microfacies:

Biomicroites with fragments of *Lithothamnium perplexum* and other undetermined crustace algae. The microfacies is rich in Foraminifera including abundant large and small *Nummulites*, some *Alveolina* and rare miolids.

Horizon and Locality:

Zone V, Prang Limestone Member, Middle to Upper Eocene, Section I, Lunshong vicinity.
Figured Specimen:

Slide CASOMF 1892.

Genus *Lithophyllum* Philippi, 1837

Type species *Lithophyllum incrustans* Philippi, 1837

**Diagnosis:**

Crustose or branching plants: hypothallus characteristically multi-layered coaxial, but also single-layered in some cases; perithallus thick, strongly to weakly layered; coaxial medullary-hypothallus in branched species surrounded by a thinner marginal perithallus; conceptacles single-pored.

**Remarks:**

Infertile specimens of *Lithophyllum* and *Mesophyllum* may not be sometimes easily distinguishable because of the similarity of their growth forms and tissue structures. Ady (1970), who pointed out that *Lithophyllum*, like *Lithothamnium*, has been used as a 'catch-all' genus for diverse kinds of crustose corallines, regards the secondary pits (minute pits connecting adjacent cells not belonging to the same filament) as very important systematic characters of
Lithophyllum (and Tenerae). However, such minute features are not distinguishable in this sections of fossil specimens. In dealing with the fossil specimens, therefore, the present author has taken guidance from the classical works of Lemoine (1911, 1917, 1939) Conti (1950) and Johnson (1961a). Johnson and Brey (1965) have reviewed the fossil species of Lithophyllum.

This living genus dates back to the Early Cretaceous (or to Late Jurassic?, vide Brey, 1977).

**Lithophyllum simplex** Lemoine, 1927

(Pl. 31, fig. 1-2)

1927-*Lithophyllum simplex* Lemoine, p. 546, text-fig. 4
1928-*Lithophyllum simplex* Lemoine-Lemoine, p. 101, text-fig. 15
1935-*Lithophyllum simplex* Lemoine-Miranda, p. 282, pl. 95, text-fig. 62
1939-*Lithophyllum simplex* Lemoine-Lemoine, p. 95, text-fig. 62
1966-*Lithophyllum simplex* Lemoine-Berkmann and Berkmann, p. 20, pl. 4, fig. 49-50.

**Description:**

Thin free crust; thallus consisting either almost entirely of hypothallus tissue or of a hypothallus and a very thin perithallus. Hypothallus 0.112-0.138 mm thick, coaxial, varying to plumose in the same specimen; cells
rectangular, 0.018-0.031 mm x 0.007-0.015 mm. Perithallus one to three horizontal cell rows thick; cells subquadrate, horizontal partitions better defined, very small; the largest cells measure approximately 0.006-0.009 mm x 0.006-0.009 mm. No conceptacles observed.

Remarks:

The growth forms and dimensional data closely fit those known for Lithophyllum simplex Lemoine. Conceptacles reported by Beckmann and Beckmann (1966) are, however, not known in the present specimens.

Associations and Microfacies:

Biolithites and associated bimicrites with Lithocoralla selbosioides, Corellina cf. C. petensae, Corellina sp. and the fossils mentioned under these articulated corallines.

Horizon and Locality:

Zone V, Prang Limestone Member, Middle to Upper Eocene; Section I, Luanhong vicinity.

Stratigraphic and Geographic Distribution:

Middle Eocene of Spain (Lemoine, 1929, 1939)
Upper Eocene of France (Lemoine, 1927)

Oligocene of Spain and Cuba (Miranda, 1935; Beckmann and Beckmann, 1966)

Figured Specimen:

\textbf{Slide CASMF 1914.}

\textit{Lithophyllum cf. L. sonatum} Johnson and Ferris, 1948

(Pl. 31, fig. 3-4)

cf. 1948-\textit{Lithophyllum sonatum} Johnson and Ferris,

p. 785, pl. 117, fig. 3.

Description:

Oblique sections through crust and branches; basal hypothallus not seen; tissue of the branches differentiated into a medullary hypothallus and a marginal perithallus. Both hypothallus and perithallus appear sonated; medullary zone strongly arched. Each zone of the medulla consists of 3 to 5 rows of larger, lighter coloured cells followed by 0.025-0.075 mm thick darker coloured areas consisting of stunted cells; the number of stunted cell rows cannot be ascertained. Perithallial zones incompletely known; apparently 3-4 (or 5?) regular cell rows alternate with 1-2 darker, indistinct rows. Cells rectangular, elongated vertically or horizontally, also quadrate and appear to be of
the same order of size in both hypothallus and perithallus. They measure: Hypothallus cells (regular) 0.016-0.031
(0.058) mm x 0.013-0.034 (0.044) mm; Hypothallus cells (stunted) 0.009-0.013 mm x 0.009-0.0125 mm; Perithallus cells 0.0168-0.044 mm x (0.009)0.013-0.036 mm. Conesptacles unknown.

Remarks:

The general appearance, cell dimensions and the presence of growth zones suggest similarity of the specimens with *L. monstum* described originally from the Upper Middle Eocene of Florida (cf. Johnson and Farris, 1948). However, a clear characterization of the hypothallus and perithallus cells being unavailable in the original description, the comparison is incomplete and hence open nomenclature has been used for the present form.

Associations and Microfacies:

Biomatrites with fragmented and worn bioclasts such as crustose corallines, and abundant robust larger Foraminifers such as *Hymulites*, *Ammonia* and *Atrypina* as also small *Hymulites* and large miliolids and rare reworked *Marinella Lucasoni* Pfender.
Horizon and Locality:

Zone V, Prang Limestone Member, Middle to Upper Eocene,
Section I, Lamshong vicinity.

Stratigraphic and Geographic Distribution:

Upper Middle Eocene of Florida (Johnson and Ferris, 1949).

Figured Specimens:

Slide CASOMF 1890.

Genus *Lithoporella* Foslie, 1909

Type species *Lithoporella melanobesioides* (Foslie, 1903)

Foslie, 1909

Diagnosis:

Thin crusts, often repeatedly superposed in a loose and capricious manner to form an appreciable thickness. Hypothallus monostromatic, cells generally isodiametric, vertically elongated, large, mostly greater than 0.010 mm and often up to 0.040 mm. Perithallus generally absent, except immediately around conceptacles; conceptacles large and single-pored.

Remarks:

This is quite a common genus. Its crusts may be epiphytic or epizoic. The morphological characters are
distinctive for the genus. *Melobesia* Lamouroux which resembles *Lithoporella* is different from the latter in having square or horizontally elongated cells in the basal layer, and multipored conceptacles. However, in fossil specimens a distinction of *Melobesia* from *Lithoporella* may be difficult unless good details of tissue and conceptacles are seen (cf. Ishijima, 1975, who in such circumstances would like to group all incompletely preserved specimens into *Lithoporella*). Pal and Dutta's (1979) *Melobesia* sp. is based on incomplete description and poor illustration.

The oldest record of this extant genus goes back to the Late Jurassic (Gray, 1977).

*Lithoporella melobesioides* (Foslie, 1903)*Foslie, 1909

(Pl. 32, fig. 1-2)

1903-*Mastophora melobesioides* Foslie, p.24-25

1904-*Mastophora (Lithoporella) melobesioides* Foslie-Weber van Rosse and Foslie, p.73-76, fig.30-32

1909-*Lithoporella melobesioides* Foslie-Foslie, p.58-59

1973-*Lithoporella melobesioides* Foslie-Lemoine, p.52

Description:

Thin, irregular, single-layered crusts, often superposed repeatedly to a composite thickness of more than 1,300 mm.
The superposition is mostly loose and capricious. New thalli are seen occasionally to bud off from the prostrate crusts. Lengths of thalli up to 7.500 mm seen. The monostromatic hypothallus consists of large, mostly rectangular, vertically to obliquely elongated, seldom nearly squarish to horizontally elongated, cells. All these variations in the cell characters can be seen even in the same individual thallus. Hypothalial cells measure 0.018–0.125 mm x 0.013–0.063 mm (0.025–0.033 mm x 0.013–0.031 mm common). The indistinct smaller perithallic cells present around a conceptacle could not be measured. In some cases cortical cells, 0.002–0.013 mm in height, were seen to cover the hypothallic cells. The single conceptacle mentioned above appears to be single-pored and is 0.250 x 0.125 mm in size.

Remarks:

This is a very common alga in the Sylhet Limestone beds. Most of the slides contain at least a few fragments of it. With the wide variation known in the cell sizes of L. malphisetoides, sometimes even in the same individual thallus, it is usually not possible to separate species of Lithoporella, unless there are differences in the conceptacles. However, thalli which are uniformly of a much smaller size
and have cells with their maximum size values going only up to the lower limits of the ranges for the cells of *L. palpobasiconides* have been assigned to a second species in the present study.

**Associations and Microfacies:**

Most common as well preserved crusts in the biomicrites and biolithites along with other frequent to abundant encrusting red algal species described in this chapter. Associated foraminifers include *Miscellanea micrella*, *Haplophila*, *Hemulites*, *Amalina*, *Discorculina*, *Palatinum*, and encrusting forms. Fragmentary specimens of the species are frequent in the back-reef biosparites and biomicrosparites containing udoteaceans such as *Ovulites*, *Halicea*, and desyclads such as *Discorcula*, *Purcorolla* and *Perforatia*, and associated foraminifers and other fauna recorded under the respective forms of algae.

**Horizon and Locality:**

Most abundant in Subzone IIb, Lekedong Limestone Member, Upper Paleocene, Section C and Zone V, Prang Limestone Member, Middle to Upper Eocene, Section I. But as mentioned above, almost at every horizon and section of the study area fragments of this species are available in greater or less abundance.
Stratigraphic and Geographic Distribution:

This is an ubiquitous species known from the Palaeocene to the Recent and, hence, is of little stratigraphic value.

Figured Specimens:

*Slide CAS 1095.*

**Lithoporella minus** Johnson, 1964

(Pl. 32, figs. 1-5)

1964 - *Lithoporella minus* Johnson, p. 10, pl. 2, fig. 6
1966 - *Lithoporella minus* Johnson-Beckmann and Beckmann, p. 23-24, pl. 5, fig. 73

Description:

Tiny thallus, consisting of a single layer of cells, except around the conceptacles where the tissue is multilayered. Crusts may be epiphytic on other crustose algae and may be loosely superposed. Individual thallus up to 0.375 mm long. Cells almost squarish to rectangular, vertically elongated and measure 0.009-0.025 (0.06?) mm x 0.007-0.014 (0.025) mm. A conceptacle and a probable conceptacular swelling with development of parietal tissue seen measure 0.190 mm x 0.090 mm, and 0.375 mm x 0.125 mm respectively.
Remarks:

The discrimination of this species has been done on the basis of cell sizes as mentioned under *L. melobesioidea*. Except for the very rare and taxonomically insignificant aberrations, the measurements indicate identity of the present form with *L. minus* Johnson, 1964.

Associations and Microfacies:

Noted mainly in the biomicrosparites and bio-microsparites with *Oryzites marginula*, *O. corallita*, *O. elongata*, *Furcoporella diopora*, *Bisociadella elliotti*, and *Distichoplas bicriellia*. Foraminiferal associations mainly include *Mamulites*, *Discocyclina*, *Alveolina*, *miliolidae* and *textulariidae*. Also frequently seen in the biolithes rich in encrusted red algal species including *Lithonorella melobesioidea* and others indicated under this species. Foraminiferal association also is similar to that mentioned under *L. melobesioidea*.

Horizon and Locality:

Mainly in Zone IV, Unletdoh Limestone Member, Lower Eocene, Section A-C, also in Zone V, Prang Limestone Member, Middle to Upper Eocene, Section I,
Stratigraphic and Geographic Distribution:

Palaocene of Sarawak (Johnson, 1966)

Uppermost Middle Eocene and Upper Eocene of Cuba
(Backmann and Backmann, 1966)

Eocene of Ishigaki, Ryukyu Islands (Johnson, 1964c).

Figured Specimens:

Slides CASGIP 1872, 1873, 1915.

Genus—Litholepis Foslie, 1905

Remarks:

Foslie never designated a type species for the genus. Lemoine (1952) elected Malobesia caspica Foslie, 1900.

Aney (1970), while discussing the problem of generic differentiation of Lithoporella, Litholepis and Heteroderma, noted that the type Malobesia caspica is a Tanarea and treated the closely related groups Lithoporella and Litholepis under the genus Lithoporella. He, however, remarked that with regard to the cell size Lithoporella and Litholepis appear to form two separate groups and hoped that further study may enable separation of the groups on a more secure basis.
In this thesis *Litholepis* is being indicated as a possible separate genus to accommodate certain crustose thalli distinguished by the smallness of their various dimensions.

*Litholepis* is not known to this author from previous fossil records.

**Litholepis** (?) sp.  
(*Pl. 32, figs. 6-7*)

**Description**:

Thin loosely superposed crusts, somewhat dull yellowish brown in colour; individual crusts about 0.030–0.050 (0.068) mm and aggregates up to 0.325 or 0.375 mm in thickness; cells small, indistinct and cannot be measured except around the conceptacles where they are 0.005–0.008 mm x 0.005–0.009 mm in size. Two conceptacles seen are probably single-pored. Their measurements are: 0.200 mm x 0.166 mm (external), 0.132 mm x 0.100 mm (internal); 0.225 mm x 0.225 mm (external), 0.125 mm x 0.125 mm (internal).

**Associations and Microfacies**:

Biosparites with the algae *Distichoplasia biseriata*, *Metagoniolithon (?) meschiana*, *solenomorina (?)* sp. and
the Foraminifera *Miscellaneous* (?), *Discocyclina* and *Nummulites*; also bimicrosporites with infrequent fragments of *Archaeolitothamnium* and *Lithoporella minus* and common *Cyclites morrelli*, and Foraminifera such as *Discocyclina*, *Nummulites* and miliolids.

Horizon and Locality:

Transition between Zone I and Zone II, Lakadoo;
Limestone Member, Upper Paleocene, Section G; and Zone IV, Unlatooh Limestone Member, Lower Eocene section A.

Figured Specimen:

Slide CASMPF 1885.

*Genus* *Tistichoplax* Pia, 1914

*Type species* *Tistichoplax biserialis* (Dietrich) Pia, 1914

Diagnosis:

Thallus platy in habit and formed principally of two symmetrically arranged layers of cells. Most frequently seen and recognized in petrographic thin sections as *straight* to moderately curved, thin chevron-shaped structures with a smooth central axis or as zipper-shaped structures with a zig-zagging central axis. The rarely seen conceptions are incompletely known.
Remarks:

Till recently the alga was considered a micro-
problematicum. Dietrich (1927) referred to it as a portion
of the perithallus of Lithothamnium. Pia (1934) recognized
it as a new genus but placed it close to Lithophyllum under
the Melobesioidae. Lemoine (1958,1960) interpreted it as
the creeping stem of the cocoonium of Rhabdopleura (class
and Segonzac (1961) did not accept Lemoine's point of view
and regarded Distichoplax as an alga. Verra in 1960
indicated the presence of a probable conceptacle, rather
imperfectly preserved, in a Distichoplax specimen and
supported the inclusion of Distichoplax under the Melobesioidae.
Following this, Keij (1963,1964) discovered well-preserved
conceptacles in Distichoplax specimens. Basing on these
discoveries and on further observations and considerations
of structural details, Denizot and Massieux (1965) concluded
that the relationship between Distichoplax and the
Melobesioidae is now well established. The present author
from his own record of a conceptacle (Pl. 33, fig. 9)
and from his observation of a large number of sections of
this alga supports the classification of Distichoplax
among the Melobesioidae and agrees with the general aspects
of the reconstruction of its proposed by Denizot and
Massieux (1965) and Ayaroglu and Gucenc (1975).
The genus has been reported from Upper Cretaceous (Andrusov, 1933) to Upper Eocene (e.g. Schalekova, 1963, 1964). However, it is restricted from the Paleocene (Danian, corresponding to the *Globorotalia pseudohulluloides* Zone) to the lower Eocene (Cuisian, corresponding to the *Globorotalia formosa formosa* Zone) throughout the Tethyan belt from Spain to Indonesia (cf. Elliott in Keij, 1963; Keij, 1964; Ayaroğlu and Ovunc, 1975).

*Distichoplex biserialis* (Dietrich) Pia, 1934

(Pl. 19, fig. 1-5; Pl. 33, fig. 1-9)

1918-*Lithoanum pseudomulticum* Cumber in Trauth, p. 219, pl. 2, fig. 1

1918-*Lithoanum* (?) *sp.* in Trauth, p. 220, pl. 2, fig. 2-3

1927-*Lithoanum biserialis* Dietrich, p. 461, pl. 2, fig. 1

1934-*Distichoplex biserialis* (Dietrich)—Pia, p. 13, text-figs. 5-8

1949-*Distichoplex uniserialis* Pfeider and Schneegans, p. 91

1956a-*Distichoplex biserialis* (Dietrich)—Elliott, p. 332, pl. 2, fig. 1

1958-*Distichoplex biserialis* (Dietrich)—Lamoine, p. 2145

1960-*Distichoplex biserialis* (Dietrich)—Elliott, p. 226, pl. 8, fig. 2-3

1961-*Distichoplex biserialis* (Dietrich)—Segonzac, p. 446, pl. 13a, figs. 3-4

1963-*Distichoplex biserialis* (Dietrich)—Keij, p. 153-155, pl. 1, fig. 2-8, text-fig. 1
1964 - *Distichoplex biserialis* (Dietrich) - Keij, p. 115-118, pl. I, fig. 1-9

1965 - *Distichoplex biserialis* (Dietrich) - Benizet and Massieux, p. 387-391, pl. 8, fig. 1-7, text-fig. 2

1975 - *Distichoplex biserialis* (Dietrich) - Yaroglou and Guven, p. 1-2, pl. 1, fig. 2-4, 6b, pl. 2, fig. 1-2.

**Description:**

Fragments of thallus up to 2.5 mm long and 0.050-0.075 mm (commonly 0.062-0.092 mm) thick. Three principal types of sections and numerous other randomly cut sections have been observed. A rare conceptacle.

0.200 mm x 0.500 mm in size has been found in a rather well preserved oblique-vertical section. The appearance of the alga and the cell dimensions vary with the orientation of the sections.

**Type I sections**

Straight or moderately curved thin rods with a herring-bone or a leaf-like structure; principal cells rhombic with oblique cell boundaries making angles of 50-70° (commonly around 61°) with the smooth central axis. Trichocytes as well as cortical cells seen.

**Measurements**

Principal cells: \(0.025-0.063\) mm x \(0.009-0.063\) mm

(commonly \(0.038-0.050\) mm x \(0.025-0.044\) mm)
Trichocytes: height 0.0297 mm; dim. 0.0198 mm
Cortical cells: height 0.0132 mm ± 10°

Type-2 sections

Straight or moderately curved rods with a zipper-structure with two rows of approximately rectangular cells perpendicularly disposed on a generally zig-zagging central axis. Both trichocytes and cortical cells seen.

Measurements

Principal cells: 0.031–0.089 mm x 0.009–0.031 mm (commonly 0.031–0.044 mm x 0.013–0.025 mm)
Trichocytes: height 0.013–0.017 mm
Cortical cells: height 0.0049–0.0066 mm

Type-3 sections

A more or less regular grid pattern of rectangular cells; the longer walls slightly arched outwards in some sections. Tiny synapses have been seen only in these sections.

Measurements

Principal cells: (0.0188) 0.031–0.0436 (0.050) mm x 0.012–0.025 mm.

Remarks:

Splitting of the thallus along the central axis
(marking the median plane of symmetry) in the type-1 and type-2 sections and a gradual or almost abrupt change from hearing bone to zipper-structure have also been noticed in many specimens. These features and the characters described above are in agreement with the structure of the thallus portrayed by Denizot and Massieux (1965) and Ayaroglu and Guvenç (1975). The three principal type of sections described above can be referred to Plate 19, figure 1 (after Denizot and Massieux, 1965) as follows:

Type-1 sections are vertical, perpendicular to plane of symmetry and parallel to the length of the cellular files; type-2 sections are also vertical but are perpendicular to both the plane of symmetry and to the length of the cellular files i.e., vertical and perpendicular to the type-1 sections; and type-3 sections are parallel to the plane of symmetry i.e., they are horizontal, and perpendicular to both type-1 and type-2 sections. The present specimens clearly fit the descriptions and measurements of *P. bicornis* by different workers and hence a consideration of the species *P. rani* Varma, 1960 and *P. huykali* Ayaroglu and Guvenç, 1975 has not been felt necessary here.

The systematic position of this alga within the Melobesioideae is once again affirmed by the discovery of the well preserved conceptacle in the present collections.

Associations and Microfacies:

Bionicraterites, bionomicrites, biolithites and rarely
arenaceous biosparites with *Neoponioolithon* (?) *necularensis*,
*Coralina* cf. *C. praria*, *Pseudolithothemnium album*,
*Solenoserris o'connmani*, *Archaolithothemnium vorplexum*,
*Lithothemnium* cf. *L. bofilli*, *L. varipes*, *Acropora ranae*,
*Hemipitrella* cf. *H. nudigenensis*, *Glyptina allioti*,
*Isorropora* (?)* sp., Trinopora* sp. and *Tripnodiscus* sp.
Important Foraminifers are *Micrallana micella*, *Amphithalia*,
*Lockhartia*, cf. *L. haimei*, *Alveolina primavera*, *Opuncolina*,
*cf. O. canalifera* and *Microcyclina raniketensis*.

Horizon and Locality:

Mainly in Subzones IIa, IIb and IIc, Lakadong
Limestone Member, Upper Palaeocene, Sections D, E, F and G;
also in Zone IV (bottom), Umotoh Limestone Member,
Lower Eocene, Section N, Lumshnong and vicinity, Jaintia Hills, Meghalaya.

Stratigraphic and Geographic Distribution:

Upper Cretaceous (?) of Carpathian (Andrusov, 1938)
Palaeocene of Persia (Dietrich, 1927)
Palaeocene of Madagascar (Pfender, 1936)
Palaeocene of France (Rech Frolo and Seyonzac, 1959;
Seyonzac, 1961; Poignant and Cheffant, 1970)
Palaeocene of Iraq and Arab (Elliott, 1956a, 1960)
Palaeocene of Czechoslovakia (Scholakova, 1963, 1964)
Paleocene of Indonesia (WeiJ, 1963, 1964)

Paleocene-(Danian?) of India (Sastri et al., 1963)

Paleocene of Cuba (Brennmann and Rigassi, 1963; Beckmann and Beckmann, 1966)

Paleocene of Turke (Myaroglu and Guvenc, 1975)

Lower Eocene of Iraq (Elliott, 1956a)

Lower Eocene of Italy (in Myaroglu and Guvenc, 1975)

Lower Eocene of Morocco (Durand-Delga, 1958)

Lower Eocene of Pakistan (Varma, 1960)

Lower Eocene of Cuba (Brennmann and Rigassi, 1963; Beckmann and Beckmann, 1966)

Lower part of Middle Eocene of Cuba (Beckmann and Beckmann, 1966)

Middle Eocene (Upper Lutetian) and Upper Eocene of Carpathian
Subfamily CORALLINOIDEAE Mason, 1953
(The Articulated Corallines)

The erect, jointed and branched thalli of the articulated corallines grow attached to the substrate. The calcified segments or intergenicula are jointed by uncalcified joints or genicula. Fossils consist more often of disjointed segments varying in shape from cylindrical to flattened types. The cellular tissue is differentiated into a medulla of partitioned vertical filaments and a cortex developing from it. Reproductive organs are single-pored conceptacles which may be axial, marginal or lateral in position. The characters used for the identification of the living articulated corallines are either not preserved or are not recognizable in the fossils. This causes difficulty in the discrimination of fossil fragments. However, of the half a dozen better known genera in the fossil records the common Cenozoic forms may be distinguished with the help of the following key (after Johnson, 1965, 1961a, 1961c; Poignant, 1973 in Deloffre and Poignant, 1978).

Key:

1. -Conceptacles axial
   -Conceptacles lateral
2. -Tissue homogenous

... ... 2
... ... 4
... ... 3
- Tissue non-homogenous; medullary cells disposed irregularly in arched rows; perithallus monostrromatic; ramification dichotomous; nodes unisomal

Jania

3. Medullary cells regularly disposed in arched rows; perithallus reduced; ramification pinnate; nodes unisomal

Corallina

-Gills of same height disposed in arched rows, but enlarged and curved at the periphery; ramification pinnate in sterile plants and dichotomous in fertile plants; nodes multisonal

Arthrocardia

4. Tissue non-homogenous; Medulla with alternating long and short cells disposed in arched rows; perithallus in rows; ramification dichotomous; nodes multisonal

Amphiroa

Genus-*Amphiroa* Lamouroux, 1912

Type species-*Amphiroa trigulus* Ellis and Solander, 1786

Diagnosis:

Segments vary from cylindrical to flattened forms; branching dichotomous; thallus non-homogenous; medullary tissue characterized by variously alternating arched tiers of long and short cells, cortical tissue layered. Nodes with several tiers of cells. Conceptacles single-pored, lateral.
Remarks:

In fossil specimens commonly the lateral occurrence of the conceptacles and the alternation of long and short cells distinguish this genus from *Jania*, *Arthrocardia* and *Corallina*.

This extant genus is known from rocks as old as Early Cretaceous.

*Amphiroa* sp.

(*Pl. 14, fig. 1*)

Description:

Longitudinal section of a single segment seen is 0.375 mm long and 0.150 mm in diameter. Medullary tissue well developed with tiers of long and short cells alternating after the formula 2 long : 1 short. Boundaries between tiers continuous, straight in the middle and arched at the sides. Long cells 0.063–0.085 mm x 0.007–0.012 mm in size. Marginal perithallus moderately developed, of rectangular to polygonal cells measuring 0.007–0.027 mm x 0.006–0.015 mm, and arranged in an irregular oblique mesh. Conceptacles not seen.

Remarks:

Whereas the characteristic alternation of long and
short cells positively places the specimen in *Amphiroa*,
the absence of conceptacles and more specimens does not allow
a safe specific determination. The specimens illustrated
(not described) by Pal and Dutta (1979, pl. 2, fig. 10, ;
pl. 2, fig. 11 and 12) as *Amphiroa iridescens* Johnson
and as *Amphiroa* sp. respectively appear to belong to
*Metagoniolithion (?) mechalevescia* n. sp. as defined in this
thesis.

Associations and Microfacies:

Biolithites with superposed crusts of *Archaeolitho-
thenium tayleri* n. sp., *A. perplexum*, *Lithothamnium manicus*,
*Lithothamnium* cf. *L. bofilli*, *Lithoporella* *pelobasioides*,
*Pseudolithothamnium album*, *Sisticoxus biserialis*,
*Metagoniolithion (?) mechalevescia* n. sp., *Salenomeris* *o'gormanii*
and Foraminifera such as *Doomulites miliolide* and other
undermined forms and abundant corals.

Horizon and Locality:

Subzone IIIb, Lakadong Limestone Member, Upper
Palaeocene, Section 8, Lumshnong vicinity.

Figured Specimen:

*Slide CAS695 1956.*

*Genus* - *Corallina* Linnaeus, 1758.

*Type Species* - *Corallina officinalis* Linnaeus, 1761

*Diagnosis*:

Plants with a markedly calcified multiaxial structure;
branching usually pinnate. Individual segments cylindrical to flattened cylindrical, in sections commonly wider at top than at base. Tissue of segments consists of a dominant medullary hypothallus and a thin and inconspicuous perithallus. Medulla homogenous, with long, narrow, rectangular cells of equal height, regularly disposed in gently and evenly arched rows. Nodes are formed of a single row of very long thick-walled cells, normally not calcified. Conceptacles single-pored, axial.

Remarks:

Segments of *Corallina* have a homogenous tissue, while those of *Amphiroa* a non-homogenous tissue consisting of variously alternating rows of long and short cells. In *Jania* the segments are slenderer and cell rows are more arcuate and irregular, the tier boundaries being commonly more or less stepped. *Arthrocardia* has centrally-flattened and marginally curving tiers of cells.

The genus *Corallina* dates from the Lower Cretaceous to the Recent.

*Corallina* cf. *Corallina prisca* Johnson, 1957

(Pl. 34, fig. 4-5)

cf. 1957-*Corallina prisca* Johnson, p. 239-240, pl. 37, fig. 4, pl. 40, fig. 10, pl. 44, fig. 1-2
cf. 1961c-**Corallina prisca** Johnson-Johnson, p. 940

cf. 1966-**Corallina** cf. **Corallina prisca** Johnson-Beckmann and Beckmann, p. 27, pl. 7, fig. 90-93

cf. 1970-**Corallina prisca** Johnson-Poignant and Chaffaut, p. 206, pl. 1, fig. 1.

**Description:**

Numerous fragmented segments; segments cylindrical to subcylindrical, slender, 1.100-2.250 mm long and 0.163-0.200 mm in diameter; 16 to 23 evenly arched rows of very regular medullary cells per segment; cells long and narrow, measuring 0.006-0.008 mm x 0.007-0.010 mm near the axis of the segments. Perithallus thin, one to two cell rows thick; cells rectangular or polygonal, 0.013-0.019 mm x 0.007-0.013 mm in size. Conceptacles not preserved.

**Remarks:**

The general appearance and the measurements resemble **C. prisca** Johnson known from the Paleocene (cf. Poignant, 1970; Beckmann and Beckmann, 1966) to the Upper Eocene (cf. Johnson, 1957). The number of cell rows in a segment are within Johnson's original values (0.008-0.021 mm, rarely 0.036 mm). Johnson's specimens, however, had greater ranges for the lengths of medullary cells (0.065-0.120 mm). Moreover, conceptacles are not known in the present specimens. The identity of the present form has, therefore, been
indicated by an open nomenclature.

Associations and Microfacies:

Bioserites mainly with frequent Distichopliax
biserialis, and rare fragments of undetermined
Archaeolithothamnium, Metagoniolithon (?) meghalayensis
and others. Foraminifera associated with these algae include
Hapalolitha, Discorcyclus, Miscellaneous miscella, miliolidae
and textularide.

Horizon and Locality:

Subzone IIIa, Lakadong Limestone Member, Upper
Paleocene, Section G, Lunshnong vicinity.

figured specimen:

Slice CASOMF 1904.

Corallina cf. Corallina matensis Johnson, 1957

(pl. 34, fig. 2)

cf. 1957a Corallina matensis Johnson, p. 239, pl. 44, fig. 3-4
cf. 1965 Corallina matensis Johnson-Johnson and Keske,
p. 54-55, pl. 31, fig. 1.

description:

A nearly complete segment and another fragmentary
segment have been observed. Segments comparatively large, flattened, and fairly wide; wider at one end than at the other. The length of the better preserved segment is 1.025 mm and the width 0.225-0.298 mm. Horizontal tiers are of uniform height and are very gently curved about 16 to 18 tiers in a segment. Cells of medulla rectangular, 0.050-0.075 mm long and 0.0063-0.0094 mm wide. Margin of the segments are somewhat frayed and indistinct. Hence the perithallic cells could not be clearly observed and measured. Conceptacles not observed.

Remarks:

The general appearance of the segments recalls \( G. \) matanaka originally described from the Upper Pocene of Saipan, although the holotype has a large size— at least 1.755 mm long and 1.00 mm thick. The present size values fall within the ranges \( (0.195-1.760 \text{ mm} \times 1.194-0.395 \text{ mm}) \) for the Lower Pocene specimens of \( G. \) matanaka described by Johnson and Raska (1965) from Guatemala. The size of medullary cells are within ranges for the Guatemalan as well as the Cuban specimens described by Beckmann and Beckmann, 1966—0.037-0.070 x 0.007-0.018 mm and 0.044-0.072 mm x 0.007-0.009 mm respectively. However, from the incomplete data regarding the present specimens the comparison is inconclusive.
Associations and Microfacies:

Biolithites with *Archeolithothamnium lycopodi*,
undetermined *Lithothamnium*, *Lithophyllum simplex* and
*Lithonorella molobasidans*. Foraminifera like *Bumulites*
and *Pellatissira* are common in the microfacies.

Horizon and Locality:

Zone V, Prang Limestone member, Middle to Upper
Eocene, Section 11, Lumphnong vicinity.

Figured Specimen:

Slide CASGMF 1916.

*Corallina* sp.

*(Pl. 34, fig. 3)*

Description:

One segment with frayed margins, wider towards the
top and tapering towards the base, and another such frag-
mented similar segment have been noticed. The better preserved
segment is 1.087 mm long. The maximum diameter of the
specimens are 0.238 mm and 0.175 mm. Hypothalial cells
long, narrow, rectangular, and arranged in widely arched
rows of uniform height. 17/18 rows have been preserved in
the more complete segment. Cells measure 0.049–0.063 mm x 0.008–0.013 mm. Perithallial tissue and conceptacles are not seen in the specimens.

Remarks:

A specific identification has not attempted because of the paucity of good specimens.

Associations and Microfacies:

Biolithite with *Archeolithothamnium lucemoni*, *Archeolithothamnium quinque* n.sp., *Lithothamnium persicinum*, *Lithophorella melobesicidae* and *L.* *minus*. Associated Foraminifera are abundant *Pellethispira* and *Hymenites*.

Horizon and Locality:

Upper part of Zone V, Prang Limestone Member.
Middle to Upper Eocene, Section I, Lungshong vicinity.

Figured Specimen:

Slide CASGMF 1895.

Genus—*Jania* Lamouroux, 1812

Type species—*Jania corniculata* Lamouroux, 1812

Diagnosis:

Plants characterized by slender, dichotomously
branched thalli made up of cylindrical segments. Comparatively large medullary cells, wedge shaped in many instances, and disposed in irregularly arcuate rows, of which the horizontal boundaries are more or less stepped. Cortical zone thin, often monoestratified. Nodes unisonal. Conceptacles single-pored, axial.

Remarks:

Distinction between fossil specimens of *Jania* and *Corallina* is sometimes very subtle. The morphology of the segments has, however, allowed the recognition of numerous segments of *Jania* at certain levels of the Sylhet Limestone Formation. Specific discrimination has been cautiously limited to the more well preserved specimens.

The earliest record of this living genus comes from the Lower Cretaceous (vide Poignant, 1974).

*Jania Saintianae* n. sp.

(*Pl. 16, fig. 6-9*)
Pl. 17, fig. 2

Derivation of Name:

The Saintia Hills of Meghalaya.

Description:

Slender, cylindrical segments; some specimens show
dichotomous branching. The lengths of segments vary from 0.413 mm to 0.700 mm and the diameters from 0.175 to 0.198 mm. Fragments of branches are 0.125-0.163 mm long and 0.125 mm wide. Medullary cells vertically elongated, rectangular, and disposed in irregularly arched rows; 14 to 20 such rows per segment. Boundaries between tiers are conspicuously stepped. Horizontal partitions of cells thicker and discontinuous; vertical partitions thinner, straight, and continuous. Cells of the axial region of segments measure 0.010-0.037 (0.040) mm x 0.007-0.017 mm in size, and those of the branches 0.014-0.040 mm x 0.010-0.013 mm in size. Marginal perithallus indistinct or thin; perithallic cells squarish to polygonal, 0.007-0.010 mm in average diameter, and arranged in a meshwork. No conceptacles observed.

Remarks:

It is possible that the numerous specimens seen in the slides belong to more species than one. But further segregation of the incompletely preserved specimens has not been attempted because of the considerable variability known in the characters of articulated coccine segments (Lemoine, 1940, p.115).

The present form differs from other known Lower Tertiary forms of Jania both in morphology and in measurements.
J. occidentalis Johnson and Kaska, 1965, J. garcourtii
Johnson, 1965, J. nummulitica Lemoine, 1934, and J. wengaudi
Lemoine, 1934 described from the Paleocene of Guatemala,
Middle Eocene of Greece, Upper Eocene of Hungary, and
Upper Eocene of Spain respectively have larger segments
and correspondingly larger cellular measurements. The alga
figured by Pal and Dutta (1979) as J. occidentalis from
the Lokadong Member of the Khari Hills, shows little of the
cellular structure and is much slenderer than the original
J. occidentalis specimens illustrated by Johnson and
Kaska (1965).

Associations and Microfacies:

Arenaceous bioseparates with rare fragments of
Archaeolitothamnum, Littichoplex biserialis (reworked?),
Dissociadella, Malizade, Euulites coronellii (common) and some
Euulites elongata. Foraminifera seen in the microfacies are
Elvocline, Nissocyclina, miliolids and textularids.

Type Level:

Top of zone IV, Usuletch Limestone Member, Lower
Eocene.
Type Locality:

Section G, Lumshnong vicinity, Jaintia Hills, Meghalaya, India.

Figured Specimens:

Holotype, Slide CASMF 1899
Paratypes 1,2, Slide CASMF 1900.

Genus—*Calliarthron* Manza, 1937
Type species—*Calliarthron chattogramiensis* Manza, 1937

Diagnosis (after Gray, 1977):

"The genus resembles *Corallina* in its growth habit and general appearance, but differs in that the cellular filaments of the medullary region are flexuous and interlaced. Conceptacles occur in marginal and lateral positions".

Remarks:

This common living genus is known so far in the fossil record only by *C. antiquum* from the Lower Miocene of Saipan (Johnson, 1957), *C. cf. antiquum* from Burdigalian of Cuba (Beckmann and Beckmann, 1966), *C. Johnsoni* from the
Oligocene of Cuba (Beckmann and Beckmann, 1966), C. sp.
from Miocene of Japan (Ishijima, 1967) and C. cfr. anticonus
from Aquitanian of Malaysia (Ishijima, 1973).

Calliarrhron (?) sp.
(Pl. 14, fig. 9)

Remarks:

Plate 14 figure shows a longitudinal section of a
cylindrical segment (0.425 mm x 0.125 mm) with a possible
lateral "conceptacle". It is doubtfully assigned to
Calliarrhron by comparison with the Calliarrhron specimens
figured by Beckmann and Beckmann (1966). The flexuous
medullary filaments, however, are missing in the present
specimen. Transverse partitions are not at the same
level. Cells measure 0.013-0.033 mm x 0.099-0.013 mm and
the "conceptacle" is 0.138 mm x 0.050 mm in size.

The solitary specimen available occurs in association
with other abundant articulated corallines such as Corallina
and Jania besides Gyulites, reworked fragments of Distichoplasia,
Lithoporella, miliolids and textularids, in the arenaceous
limestone of the Umataq Limestone Member in zone IV of
section G in the vicinity of Lunghnong.

Figured Specimen:

Slide CASGMF 1899.
Genus *Metagoniolithon* Weber van Bosse, 1904

Type species: *Metagoniolithon charoides* Weber van Bosse, 1904

**Diagnosis** (after Johnson, 1954):

"Fronds fragile, branching verticillate, dichotomous or verticillate-dichotomous, with branches arising from cortex of nodes, and with spines covered with a mucilaginous cap; nodes multizonal; medullary filaments of segments straight, with cells in transverse zones of equal length; conceptacles lateral, scattered over surfaces of segments or restricted on lower side of branches."

**Remarks**:

This living genus is characterized by the multizonal nodes and the lateral conceptacles. Unlike most other genera of articulated corallines, the nodes are less clearly differentiated from the internodes (Weber van Bosse and Roslie, 1904; Hanza, 1940). Numerous specimens of an articulated coralline alga characterizing the lower part of the Upper Paleocene Lekadong Limestone Member in Meghalseya have been assigned to *Metagoniolithon* provisionally, as complete thalli representing definite multizonal nodes as also the lateral conceptacles are lacking in the specimens. The only other fossil forms of this genus so far known are *Metagoniolithon (?)* goschel and M (?) sp. indet. A described
by Beckmann and Beckmann (1966) from the Oligocene and Aquitanian of Cuba. Present Indian record probably extends the antiquity of the genus to the Upper Paleocene.

**Metagoniolithon (?) meghalaysensis** n. sp.

*(Pl. 35, fig. 1-5)*

**Derivation of name:**

The state of Meghalaya in India.

**Description:**

Fragments of cylindrical, terminally tapering to rounded branches; branches straight to nearly straight, occasionally twisted, up to 3.375 mm long and 0.438-1.108 mm wide. Articulation not clearly seen possible not clearly distinguishable; the intermittent layers of low, irregular cells in Plate 35, figure 1, for example, may possibly be multizonal nodes. Medulla up to 0.938 mm thick; cells of medullary tissue in gently and evenly arched rows; cells vertically elongated, rectangular in longitudinal sections, and polygonal (hexagonal) in oblique and transversal sections. Horizontal partitions of cells thicker, discontinuous; vertical partitions thinner straight in longitudinal sections, sometimes incomplete. Cells measure 0.032-0.104 mm x 0.013-0.052 mm (0.050-0.090 mm x 0.022-0.082 mm more common)
in longitudinal sections. In transversal sections they are 0.019-0.036 mm in diameter. Perithallus mostly absent or inconspicuous, up to 0.125 mm thick. Passage of the modulary tissue into the perithallic tissue is abrupt. Perithallic cells square to rectangular, somewhat elongated parallel to the growth surface, usually measuring 0.0125-0.025 mm x 0.0125-0.025 mm; both vertical and horizontal walls of similar thickness and not perfectly continuous. Conceptacles not preserved.

Remarks:

The specimen described above are here assigned tentatively to the genus *Metagoniolithon* because of their close affinity in growth form and anatomy with the fossils described as *Metagoniolithon* (7) by Beckmann and Beckmann (1966). However, the alleged lateral conceptacular cavities of the latter are absent in present case. In this connection Plate 1, figures 3-4 of Pal and Dutta (1979) illustrating some specimens described by them as *Metagoniolithon* seechulawensis appear very interesting. The hexagonal appearance of the cells in tangential and oblique sections seem to suggest that the specimens belong to *Metagoniolithon* (7) as described here. The alleged conceptacles in these specimens may, therefore, be the lateral conceptacles of
*Metagoniolithon*(?) *mehalayensis* missing in the present author's collections.

The present form is identified as a new species because the Cuban species *H*(?) *ganshei* has more irregular and discontinuous horizontal and vertical cell walls, allegedly 'characteristic flexuous cell rows' (Beckmann and Beckmann, 1956, pl. 7, figs. 99-102) and proportionately longer cells (0.070-0.090 mm x 0.010-0.050 mm). Cellular proportions of the present form possibly recalls *Lithothamnium thikambium* Johnson and Ferris, 1950, but the latter is a crust of lesser dimensions.

Fossils described and illustrated as *Corallina grandis* by Rao (1943) and illustrated as such by Pal and Dutta (1979) from the Sylhet Limestone Formation of Meghalaya appear to have characters identical with *H*(?) *mehalayensis*. The available cell sizes of the former lie within and close to the lower limits of the size ranges obtained for the latter. In the experience of the present author, *Corallina grandis* Rao, 1943 does not possess characters belonging to *Corallina*.

**Associations and Microfacies:**

*Metagoniolithon*(?) *mehalayensis* predominantly occurs in the recrystallized bioclastites of Lakadong Limestone Member.
either alone or in association with Distichoploca biserialis, some undetermined crustose Corallines and Corallina. Foraminifera such as Miscellaneous, Amoebolithia, Lockhartia cf. L. haimai, Micocyclus, Selenites, Alveolina, Opekarbitolites, Opereolina, miliolids and textulariids have been recognized in this microfacies. Also, less frequently specimens of M. (? megalovensis are seen in the biomicroparites with Corallina, Lithonella melobesicola, other undetermined crustose corallines, Clylitae and Foraminifera as mentioned above. Rare Metacololithon (?) megalovensis fragments have been seen in biolithites with abundant crusts of Pseudolithothamnium album, Selonoceras o'gormanii, Archaeolithothamnium, Lithothamnium, rare Amphiroa and Corallina along with corals and bryozoans besides the Foraminifera, as listed above. Bimicroparites rich in spongiocands like Acroporella ancona, Clymene elliptica, Taw mutations cf. M. sedalanensis, Acroporella (?) sp., Triplomorpha sp., Noemertes cf. N. pleurinensis and containing Foraminifera, coral fragments and echinoid spines have also shown fragments of Metacololithon (?) megalovensis.

Type Level:

Zone I, Lakadong Limestone Member, Upper Palaeogene.

Type Locality:

Section C, Lunsongon vicinity, Jaintia Hills,
Meghalsya, India.

Figured Specimens:

Holotype, Slide CAS0001 1906
Paratype 1, 2, 3, 4, Slides 1909, 1901, 1978, 1902, respectively.

(b) The Green Algae

Division CHLOROPHYTA Pascher, 1914
(Syn. CHLOROPHYCOPHYTA Papenfuss, 1946)

The green algae comprise one of the major groups of algae. Their species and genera are greatly abundant. The group is represented by nearly two hundred genera in fossil records, and dates from the Early Cambrian to the Recent.

In the confusion that prevails at present over the systematic treatment of fossil green algae, the author adopts the practice of many a modern worker in Europe on Fossil algae (e.g., Massieux, 1966; Valet, 1968-69; Segonzac, 1971; Deloffre, 1971; Deloffre and Radicic, 1978; Deloffre, Poignant and Teherani, 1977). Accordingly, the class CHLOROPHYCRAE Putzing, 1843, which covers the fossil chlorophytes in the author's collections, encompasses here the orders BABYCLADALES Pascher emend. Feldmann, 1946 and
CAULERPALES Feldmann, 1946. Of these orders, the former includes the families, subfamilies etc. proposed by Valet (1968-69), and the latter includes the family UDOTRACEAE Feldmann, 1946 whose genera have been earlier described under the family CODIACEAE (Trevistan) Zanardini, 1843 under the order SIPHONALES Hille, in Warming (1884) orth. mut. Blackman et Tansley, 1902 by Johnson, 1961a and Bray, 1977 amongst others.

Order CAULERPALES Feldmann, 1946

The classification of living coenocytic CHLOROPHYCEAE or SIPHONALES sensu lato was recast by Feldmann (1946, 1951, and 1954) on the basis of certain cellular structures, chemical composition and mode of reproduction.

Family UDOTRACEAE Feldmann, 1946

The family is related to the CODIACEAE through the common possession of a multiaxial structure, but is distinguished from the latter by the presence in it of specialized reproductive structures and by its heteroplastidity (Bold and Wynne, 1978).

Genus-Oculita Lamarck, 1816

Type species-Oculita margaritula Lamarck, 1801
Diagnosis (after Wray, 1977):

"Sylvites grew as an erect, articulated plant several centimeters high, consisting of segments varying in shape from simple cylinders to globular forms up to 2 mm long and generally less than 0.5 mm in diameter. Specimens are hollow, suggesting that the medullary region was uncalcified, but a finely perforate network is preserved in the cortex."

Remarks:

Although fossil specimens are mostly individual segments, occasionally 2 or 3 segments in their natural end-to-end joined position have also been found (e.g. Morelet, 1939 vide Johnson, 1961a, pl. 17, figs. 3-4; Massieux, 1966, pl. 2, fig. 24). Terminal orifices in the segments represent the apertures where the segments were conjoined in life; and the rarely found double apertures at the wider upper ends indicate occasional dichotomous branching of the thallus. Plate 11, figure 3 shows the growth habit of *Sylvites margaritula* (after Munier-Chalmas, 1879) which together with *O. moreletii*, *O. elongata*, and some *O. mailloensis* grew as volumetrically important sediment-producing plants in the back-reef environments of Sylhet Limestone times. Munier-Chalmas in 1879 first
recognized the fossil genus *Oxylites* to be analogous to the living udoteacean alga *Pennicillus* Lamarck.

The genus is now known to range from the Upper Cretaceous to the Eocene.

*Oxylites margaritula* Lamarck, 1801.

(P1. 11, fig. 3; pl. 36, fig. 1-7)

1801—*Oxylites margaritula* Lamarck, in Munier-Chalmas, 1880
1966—*Oxylites margaritula* Lamarck Massieux, p. 241, pl. 1, figs. 1-4
1970—*Oxylites margaritula* Lamarck-Deloffre, p. 355, pl. 1, fig. 1-3
1974—*Oxylites margaritula* Lamarck-Poignant and Lorenz, p. 8, pl. 1, fig. 2-4

Description:

Segments variable in their general form from subspherical to ovoidal, sometimes somewhat elongated and swollen towards the upper part; the generally large measurements vary within wide ranges. In sections either both or one (the upper) or none of the orifices are seen. Transverse sections are circular. The relatively thick calcified wall is finely perforated by straight, rectangular, radial
canals which may slightly enlarge towards the exterior. In tangential sections, these canals appear as a densely packed array of small pores.

Measurements

- Maximum external length: 1.088–2.125 mm
- Maximum external diam.: 0.675–0.187 (2.375) mm
- Thickness of calc. wall: (0.037) 0.50–0.125 (0.139) mm
- Diam. of pores: 0.0125–0.025 mm
- Diam. of upper orifice: 0.075–0.300 mm
- Diam. of lower orifice (seen in a few sections): 0.075–0.175 mm

Remarks:

The large size is distinctive for this species. The above values compare very well with those for Q. margaritula Lararck given by others as shown below:

<table>
<thead>
<tr>
<th></th>
<th>Lararck, 1861</th>
<th>Peloffre, 1970</th>
<th>Poignant and Lorentz, 1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>L (max.)</td>
<td>1.4 mm</td>
<td>1.2–2.1 (av. 1.9) mm</td>
<td>–</td>
</tr>
<tr>
<td>D (max.)</td>
<td>1/2–1 mm 3/4</td>
<td>0.134–1.62 mm (av. 1.08 mm)</td>
<td>0.45–0.70 mm</td>
</tr>
<tr>
<td>Thickness calc.</td>
<td>0.030–0.150 mm (very rarely 0.30 mm)</td>
<td>0.05–0.125 mm (av. 0.075 mm)</td>
<td>0.05–0.07 mm</td>
</tr>
<tr>
<td>wall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diam. of pores</td>
<td>0.012–0.026 mm (av. 0.025 mm)</td>
<td>0.020–0.025 mm (av. 0.025 mm)</td>
<td>0.014–0.018 mm (in tangential sections)</td>
</tr>
<tr>
<td>Diam. of up. orifice</td>
<td>–</td>
<td>0.075 mm</td>
<td>–</td>
</tr>
</tbody>
</table>
From the description and the illustration of *Griphonocoralla arabica* (cf. Massieux, 1966; Elliott, 1968) by Pal and Dutta (1979), their algae under reference appears to be an *Ovulites* (most probably *Ovulites marcaritula*).

**Associations and Microfacies:**

Biocoerotes and biomicroseerotes rich in *Ovulites* including *Q. moreleti*, *Q. elongata* and rarely *Q. millichensis*. In some samples *Ovulites marcaritula* alone or along with *Q. moreleti* and/or *Q. elongata* compose nearly the only biotic constituents. Further, whereas in the uppermost Lakadong limestone beds, frequent fragments of *Marina luegani* are some times significantly associated besides some miliolids, *Spencerula* and other small Foraminifera, in the Umletsoh Limestone Member important associations of *Ovulites* are (i) algae such as, *Disoscidella* sp. A and D*.* sp. B, *Periplocoralla dhianpora*, *Ferradiella asconseci* n.ssp., *Triplocladus* sp., *Terquemella* cf. *T. lenticularis*, *Halimeda prasenollis*, H*.* sp., articulate corallines, fragments of *Archeocithothamnium*, *Lithothamnium* and *Solenoporees* (?), (ii) Foraminifera such as *Alveolina elliptica*, *A. oblonga*, *Eumulites stericus*, *Disiscyclina renibotensis*, *Opertorbitolites*, *Opencrula*, miliolids and textularids, (iii) gastropods, palaeocypons, echinoid spines, corals and bryozoan fragments.
Horizon and Locality:

Zone III, Lakadong Limestone Member, Upper Paleocene,
Sections C, D and F, Lumshnong and vicinity; Zone IV,
Umilchod Limestone Member, Lower Eocene; Sections A, C, D, F, G,
H and I, Lumshnong and vicinity.

Stratigraphic and Geographic Distribution:

Montian of Paris Basin, France (Morellet, 1
Sparnacian of South West France (Deloffre, 1970)
Middle Eocene of England, Belgium, France, Italy and
Hungary (vide Munier-Chalmais, 1979)
Lutetian of Cotentin, France (Poignant and
Lorenz, 1974).

Figured Specimens:

Slides CASGMF 1882, 1883.

Oryolites morelleti Elliott, 1955
(Pl. 37, figs. 2-5, 9 )

1955-Oryolites morelleti Elliott, p. 126, pl. 1, figs. 4-6

1966-Oryolites morelleti Elliott-Beckmann and Beckmann,
p. 35, pl. 10, figs. 147-149.

Description:

Narrow, elongated cylindrical segments, open at
both ends, and with slightly inflated extremities. Calcareous wall finely perforated. Longitudinal, transversal and tangential sections are present in great abundance in the slides. The following biometric data have been collected from the appropriate sections.

**Measurements**

- Length of segments: 0.800–2.250 mm
- Extn. diam. of segments: 0.150–0.350 mm (0.187–0.225 mm) (common)
- Thickness of calc. wall: 0.040–0.050 mm av.
- Diam. of pores: 0.009–0.0125 mm (0.0100 mm)
- Distance between pores (canals): 0.0125–0.0150 mm

**Remarks:**

Except *O. margaritula* the other known species of *Oxylites* have comparable measurements. The present form resembles in general character and measurements *Oxylites morabilis* Elliott originally described from the Paleocene of North and North-East Iraq (Elliott, 1955). Compared to *O. elongata*, its less numerous associate in the Meghalayan microfacies, it has wider segments with thicker walls and slightly larger pores. Plate 37, figure 9 which shows an *O. elongata* adventitiously wedged in the medullary cavity
of *Q. morrelli* illustrates the differences in dimensional characters of the two forms. The rare, elongated club-shaped *Q. megalolensia* has distinctly much wider segments.

Associations and Microfacies:

Same as in case of *Q. margaritula* except that *Q. morrelli* has also been found as almost the lone component of the core of well sorted oolites in some biooosparites at the upper and lower parts of Unaltdoh Limestone Member. In the bioarenosparites of the upper and lower parts of this member it is associated with frequent to common articulated corallines such as *Jania laintiensia* n.sp.

Horizon and Locality:

Zone III, Lakadong Limestone Member, Upper Palaeocene, Sections C, D, and F, Lunehong and vicinity; Zone IV Unaltdoh Limestone Member, Lower Eocene, Sections A, C, D, F, G, H, and I.

Stratigraphic and Geographic Distribution:

Paleocene of Iraq (Elliott, 1955)

Transition Lower to Middle Eocene of Cuba (Beckmann and Beckmann, 1966)

Figured Specimens:

Slides CASEMF 1869, 1882, 1886.
Ovulites elongata Lamarck, 1816

(Pl. 37, figs. 5-9)

1816—Ovulites elongata Lamarck (in Munier-Chalmas, 1879)
1938—Gryphonorella arabica Pfender (in Massieux, 1966)
1939—Ovulites elongatus Lamarck—Morelet (in Johnson, 1961),
pl. 37, figs. 9-11
1966—Ovulites elongata Lamarck—Massieux, p. 140, 142;
pl. 3, figs. 3-4.

Description:

Elongated, narrow cylindrical articles a little
more inflated at the upper end than at the base. Such
sections are less numerous than those of the comparable
O. moreleti in the present collections.

Measurements

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (incomplete)</td>
<td>1-1.2 mm</td>
</tr>
<tr>
<td>Diameter (max.)</td>
<td>0.200 mm</td>
</tr>
<tr>
<td>Thickness of calc. wall</td>
<td>0.025-0.032 mm</td>
</tr>
<tr>
<td>Dim. of pores</td>
<td>0.008-0.009 mm</td>
</tr>
</tbody>
</table>

Remarks:

Where comparable sections do not show both the
terminal inflations, less wide segments and thinner
calcareous walls with very fine perforations O. elongata
apart from O. moreleti, which has larger values for
the corresponding dimensions.

**Associations and Microfacies:**

Same as in case of *Q. margaritula* and *Q. morellati* described here.

**Horizon and Locality:**

Zone III, Lakadong Limestone Member, Upper Palaeocene
Sections C, D, and F, Lunshnong and vicinity.
Zone IV
Unladah Limestone Member, Lower Eocene, Sections A, C, D, F, G, H and I, Lunshnong and vicinity.

**Stratigraphic and Geographic Distribution:**

Middle Eocene ('calcaire grossier') of Paris Basin, France (Lamarré, 1916 in Munier-Chalmas, 1979; Morellet, 1939).

**Figured Specimens:**

Slides CASGME 1882, 1886, 1900.

**Orylitites maillolensis** Massieux, 1966

(Pl. 36, figs. 9-9; pl. 37, fig. 1)

1966—**Orylitites maillolensis** Massieux, p. 241-249, pl. 1, figs. 12-12;
pl. 2, figs. 16-20

1968—**Griphocrassa arabica** Pfeffer-Elliot, p. 51, pl. 12,
fig. 1, 3.
Description:

The longitudinal and tangential sections identified here as belonging to this species clearly suggest elongated club-shaped segments which may be sometimes a little bent also.

Measurements

Length of segments (incomplete) : 0.685-2.750 mm and above

Maximum diam. of segments : 0.375-0.390 mm

Thickness of calc. wall : 0.050 mm

Diam. of pores (in tangential sections) : 0.013 mm

Remarks:

The distinctly club-shaped form of the articles is characteristic and the dimensional data compare very closely with those given by Massieux for O. canilloiensis from the Ilerdian of Corbières septentrionales (France). Her measurements are : L = 0.60-2.15 mm; Diam. = 0.35-0.60 mm; Thickness = 0.050 mm and Pores = 0.0125 mm. The minor differences in the two cases are not believed to be of any taxonomic significance.

Associations and Microfacies:

Biomicrosparites bearing some oolites and pellets
and comprising *Ovalites marmoritula* (badly recrystallised), *Q. moreleti*, *Q. elongata*, and *Hastinella lunensis*; and biosparites with *Q. marmoritula*, *Q. moreleti*, *Q. elongata*, *Halimeda prasmonilia*, *Seriatella reconnexa* n. sp., and Foraminifera such as *Alveolina* (common), *Ocaptorbitolites*, and *miliolids*.

Horizon and Locality:

Zone III, Lakadong Limestone Member, Upper Palaeocene, Section D, Lumshnong; Zone IV, Unladoh Limestone Member, Lower Eocene, Sections A and D, Lumshnong and vicinity.

Stratigraphic and Geographic Distribution:


Figured Specimens:


Genus *Halimeda* Lamouroux, 1812

Type species *Halimeda tuna* Lamouroux, 1812

Diagnosis (after Endo, 1961):

"Thallus irregular to bushy, commonly starts from a
short basal stalk attached to the substratum by rhizoids. The thallus is branched, composed of calcified segments separated by uncalcified nodes. Segments cylindrical, flattened, circular or somewhat lobed. Each segment is composed of interwoven tubular threads. The inner threads are coarse, but branch repeatedly into thinner and thinner ones with the fine outermost branches perpendicular to the surface. Calcification is variable, commonly strong on the outer surface becoming weaker inward. Sporangia globular to ovoid, borne on stout short slender filaments projecting beyond the surface of the segments.

Remarks:

Fossil specimens are the disintegrated whole or fragmented segments, in which the cortex is the most calcified part. Segregation of species is largely done on the character of the segments and the mode of branching of the calcified filaments. This is seldom an easy task in thin sections, although a generic identification is often very easy. However, for the present, specific identification has been attempted on the basis of a study of a large number of sections where possible.

This is a living marine genus. 'The first occurrence of Halimeda is not certain because of taxonomic problems in
distinguishing the morphologically similar Jurassic and
Early Cretaceous genera *Pomaina* and *Arabicodium* (Gray, 1977,
p. 96).

*Halimeda praemonilis* Morellet, 1940

(Pl. 38, figs. 1-3)

1940-*Halimeda praemonilis* Morellet, p. 201, fig. 1
1956-*Halimeda praemonilis* Morellet-Elliot, p. 793, pl. 25,
fig. 1, 4
1966-*Halimeda praemonilis* Morellet-Beckmann and Beckmann,
p. 33, pl. 9, figs. 130, 131
1971-*Halimeda praemonilis* Morellet-Leonzac, p. 11, pl. 3,
figs. 23, 26, 29
1977-*Halimeda praemonilis* Morellet-Peloffre, Poignant,
and Teherani, p. 43, pl. 6, figs. 1, 2

Description:

Irregularly cylindrical segments of variable diameters. Lengths of segments incompletely known because the specimens available are only fragments of segments. The medullary part is composed of less calcified filaments or this part is even uncalcified in some specimens. The filaments are erect and independent of each other. At intervals they give rise to progressively finer cortical filaments which, near the periphery, are nearly perpendicular to the external wall and appear as dense and narrow pores in tangential sections.
Measurements

Maximum length of segments: 2-2.5 mm
(incomplete)

Diameter of segments: 0.375-0.875 mm

Diameter of medullary filaments: 0.0375-0.061 mm
(0.05-0.07 mm common)

Diameter of cortical filaments: 0.0125-0.032 mm.

Remarks

A comparison of these specimens with, for example, those described by Morellet (1940), Beckmann and Beckmann (1966) and Segonzac (1971) shows that, while in respect of diameters of filaments there is almost complete similarity, the diameter of segments are larger in the later cases (e.g. 0.9-1.02 mm in Morellet; 0.975-1.18 mm in Segonzac; 0.5-1.3 mm in Beckmann and Beckmann, 1966). Elliott, 1956b described Halicada praemoinlis measuring 3 x 1 x 1 mm or 5 x 1 x 0.5 mm. The present measurements fit better those for the H. praemoinlis specimens described by Deloffre et al. (1977): max. length 1.9-2.4 mm, diam. segments 0.36-0.42 mm, diam. med. filaments 0.37-0.45 mm, diam. cort. filaments 0.012-0.025 mm.

However, it is possible that Halicada praemoinlis as it has been defined here comprises more than one form which escaped differentiation in the thin sections because of
the difficulties of specifically identifying fossil fragments of *Halimeda* (Johnson, 1961a).

Section figured by Pal and Dutta (1979) as *Cymopolia* sp. is, to all appearances, a transversal section of a *Halimeda* (? *preammonilis* ?) and not a dasyclad, as it clearly shows the circular transverse cuts of erect medullary filaments.

**Associations and Microfacies:**

Biomicrosporites and biosparites with *Cylites*,
*Burconoria* diappora, and *Sarafatiella* sp. n. sp. and
rarely fragments of *Archeolithothamnium*, *Lithothamnium*,
and *Lithophyllia*. Other biotes include mainly *Alveolina*,
**miliolides**, echinoid spines and gastropod sections.

**Horizon and Locality:**

Zone IV, *Ualatdoh* Limestone Member, Lower Pecene,

**Stratigraphic and Geographic Distribution:**

Paleocene of *Iraq* (Elliott, 1956b)
Paleocene of central *Iran* (Peloffre *et al.*, 1977)
Sparncian of *Levalanet* (Sagonzac, 1971)
Lower Eocene and Oligocene of Cuba (Backmann and Backmann, 1966)

Eocene of Cotentin (Auversian) (Morellet, 1940)

Figured specimens:

Slide CASGMP 1692.

Halimeda sp.

(pl. 30, fig. 4-5)

Description:

Rather flattened, short segments. The segments noticed are 1.337-2.00 mm long and 0.087-1.000 mm in diameter at the widest part. Medullary filaments are coarse, 0.038-0.063 mm in diameter and longitudinally directed. Cortical filaments ramified and oblique to nearly perpendicular to the surface. Diameter of these filaments vary from 0.025 to 0.032 mm at the middle of the cortex and from 0.013 to 0.025 mm at the outer margin of the cortex.

Remarks:

A specific determination has not been risked because of the paucity of specimens in the collection.
Associations and Microfacies:

Biosparites with *Eulites*, *Carfatiella seconsacc*ini sp., and Foraminifera such as *Alysonia* and miliolids.

Horizon and Locality:

Zone IV, Umatlah Limestone Member, Lower Pocene, Section A, Lumpzong vicinity.

Figured Specimens:

Slide CASCMF 1893.


The systematic treatment of fossil dasyycladales have been generally based on palaeontologists (e.g. Kemptner, 1956; Rezak, 1959; Johnson, 1961; Endo, 1961; Harek, 1969; Elliott, 1969) on Pie's (1920) pioneer scheme which considered for this purpose the following: (i) general shape of the thallus, (ii) dimensions, (iii) type of skeleton, (iv) shape of vertical branches, (v) disposition of vertical branches, (vi) shape of axial cell, (vii) reproductive organs. Lately, Bassoulet et al. (1975, 1977) critically reviewed the classification criteria of fossil
dasycladales and established certain hierarchy among morphological characteristics of fossil dasycladales. (Valet, 1968-69, used such characters also in his description of present day dasyclads). They concluded: (i) the disposition of first order ramification is important for defining the family, (ii) general shape of thallus, shape and order of the ramifications and reproductive organs determine generic to subfamilial taxa, (iii) dimensions, nature and degree of calcification and morphology of the axial stem characterize the species.

Using the vocabulary of Bassoulet (1975, 1977) and following Deloffre (in Deloffre and Poignant, 1978) a key for generic determination of some Tertiary and some possible Tertiary dasycladales depending on the morphological criteria alone (without considering their familial and subfamilial affiliations) is given below.

**Key:**

- Thallus with first order ramification \((R_1)\) ... Group I
- Thallus with second order ramification \((R_2)\) ... Group II
- Thallus with third order ramification \((R_3)\) ... Group III
- Thallus with fourth and higher order ramification \((R_4)\) ... Group IV
- \((R_5)\)
- \((R_6)\) etc.
**Group I**

1. Thallus cylindrical, articulated ... 2
   - Thallus cylindrical, non-articulated ... 3

2. $R_1$ trichophorous essentially euspondyl,
   numerous, generally oblique to the axis,
   upwardly tilted
   - Tautioporella

3. $R_1$ phloiophorous, euspondyl
   - closely spaced verticils, ramifications
     oblique to principal axis, alternate
     verticils of numerous sterile, simple
     ramifications and of fewer inflated
     fertile ampullae; sterile ramifications
     bend upward peripherally to envelop
     the upper fertile ramifications;
     calcification varies in the sterile
     and fertile verticils
     - Angioporella

   - distantly spaced verticils; inclination
     with principal axis variable;
     flat saucer-, bowl-, or funnel-shaped
     calcareous discs; fertile ramifications
     open/closed at the distal extremity,
     communicate with the axis by a pore;
     capillary, sterile ramifications also
     present
     - Clypeina

   - $R_1$ vesicular, euspondyl
     - closely spaced verticils of spherical
       to subcircular ampullae which
       communicate with the axial siphon
       simply by a short peduncle or
       proximal narrowing
     - Farfatiella

**Group II**

- Thallus cylindrical, articulated ... Subgroup II A
- Thallus cylindrical, non-articulated ... Subgroup II B
- Thallus moniliform ... Subgroup II C
- Thallus claviform ... Subgroup II D
- Thallus barrel-, or keg-shaped ... Subgroup II E
Subgroup IIA

- $R_1$ skrophorous, perpendicular to the axis
- fertile and sterile primary ramifications alternate in each verticil, as well as vertically; fertile ampullae of large size, nearly spherical; secondary ramifications small, 4 to 5 per $R_1$; central stem narrow
  ... \textit{Cylindroporcella}

- $R_1$ phloiophorous, oblique to principal axis
- truncated-cone-shaped serial segments, distal end wider, about 13 distinctly hook-like $R_1$ with short proximal extension below stem-cell connection and longer distal portion; possibly secondaries also present
  ... \textit{Hemuloporcella}

Subgroup IIB

- $R_1$ perpendicular to the principal axis
- $R_1$ phloiophorous; straight cylindrical thallus, calcification not reaching the central cell; $R_1$ short, disposed in whorls, widen towards exterior and bifurcate at once to two divergent secondaries extending probably beyond the calcareous skeleton
  ... \textit{Furconoporcella}

- $R_1$ oblique to the principal axis
- $R_1$ may also be 'skrophorous' (?), long in verticils, distally ramified into clusters of button-shaped secondaries
  ... \textit{Acroporcella}

Subgroup IIC

- $R_1$ phloiophorous or skrophorous, suspundyli, short.
-plants simple or ramified, composed of a group of calcified articles of which the extremities are perforated;
comprise tufts of whorled ramifications; \( R_1 \) large with a cluster of \( R_2 \) of which the distally enlarged extremities form a cortex; a "sporangium" between at least four sterile secondaries ... *Cymopolia*

**Subgroup III**

1. \( R_1 \) perpendicular to the principal axis
   - ramifications phloiphorous ... ... 2
   - ramifications axrophorous ... ... 3

2. Thallus cylindrical to claviform,
   skeleton often annular; whorled ramifications; \( R_1 \) short, globular or splayed out distally ramified into bunch of short secondaries; \( R_2 \) phloiphorous and comparable to \( R_1 \) in form ... *Bissoclidella*

3. Plants subcylindrical claviform
   with verticils of \( R_1 \) in independent or tightly soldered rings; \( R_1 \) at the upper part of plant gives rise to reproductive ampullae at the apex of which there is only a single cyst surrounded by 2 or 3 sterile \( R_2 \); \( R_1 \) rarely calcified ... *Nemania*
   - Thallus claviform, upper part subspherical, large sized; nearly perpendicular, numerous, elongate cylindrical, \( R_1 \) arranged in verticils, partly cladosporous; thin \( R_2 \), only basal portion generally preserved ... *Triplonorella*

**Subgroup III* 

- Thallus constituted of successive barrel-shaped calcareous articles, hollow, open at both extremities; \( R_1 \) in regular whorls, short peduncle of \( R_1 \) suddenly enlarges into a sac or ball; fertile ampullae with cysts fine, short \( R_2 \) arise distally from \( R_1 \) and slightly enlarge outwards ... *Broecellia*
Group III

- Thallus claviform, cylindrical; $R_1$ perpendicular to central axis,
  euspondyl, thick, phloeophorous, with several $R_2$ similar in form to $R_1$; $R_2$
  with a cluster of $R_3$; very often only
  $R_1$ and $R_2$ are seen; $R_3$ develop only
  in the upper part of the plant ... Trinocladium

Group IV

1. - Thallus cylindrical, articulated ... ... 2

   - Thallus cylindrical, non-articulated ... ... 3

2. - Distinct superposed articles; articles
   vary from elongated cylindrical to
   small ovoidal; calcareous wall conti-
   nuous, thick and compact; ramification
   up to 6th order with 32 pores on the
   surface; more important characteristics
   in thin sections are the successively
   dichotomous ramification all through;
   ramifications irregularly disposed ... Balanogia

3. - Continuous tube; calcification feebie,
   calcareous wall appears as constituted
   of small rectangular, juxtaposed plates;
   ramification up to 4th order (32 pores);
   more important characteristics are the
   tetradichotomous branching setting out
   from the 2nd order and the regular dis-
   position of the ramifications; thallus
   continuous slender tubes ... Thyasorulla

Parameters for Specific Identifications:

The following system of letters as proposed by
Bassoulet et al. (1978), modified after Pia, 1920 and
Praturlon, 1964) will be followed in the description of
the dasyclad species in this chapter, whenever expressions will be symbolized.

L : Maximum length of the thallus
D : External diameter of the thallus
d : Diameter of the axial cavity
e : Thickness of the calcified wall
H : Height of an article + height of a furrow
h : Difference between two successive verticils
g : Number of verticils per article
w : Number of ramifications per verticil or number of tufts of ramifications in transversal sections
w' : Number of secondary ramifications per primary ramification
b : Number of ramifications per tuft (type I: metaspondyl)
st : Diameter of the principal axis
l : Length of primary ramifications
l' : Length of secondary ramifications; l'' : length of tertiary ramifications...etc.
ϕ : Breadth of primary ramifications
p' : Breadth of secondary ramifications; p'' : breadth of tertiary ramifications...etc.
α : Inclination of ramifications with the principal axis
ns : Number of fertile ampulæ per verticil
ds : Diameter of fertile ampulæ
Family DASYCLADACEAE Rutsing orth. mut.
Stizenthaler, 1860

The Dasycladaceae are characterized by their erect, radially symmetrical stem-cells with one or more verticils of lateral branches belonging to one or more orders. This generally suggests 'a small cylindrical brush' less than a tenth of a millimeter to several millimeters in size. The stem and the branches appear as canals in the fossils which are calcareous moulds of disarticulated segments and fragments. Reproductive organs occur within the stem-cell or on the branches. The family is represented by over a hundred genera and is known from the Cambrian upwards.

Subfamily DASYCLADOIDAE Valet, 1968

Genus - Acronorilla Praturlon, 1964 emend.
Praturlon and Radoicic, 1974

Type species - Acronorilla radoicici Praturlon, 1964

Diagnosis (after Praturlon and Radoicic, 1974):

Cylindrical, non-articulated thallus with verticils of long primary ramifications; clusters of short button-shaped secondaries occur at the distal end.
Remarks:

An akrophorous character of primary ramifications was considered as fundamental in the original diagnosis by Praetorion (1964). In the emendation, however, this character was no longer mentioned, and a presence of button-shaped secondaries in clusters was included as an important character. Characters of primary and secondary ramifications have permitted clear distinction of the genus from other Desmoclad. In the present study. In *Triplopora*, the primaries are perpendicular to the axis whereas in *Acropora* they are oblique.

First reported from Lower Cretaceous of Italy (Praetorion, 1964), the genus has been described also from Thanetian of Pyrenees (Segonzac, 1976) and Palaeocene of Central Iran (Deloffre et al., 1977). From India there is no previous record.

*Acropora* *anceps* Segonzac, 1976
(P1. 20, fig. 1; P1. 39, fig. 1-2)

1976-*Acropora* *anceps* Segonzac (p. 127-129, pl. 1, fig. 1; pl. 2, fig. 6-7, pl. 3, fig. 13)


Description:

A few longitudinal sections of fragments with up to 6
verticals of primary branches, and an oblique longitudinal section as also an oblique transversal section showing secondary branches of this form has been observed in the collection, clearly showing the following characters.

Cylindrical, non-articulated thallus with long, strongly inclined, 'akrophorous' primary ramifications and button-shaped secondary ramifications (cf. Segonzac, 1976, Pl. 3, fig. 13; Peloffre et al., 1977, Pl. 5, fig. 2). Primary branches show a little proximal swelling perhaps as a mark of their sinuosity. Primaries in regular, widely spaced verticals.

Measurements

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td>upto 0.875 mm</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>0.525–0.562 mm</td>
</tr>
<tr>
<td>d</td>
<td></td>
<td>0.275 mm</td>
</tr>
<tr>
<td>h</td>
<td></td>
<td>0.1375–0.150 mm</td>
</tr>
<tr>
<td>w</td>
<td></td>
<td>20°</td>
</tr>
<tr>
<td>l</td>
<td></td>
<td>0.135–0.150, 0.250? mm</td>
</tr>
<tr>
<td>R1</td>
<td></td>
<td>0.162–0.175 mm x 0.031–0.037 mm</td>
</tr>
<tr>
<td>R2</td>
<td></td>
<td>? x 0.037 mm</td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td>50°</td>
</tr>
</tbody>
</table>

Remarks:

The description and measurements clearly suggest the
similarity of our form with *Acrocoralla schnepf* Ségonzac, 1976, originally described from the Palaeocene (Thanetian) of Pyrenees. Our dimensional data mostly lie within and close to the lower limits of the ranges given by Ségonzac which are as follows:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>1.2–3.5 mm</td>
</tr>
<tr>
<td>p</td>
<td>0.50–0.963 mm</td>
</tr>
<tr>
<td>d</td>
<td>0.250–0.510 mm</td>
</tr>
<tr>
<td>h</td>
<td>0.120–0.166 mm</td>
</tr>
<tr>
<td>w</td>
<td>12–20</td>
</tr>
</tbody>
</table>

Thickness of calcareous wall: 0.115–0.250 mm

Primary ramification: 0.150–0.300 mm x 0.028–0.052 mm

Secondary ramification: 0.132 x 0.030 mm,
                      0.116 mm x 0.050 mm,
                      0.090 mm x 0.035 mm

Cortex: 0.080–0.115 mm

Cysts: 0.050 mm

Angle of inclination: 35–50°

The full range of variations of dimensional values are not known in the present case because of the paucity of good specimens.

*A. occidentalis* Johnson, 1965 (in Johnson and Raska, 1965, p. 78–79, pl. 7, figs. 1–2) is much thinner than
A. angana with the verticils more widely spaced; a thickening at the base of the primaries was, however, noticed in the former also. According to Segonzac (1976), A. occidentalis is to A. angana what Cyrtina elliotii Beckmann and Beckmann, 1966 is to C. johnsoni Remak, 1957 i.e. the former is a 'minor' form of the latter.

Genus Diascoliadella Pia, 1936 amend.
Bassouillet et al., 1978

Type species D. savitriae Pia, 1936

Diagnosis (after Bassouillet et al., 1978):

"Cylindrical to club shaped thallus. The skeleton may be linked in successive rings. The primary branches are short, globular or widened. At the distal end of the primary branches, there are at least 4 secondary phloophorus branches having a shape similar to the primary branches. Possible adaptation of slightly modified primary branches into fertile ampulla".

Remarks:

Diascoliadella resembles the genus Trinocladius. But the latter is distinguished in having ramifications of the third order also. Further, in Trinocladius, the secondary ramifications are much smaller than the primary ramifications.
**Dissoclædia** as a genus is known since long in the Palaeocene and the Lower Eocene from South India (Rao and Pia, 1936), North India (Rao, 1952, Verma, 1955), Egypt and Madagascar (Massieux, 1966), Iraq, Arab, the Middle East (Elliott, 1955, 1968) and Pyrenees (Segonsac, 1979). However, *D. undulata* (Reineri), 1922 (Elliott, 1978) favours removal of this form to *Trinoclæna* because of morphological considerations and *D. cretica* Ott, 1965 are known respectively from the Campanian-Turonian of Libya, Iraq, Arab, Portugal and France (vide Bessouillet et al., 1978) and Biofacies of Ithaca and Creta in Greece (Ott, 1965, 1967).

The genus is an important constituent of the back-reef Lower Eocene limestone beds of the present area.

**Dissoclædia elliottii** n.sp.

*(Pl. 40, fig. 9-10)*

**Derivation of Name:**

In honour of Dr. C.F. Elliott, British Museum (Natural History), London.

**Description:**

Rather thick-walled, cylindrical thallus with some
clubbing at the apex and somewhat irregular surface. Axial cavity about as wide as the calcareous wall. An occasional lateral constriction of the cavity seems to correspond to a thickening of the calcareous wall.

Primary ramifications short; circular in cross section, and distally widening and dividing into two (or three?) secondaries. They may be somewhat alternating in successive whorls. Secondaries narrower and longer than the primaries, similarly shaped and widening to varying degrees. Those at the apex of the thallus are slenderer and almost uniformly tubular.

Measurements

| L (incomplete) | 0.760 mm |
| D | 0.175–0.4375 mm |
| d | 0.112–0.150 mm |
| d/D | about 26 to 40% |
| h | 0.060–0.0675 mm |
| w | ? |
| p (distal) | 0.037–0.050 mm |
| w' | 2–3, or 4? |
| p' | 0.025–0.037 mm |

Remarks:

The species is distinctly different from *Dissocladella*.
sp. A and sp. B described in this chapter in being a much larger form and in having secondaries narrower than the primaries. This distinguishes it also from D. lunata Segonzac, 1979. D. savitrina Pia, 1936 has a distinctly annular-elongate thallus with much larger dimensions and globular to bluntly ovoid sporangial swellings. D. desertica Elliott, 1969 has larger axial cavity (d = 0.23–0.29 mm), more spaced verticils (h = 0.13 mm) and larger number of secondary ramification in a verticil (w =12). D. undulata (Raineri) has different measurements and 6 secondaries in clusters. D. cretica Ott, 1965 has a very massive ovoid-elongate skeleton with wide axial cavity, relatively thin calcified cortical layer and near-spherical primaries.

The illustrations of Dissoscadella lakadongensis given by Pal and Dutta (1979) do not fit the description of it provided by them. The specimen shown in Plate 3, figure 23 is a Clypeina (most probably Clypeina elliottii) and not a Dissoscadella. In their illustrations 'Holotype Pl. 1, fig. 11' is missing; further Plate 3, figure 22 (magnification?) cannot be transverse section of a Dissoscadella, but is a subaxial section of a dasyclad whose affinity is not doubtlessly obvious from the illustration.
Associations and Microfacies:

Biomicrite, with *Purcicorella diplopora*, *Ovalites*,
*Corallina*, *Dictyoplex biseriatus*, *Lithoporella unia*.
Other biota are *Alveolina*, *Discorvelina*, *Lockhartia*,
miliolids, textularids and fragments of corals.

Type Level:

Zone IV, Ualatoch Limestone Member, Lower Eocene.

Type Locality:

Section D, Lumshnong, Jaintia Hills, Meghalaya, India.

Figured Specimens:

Holotype, Slide CASGMP 1870
Paratype, Slide CASGMP 1870.

*Discorvelina sp. A*  
(Pl. 40, fig. 5-6)

Description:

Narrow tubular thallus; only longitudinal sections have been definitely recognised. The straight axial cavity is mostly up to about one and a half times as wide as the calcareous wall. Perpendicularly arranged short primary ramifications, circular in longitudinal sections, divide
into two divergent secondaries reaching to the periphery of the calcareous wall. Secondaries have relatively long stalks and appear to be larger in diameter than the primaries.

<table>
<thead>
<tr>
<th>Measurements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>0.332-1.0046 mm</td>
</tr>
<tr>
<td>D</td>
<td>0.150-0.187 mm</td>
</tr>
<tr>
<td>d</td>
<td>0.050-0.087 mm</td>
</tr>
<tr>
<td>Thickness of calc. wall</td>
<td>0.045-0.075 mm</td>
</tr>
<tr>
<td>h</td>
<td>0.050 mm</td>
</tr>
<tr>
<td>w</td>
<td>?</td>
</tr>
<tr>
<td>l</td>
<td>0.133-0.180 mm</td>
</tr>
<tr>
<td>Diam. $R_1$</td>
<td>0.024-0.030 mm</td>
</tr>
<tr>
<td>Diam. $R_2$</td>
<td>0.030-0.034 mm</td>
</tr>
</tbody>
</table>

Remarks: In thin sections this form may be confused with *Sarfatiella ronzonzi* n. sp. when the dilatations of secondaries or their corresponding cavities alone are visible. The form recalls *Launata* Segonzac, 1970 described from the Thanetian of Esperaza, in that in both $R_2$ is greater than $R_1$. However, the latter species has otherwise bigger dimensional values. The present form does not compare with any other known species of *Sarcoclidella*.
and is most probably a new species. But as the transversal and tangential sections are not known a specific nomenclature is not proposed here.

Associations and Microfacies:

Siosparites and bionicrosparites with *Discocladella* sp. B, *Ovulites margaritula*, *Ovulites corelleti*, *Halimeda prasmonilia*, *H. sp.*, *Serpatiella senonceni* n. sp. and *Furcogramella dioecora*. Other biotas include *Alveolina*, *Hammulites*, *Gephyroebolites*, *miliolids* and echinoid spines.

Horizon and Locality:

Zone IV, Unalasch Limestone Member, Sections A and B, Lunshnoqg vicinity.

Figured Specimens:

Slide, CASMP 1912.

*Discocladella* sp. B

(Pl. 40, fig. 7-8)

Description:

Several transversal and oblique transversal sections and a longitudinal tangential section of a *Discocladella* with somewhat larger measurements than those of B. sp. A have
been noticed. The primaries are short and distally swollen; they communicate with the axial siphon through a short basal stalk. Secondaries are also short-stalked and similarly widening towards the exterior. They are, however, bigger than the primaries. In the sections available there seem to be about four secondaries per primary ramification.

Measurements

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>0.216-0.415 mm</td>
</tr>
<tr>
<td>d</td>
<td>0.080-0.160 mm</td>
</tr>
<tr>
<td>Thickness of calc. wall</td>
<td>0.066-0.120 mm</td>
</tr>
<tr>
<td>Diam. R₁</td>
<td>0.032-0.050 mm</td>
</tr>
<tr>
<td>Diam. R₂</td>
<td>0.048-0.066 mm</td>
</tr>
<tr>
<td>h</td>
<td>0.045 mm (average)</td>
</tr>
<tr>
<td>w</td>
<td>6-9</td>
</tr>
<tr>
<td>w'</td>
<td>47</td>
</tr>
</tbody>
</table>

Remarks:

This form is differentiated from Diplorhynchia sp. A by its larger dimensional values. But Diplorhynchia sp. B too has R₂ diameter greater than R₁ diameter as in the cases of Diplorhynchia sp. A and Diplorhynchia lunata Segonzac, 1979. These species are, therefore, probably of the same lineage.

The open nomenclature used for the present form
reflects non-availability of all the requisite data from the available specimens.

Associations and Microfacies:

Biosparites and bionicrosparites with *Dissocladella* sp. A, *Saratiatella moenconrei* n.sp., *Surunorella diminora*, *Tarformella* cf. *T. lenticularis*, *Oryolites trisperitula*, *Q. morallati*, *Q. elongata* and *Halmada praemonilis*. Other biotas include *Alveolina*, *Hammulites*, *Lockhartia*, *Spaertorohitollites*, *miliolidae*, and *textularidae*, *echinoid spines* and *gastropods*.

Horizon and Locality:

Zone IV, Umatlah Limestone Member, Lowerocene, Sections A, C, G and I, Lushnong vicinety.

Figured Specimens:

*Slide, CASGMF 1911.*

Genus *Trinocladium* Raineri, 1922

Type species *Trinocladium triolitans* Raineri, 1922

Diagnosis:

Cylindrical or slender club-shaped thallus shows successive verticils of radial ramifications. Each outwardly
widening ramification gives rise to several similar-shaped secondaries and these in turn to bunches of tertiarics. The ramifications may or may not be alternating in position from verticil to verticil.

Remarks:

Commonly primary ramifications alone appear to be present in the lower verticiles. Secondary ramifications appear a little higher as the plant grows. In the upper portions primary, secondary, and also tertiary ramifications i.e., 3 orders of ramifications develop. The swollen ends of the primaries probably act as "sporangia".

In comparison to Dissocledella, the secondaries in Trinocladus are much narrower than the primaries. Further, Dissocledella has only two orders of ramifications whereas Trinocladus has three, and the closely related genus Thyraconoralla is characterised by four orders of ramifications. According to Pia (1936 in Rao & Pia, 1936) Trinocladus is an intermediate typical genus between Dissocledella and Thyraconoralla.

The genus is known from Oxfordian to Paleocene.

Trinocladus sp.

(pl. 39, fig. 4)

Description:

Two fragments of longitudinal sections have been
observed in the present collections. They, however, clearly show a few primary and secondary ramifications and obscurely suggest also the presence of incomplete tertiaries in clusters at the worn edges of the calcareous walls. The primaries are swollen towards their distal ends. The other ramifications also appear to be more or less similarly shaped, but the successively higher orders of branches are progressively thinner. A maximum of three secondaries per primary and probably also three tertiaries per secondary are discernible in the plane of the sections.

Measurements

Thickness of calc. wall : 0.212, 0.225 mm
Length of $R_1$ : 0.112, 0.112 mm
Diam. (max.) of $R_1$ : 0.037-0.050, 0.062 mm
Vertical distance between successive $R_1$'s : 0.068, 0.075 mm
(measured between centres)
Length of $R_2$ : 0.075-0.097, 0.075 mm
Diam. (max.) of $R_2$ : 0.012, 0.013 mm
$w'$ : 3, or more?
Length of $R_3$ : - , 0.037 mm
$w''$ : 3, or more?
Remarks:

The limited data available seem to suggest a similarity of the present form with *Trinocladius tripolitanus* Raineri, 1922 described from the Cenomanian/Turonian in Europe, Northeast Africa and the Middle East. *T. perplexus* Elliott, 1955 has a thinner calcareous wall, although the number of secondaries and tertaries in it are close to that in the present case. *T. pinarensis* Keijzer, 1945 is a much larger species. The specimen used by Pal and Dutta (1979, pl.3, fig. 19) to illustrate the holotype of *T. unlaetophrensis* proposed by them is, according to the present author, a *Halimeda* as can be obviously seen from the nature of progressive ramification of the cortical filaments.

From *Disocladius undulata* (Raineri), the present form is different in possessing markedly thinner *R₉'s* compared to the *R₁'s*.

However, because of the fragmentary nature of the specimens and because the d/D and other values are unknown, a specific name is not being proposed here for the specimens.

Associations and Microfacies:

C. priera. Associated Foraminifera include Miscellanea miscella, Discocyclina, Nummulites, Operculina and miliolids.

Horizon and Locality:

Subzone IIb, Lakadong Limestone Member, Upper Paleocene, Section C.

Figured Specimen:

Slide, CASME 1986.

Genus: *Sarfatiella* Conrad and Peybernes, 1973

Type species: *Sarfatiella dubari* Conrad and Peybernes, 1973

Diagnosis (after Conrad and Peybernes, 1973):

Cylindrical axial siphon bearing tight whorls of spherical or sub-spherical ampullae; the ampullae communicate with the axial siphon simply by a peduncle or a proximal narrowing, of which the length is shorter than that of the corresponding ampulla. The calcareous envelop is made up of a simple layer of sparry calcite.

Remarks:

The shape of the fertile ramification as also the lack of sterile ramifications characterize the genus. Bassoulet et al. (1978), how ever, think that the genus
may be a junior synonym of *Hollosporella* Pia (1930). On the other hand, according to Segonzac (1979) who has described *Serfatiella* (?) in the Thanetian of Esperanza, the important question, in this connection, is to know whether the cavities (ampullae) in the calcified wall are joined to the central axis or not. In case of *Serfatiella* the ampullae communicate with central axis through a tiny peduncle. Illustrations of Hollosporella by Pia (1930, pl. 4, figs. 1–6) as also those by Pia, Rao and Rao (1937, pl. 1, figs. 10–11) do not show this proximal communication.

Meghalayan specimens, when appropriately cut, show clearly a tiny peduncle linking the ampullae with the axial cavity (pl. 20, figs. 4: pl. 40, fig. 13) and have, therefore, been assigned to *Serfatiella* here. Further, Segonzac's (1979) comparison of *Hollosporella* and *Serfatiella* shows that ampullae in the former are much larger than those in the latter.

The genus has been known from Bajocian of Corbières, Bajocian–Bathonian of Algeria, Dogger of Central Nepal and Sardinia (vide Massouliet et al., 1978), and Thanetian of Esperanza (Segonzac, 1979). This report extends its range into the Lower Eocene.
Sarfatiella segonzaci n. sp.

(Pl. 20, fig. 4; Pl. 40, fig. 11-13)

Derivation of Name:

In honour of Mme G. Segonzac, Toulouse, France.

Description:

A number of thin thalli conforming to the definition of Sarfatiella have been noticed in the present petrographic thin sections. The longitudinal sections show a cylindrical thallus bearing relatively large closely packed spherical to subspherical ampullae, each with a very short and narrow peduncle, perpendicular or nearly perpendicular to the axial siphon. A tangential section shows only the cavities belonging to the fertile ampullae. Also, a probable badly recrystallized transversal section suggests 5 to 7 ampullae in a whorl. The calcareous envelop is a simple layer of sparry calcite.

Measurements of the present form are presented here together with those for comparable forms given by Fia (1930), Lemoine and Sarfati (1963), Conrad and Peybernès (1973) and Segonzac (1979).
<table>
<thead>
<tr>
<th>Piia</th>
<th>Lemoine</th>
<th>Conrad &amp; Peybernes</th>
<th>Segonzac</th>
<th>Des</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holomycoralla</td>
<td>Dasycladaceae</td>
<td>S. duboeri</td>
<td>Saratrella?</td>
<td>S. segonzaci</td>
</tr>
<tr>
<td>L</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.451-1.080</td>
</tr>
<tr>
<td>T</td>
<td>0.400</td>
<td>0.320</td>
<td>0.170-0.332</td>
<td>0.187-0.212</td>
</tr>
<tr>
<td>d</td>
<td>0.150</td>
<td>0.100</td>
<td>0.060-0.140</td>
<td>(0.040-0.050)</td>
</tr>
<tr>
<td>h</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.062-0.075</td>
</tr>
<tr>
<td>Thickness of calc. wall</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(0.050-0.066)</td>
</tr>
<tr>
<td>l</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.123-0.170</td>
</tr>
<tr>
<td>Diam. of ampullae</td>
<td>0.120</td>
<td>0.070-0.080</td>
<td>0.090-0.120</td>
<td>0.032-0.080</td>
</tr>
<tr>
<td>Thick. of ampullae</td>
<td>0.010</td>
<td>-</td>
<td>Calcified</td>
<td>not calcified</td>
</tr>
<tr>
<td>w</td>
<td>10</td>
<td>7-8</td>
<td>8-9</td>
<td>7 probably</td>
</tr>
<tr>
<td>Peduncle</td>
<td>-</td>
<td>0.160-0.290</td>
<td>-</td>
<td>5, or 6-7?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.160-0.230</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: On the basis of the shape of the fertile branches,
the presence of a tiny peduncle and the lack of sterile branches in the specimens, the specimens have been assigned a place within the genus *Saratiella*. E. *Cubertsen* Conrad and *Peybernes* has larger measurements and *Segonzac’s Saratiella* has similarity with the present form only in respect of the size of the 'sporangia'.

**Associations and Microfacies:**

- Biosparites and bimicrites with *Ovulites margaritula*,
- *Lenticularia*, articulated corallines and occasionally *Archaeolithothamnium*. Foraminiferal association includes *Alveolina*, *miliolids*, *Cortorbitolites* and *Lockhartia*.
- Echinoid spines have also been noticed.

**Type Level:**

- Zone IV, Umatlah Limestone Member, Lower Eocene.

**Type Locality:**

- Section C, Lumshnong vicinity, Jaintia Hills, Meghalaya, India.

**Figured Specimens:**

- Holotype, Slide CASGMF 1912
- Paratype 1,2, Slides CASGMF 1993, 1913 respectively.
Genus—**Triploporcella** Steinmann, 1880 amend.
Bassoulet *et al.*, 1978

Type species—**Triploporcella freasi** Steinmann, 1880

**Diagnosis** (after Bassoulet *et al.*, 1978):

“Club-shaped relatively large sized desyclad with wide primary branches arranged in whorls. These primary branches are perpendicular or very gently inclined on the wall of the axial cavity. Generally they are very numerous, partly cladosporous and approximately the same diameter is kept throughout their whole length. They give rise to secondary branches of which only the basal portion seems to be generally observed.”

**Remarks**:

In the present collection a single fragment of a thallus shows characters of ramifications conforming to the above definition. The sporangial bodies, however, are not observable.

The genus has so far been known from the Jurassic to the Cenomanian-Turonian. The present occurrence extends its range to the Upper Paleocene.

**Triploporcella sp.**

(Pl. 21, fig. 21; Pl. 39, fig. 13)
Description:

Cylindrical segment with one whorl preserved. Primary ramifications elongated—cylindrical, somewhat widening towards the cortex and with a very little stalk. They are very gently inclined on the wall of the axial cavity. Thin, similarly shaped secondary ramifications, probably 6 in number per primary ramification, are seen at the periphery of the fossil—only the basal part is preserved.

Measurements

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L (incomplete)</td>
<td>1.433 mm</td>
</tr>
<tr>
<td>D (max.)</td>
<td>1.392 mm</td>
</tr>
<tr>
<td>d (very small)</td>
<td>0.253 mm</td>
</tr>
<tr>
<td>R₁</td>
<td>0.365 mm x 0.080 mm</td>
</tr>
<tr>
<td>R₂</td>
<td>0.166 mm x 0.050 mm</td>
</tr>
</tbody>
</table>

Remarks:

With the lone specimen giving only incomplete biometric data a comparison with previously described species is difficult. However, the absence of constrictions between R₁ and R₂ excludes the possibility of its being a *Montanocrassa* Sokac' and Nikler, 1973. The secondary ramifications show a basal thickening in the latter, whereas in the present form they do not.
**Triplonorella merciana** Preturion, 1964 known from the Malm up to the Albian in Italy, Yugoslavia, Tunisia and Lebanon, resembles the present form in the phase of the primary ramifications but the former is a larger species.

**Associations and Microfacies:**

Biosparite with *Clypeina eliotti*, *Hamulussella* cf. *U. endalavensis*, *Acroporrella encaps*, *Metactenioidolithon* (*) *rothalevensis* n. sp., *Distichoplax biserialis* and rare *Ovulites morolitii*. Other associated biotas include Foraminifera such as *Miscellancea miscella*, *Discocyclina*, *Spencerina* and rare echinoid spines.

**Horizon and Locality:**

Subzone IIR, Lakadong Limestone Member, Upper Palaeocene, Section G, Lamshnong vicinity.

**Figured Specimen:**

Slide, CASMF 1909.

Genus-**Angionorella** Masse, Conrad and Radolicic, 1973

Type species-**Angionorella fournzae** Masse, Conrad and Radolicic, 1973
Diagnosis (after Masse, Conrad and Radovic, 1973 in Sassaoulet et al., 1978):

"Cylindrical thallus made up of an alternation of whorls of sterile, simple and numerous branches, and whorls of a small number of inflated fertile blisters. Sterile branches bend upwards, at the periphery of the thallus and completely envelop the upper fertile whorl. Calcification of the sterile branches differs from the one of the fertile blisters."

Remarks:

The character of the sterile ramifications of the genus distinguishes it from *Heteronorella*. Moreover, the calcification of the sterile ramifications and fertile ampullae are of two different kinds in case of the former.

The genus is so far known only by its type species belonging to the marine Barremian sediments of SE and SW France.

*Angioporella* (? sp.

(P1. 39, fig. 12)

Description:

A solitary, reworked, micrite-filled fragmentary specimen showing two probable "sporangia" on rather long
and narrow stalks; stalks oblique to the main stem. However, no trace of the sterile whorls and no communication of the "sporangia" with the main stem could be noticed, probably because of the smallness and fragmentary nature of the specimen.

Measurements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>0.996 mm</td>
</tr>
<tr>
<td>d</td>
<td>0.282 mm</td>
</tr>
<tr>
<td>Thickness of calc. wall</td>
<td>0.332 mm</td>
</tr>
<tr>
<td>h</td>
<td>0.580 mm</td>
</tr>
<tr>
<td>&quot;Sporangia&quot; (without stalk)</td>
<td>0.280 mm x 0.133 mm</td>
</tr>
<tr>
<td>Length of stalk</td>
<td>0.170 mm</td>
</tr>
</tbody>
</table>

Remarks:

The specimen has been doubtfully assigned to the genus *Anisoporella*. Recognition of some secondary ramifications (R2) at the end of the "sporangia" would probably suggest it to be a *Prestackella* instead. Or, the section, as it is preserved now, may even be visualized simply as the remnant of two hat-shaped whorls - the lower one much worn peripherally - of a *Clypeina* or a *Humulosella*, both of which are present in the corresponding microfacies.
Associations and Microfacies:
Same as in case of *Triplocorella* sp.

Horizone and Locality:
Subzone IIc, Lakadong Limestone Member, Upper Palaeocene, Section G, Lunshnong vicinity.

Figured Specimen:
Slide, CASGMF 1909.

Subfamily BORNETELLOIDEAE Vallet, 1960

Genus *Termocorella* Munier-Chalmas, 1877

Type species *Termocorella lillovacina* Munier-Chalmas in Constantin, 1929

Diagnosis (after Elliott, 1969):
Small, disc-like, lenticular or spherical calcareous bodies with numerous tiny subdermal spherical cavities.

Remarks:
Munier-Chalmas proposed *Termocorella* as a 'catch-all' genus for isolated sporangia of Desycladaceae. The Morellets (1913) redefined it to represent isolated sporangia of bornetelloid algae.
Formerly circular discs (as seen in sections) with spore chambers around the outer margin have been assigned to Acicularia and the generic name Terranella has been applied only to entire fossils from washed samples. But in recent years Haslov (1956, 1960) began using the name also for sections of sporangia seen in petrographic thin sections. He has since been followed by others (e.g. Johnson and Kaska, 1965; Beckmann and Beckmann, 1966; Preturion, 1966) in the recognition of Terranella from thin sections alone.

Terranella is known from Jurassic to Lower Eocene,

Terranella sp.

(Pl. 38, fig. 6-7)

Description:

Numerous random sections suggesting subspherical to thick flattened, irregularly rounded solid calcareous bodies with globular spore cavities regularly distributed within it. Depending upon whether a section is axial, subaxial or tangential, its outline as well as the arrangement of the spore cavities in it vary. Thus, sections may be circular, subcircular etc. and spore cavities may be arranged around the periphery or also in the inner parts of them.
Measurements

Maximum diameter of the calcareous bodies: 0.35 mm (commonly 0.19-0.31 mm; but value as small as 0.15 mm has also been found in a tangential section)

Diameter of spore cavities: (0.025-0.031-0.037-0.05) mm

No. of spore cavities in section: 12 to 15; up to 187 (arranged around the periphery of sections)

9-10 (arranged all over the tangential sections about 0.19 mm in diam.)

Remarks:

Kajzer (1945) and Praturion (1966) pointed out that the specific identification of Terquemella specimens is difficult and may even be hazardous sometimes. An open nomenclature has, therefore, been used in case of the Meghaleyan forms described here.

While the dimensional values for the present form suggest similarity with Terquemella globularis Mott, 1956, the shape is less spherical in the former than that in the latter.

Acicularia sp. A associated with the present form shows a spicule and perfectly circular transversal sections of spicules.
Associations and Microfacies:

Oolitic biosparites with *Acicularia* sp. A
*Zurconoxolella diplonora*, *Marinella lugooni*, and *Ovulites moraliati*. Other biotas are lacking in the microfacies except rare miliolids and testulanids.

Horizon and Locality:

Zone III, Lakadong Limestone Member, Upper Paleocene;
Section D, Lauoshong.

Figured Specimens:

Slide, CASMIF 1069.


(Pl. 38, fig. 8-9)

p. 231-232, pl. 2, fig. 15-25
cf. 1966-*Terquemella* sp. indet B -Beckmann and Beckmann.
p. 39, pl. 12, figs. 174-175.

Description:

Rather thick, distinctly lenticular calcareous bodies with globular spore cavities arranged around the peripheral part.
Measurements

Maximum diameter of calc. bodies : 0.375–0.4375 mm
Thickness : 0.225–0.300 mm
Diameter of spore cavities : 0.0375–0.0625 mm
Number of spore cavities : 14–15.

Remarks:

The lenticular form and comparable measurements indicate similarity of the present form with Terquemella lenticularis from the Danian (Inter-Trappan) of South India. Also, the form somewhat resembles T. sp. indet. B described by Beckmann and Beckmann from the Cretaceous of Cuba. The present form, however, is slightly bigger than both of them.

Associations and Microfacies:

Bioseparites and biomicroparites with Oomulites carnositula, O. murali, Haliopoda praemonilla, Furcophyse diplomata, Seriaticella aenonaci n. sp., Diacocidella sp. B and Solenoporaceae(?). Associated Foraminifera include rare Alveolina, Operorbitolites, miliolids and textularides. Rare echinoid spines are also seen.

Horizon and Locality:

Zone IV, Ulidctoh Limestone Member, Lower Eocene.
Section G, Larnemong vicinity.

Figured Specimens:

Slide CASOMF 1911.

Subfamily NEOCHERIDOIDEAE Valet, 1969

Genus—Neomeria Lamouroux, 1816 emend. Deloffre, 1970

Type species—Neomeria dumetora Lamouroux, 1816.

Diagnosis (after Deloffre, 1970)

"Egg-shaped calcareous capsules (sporangia) grouped in fragments of rings or whole rings; these rings are either independent or tightly soldered together forming an uninterrupted tube. Primary branches are weakly calcified and rarely preserved. In each ring, either two whorls of p radial channels situated on both sides of one whorl of p sporangial capsules or only one lower whorl with 2p radial channels under a whorl of p sporangial capsules. In each case, each pear-shaped sporangium corresponds to a pair of radial channels (or secondary sterile branches) which are not necessarily situated in the same level as the sporangium they surround."

Remarks:

The extant genus Neomeria was founded on recent species.
There are differences of opinion regarding the concept of some fossil forms, particularly those from the Cretaceous and Early Cenozoic. Deloffre, in the above amendment, included the closely related genus Larvaria Defrance, 1822 on grounds of morphological considerations. Segonzac (1971, p.9), however, writes that if we do not use the tangential sections, it is indeed very difficult to distinguish Larvaria from Neomeria in the same manner as we can not distinguish certain Neomeria from Cymopolia on the basis of cortical structure alone, which is perfectly identical in the two cases. In the study of the very homogenous Neomerioidea the tangential sections are of the highest importance.

Neomeria dates from the Lower Cretaceous (?Hauterivian).

Neomeria cf. N. plagensia Deloffre, 1970
(pl. 39, fig. 15-17)

cf. 1970-Neomeria plagensia Deloffre, p.356-357, pl. 2, fig.1-8;
pl. 3, fig. 1-8

cf. 1977-Neomeria plagensia Deloffre, Poignant and Teherani,
p. 41, pl. 5, fig. 3-7

cf. 1979-Neomeria plagensia Deloffre-Segonzac, p. 445

Description:

A fragmentary longitudinal section, a few fragmentary oblique longitudinal sections and a fragmentary tangential
section have been noticed in the collection. Thallus cylindrical, with a large axial cavity and a relatively thin calcareous wall. Rather thin indistinct secondary ramifications; pear-shaped to avoid sections of sporangial chambers are seen to possess a short connecting extension towards the side of the central cavity.

**Measurements**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum length (incomplete)</td>
<td>1.225 mm</td>
</tr>
<tr>
<td>External diameter</td>
<td>0.525–0.65 mm</td>
</tr>
<tr>
<td>Internal diameter</td>
<td>0.312–0.350 mm</td>
</tr>
<tr>
<td>d/D</td>
<td>54–66.8%</td>
</tr>
<tr>
<td>Thickness of calc. sheath</td>
<td>0.075–0.175 mm</td>
</tr>
<tr>
<td>No. of sporangial chambers per verticil</td>
<td>about 20</td>
</tr>
<tr>
<td>Sporangial cavities</td>
<td>0.038–0.125 mm x 0.063–0.113 mm</td>
</tr>
<tr>
<td>Distance between centres of sp. cavities</td>
<td>0.100–0.131 mm</td>
</tr>
<tr>
<td>Length of secondary ramifications</td>
<td>12.125 mm</td>
</tr>
<tr>
<td>Distance between secondary ram.</td>
<td>0.094–0.100 mm</td>
</tr>
</tbody>
</table>

**Remarks:**

From a comparison of the present form with other described species of *Hecmania* it has been found to compare best with *H. pleuromelas* Deloffre. d/D values and number
and shape of sporangial chambers are nearly identical in both the cases. But most of the other values for the present specimens are close to the lower limits of the ranges for Deloffre's specimens. *Eosmeria* sp. illustrated by Pal and Dutta (1979, pl. 3, fig. 17) could be only a fragment of the transverse section of a whorl of a *Clypeina*.

**Associations and Microfacies**

Bioesperites with *Clypeina elliotii*, *Acroporella ancaena*, *Parasulcina cf. H. sechalerensis*, rare *Ovulites moralloti*, *Dictichopleres bispinolus*, *Matongolithon (?) sechalerensis* n.sp., and *Anconopora (?)* sp., *Triploporella* sp. and Foraminifera like *Micrallinae micella*, *Lockhartia*, *Alveolina*, some miliolids and textularides. Also, Bioesperites with *Ovulites moralloti*, and rare fragments of *Lithothamnium*, associated with *discocyclina*, *grosulites*, *Alveolina*, miliolids and textularides. Or, bioesperites with abundant articulated corallines and fragments of crustose corallines, miliolids, textularides, small *Discocyclina* and other small Foraminifera.

**Horizon and Locality**

Subzone IIC, Lakehong Limestone Member, Upper Palaeocene, Section C, Lumshong vicinity; Zone IV, Ulladcah Limestone Member, Lower Eocene, Sections A and G, Lumshong vicinity.
Stratigraphic and Geographic Distribution:

Sarmatian of SW France (Deloffre, 1976)
Paleocene of Central Iran (Deloffre et al., 1977)

Figured Specimens:

Slides CASGMP 1879, 1908.

Sub Family UNCERTAIN

Genus—Furcororalla Pic, 1918

Type species—Furcororalla diplonora Pic, 1918

Diagnosis (after Elliott, 1969):

"Cylindrical dasyclad tube with successive verticils of horizontal, paired, straight, radially divergent branches; each pair of branches commences at a single opening on the interior; bifurcation occurs almost at once and the two divergent secondaries extend to the exterior."

Remarks:

Calcification is confined to the primaries and bases of the divergent secondaries near the main stem-cell, and there is no evidence of the sporangia. The genus is still an incerta sedis within the Dasycladaceae (Elliott, 1978).

Furcororalla is known from the Paleocene and Eocene.
of the Middle East (Pfender, 1940; Elliott, 1956,1960,1968; Massieux, 1966) and Central and Southern Europe (Pie, 1913; Praturlon, 1966).

*Furcophylla diplopora* Pie, 1913

(P1. 21: fig. 1 | Pl. 40, fig. 1-4)

1913-*Furcophylla diplopora* Pie, p. 209, pl. 1, fig. 1-2, text-fig. 46

1940-*Furcophylla diplopora* Pie-Pfender, p. 242

1956-*Furcophylla diplopora* Pie-Elliott, p. 332, pl. 2, figs. 5, 6

1960-*Furcophylla diplopora* Pie-Elliott, p. 225

1966-*Furcophylla diplopora* Pie-Massieux, p. 121, figs. 4, pl. 4, figs. 8, 9

1968-*Furcophylla diplopora* Pie-Elliott, p. 49, pl. 11, fig. 7-9.

Description:

Long, straight, hollow, cylindrical tubes, calcification not reaching the central cell. Primary ramifications regularly disposed in numerous verticils and perpendicularly traversing the calcareous wall and enlarging towards the exterior. They are about 9-11 in number per verticils. In vertical sections a succession of regularly arranged straight, coarse, 'waisted', outwardly enlarging canals are seen, whereas in transverse sections short primaries are seen to divide abruptly into two diverging secondaries. In some oblique vertical sections, along with larger primary pores coupled smaller secondary
pores are also seen. Primary pores appear to widen transversely before bifurcating into progressively diverging secondary pores.

Measurements

Length (incomplete) : 1.240–2.950 mm
External diameter : 0.300–0.688 mm
Diameter of axial cavity : 0.130 mm
Thickness of calcareous wall : (0.063)0.088–0.166 mm
D/D : 32–62% (50–56% most common)
No. of verticils : about 11 per mm of tube length

Distance between verticils (measured between centres of successive verticils) : (0.032)0.063–0.125 (0.137) mm
No. of primary ramifications per verticil : 8–11
Proximal pores : 0.035–0.055 mm
Distal pores : 0.050–0.090 mm (0.060 mm av.)

Remarks :

In most cases the Meghalayan specimens reach a larger size than Pin's type material from the Austrian Middle Eocene, and Pfender's (1940) Egyptian and Syrian Middle Eocene forms. For example, the external diameter in the latter two cases are only 0.26–0.34 mm and 0.35–0.45 mm respectively.
But the Meghalayan form agrees well with Elliott's (1968) Palaeocene-Lower Eocene Iraqi material which attains a diameter of up to 0.6 mm.

The figured specimens of Pal and Dutta (1979) do not fit the description of *Peronporilla diplopora* Pia. If, for example, certain circular indentations on the inner surface of the calcareous wall in the specimen shown in their Plate 4, Figure 26 mark positions of perpendicularly cut erect medullary filaments, its place among the *Halimeda* is affirmed.

**Associations and Microfacies:**

Biosparites, Biomicrosparites or rarely biomicrites, mainly with *Sculptus arenicola*, *S. coralli*, *S. alienata*, *Halimeda porphyridiia*, *Biomicrospora sp. A*, *B. sp. B* and other biota listed under these species.

**Horizon and Locality:**

Rarely found in Zone III, Lakadong Limestone Member, Upper Palaeocene, Section D, Lamphangyi more common in Zone IV, Umaksoh Limestone Member, Lower Eocene, Sections A, C, D, F, G, H and I, Lamphangyi and vicinity.

**Stratigraphic and Geographic Distribution:**

*Palaeocene-Lower Eocene of the Middle East* (Elliott, 1955, 1960, 1968)
Palaeocene-Lower Eocene of Italy (Praturlon, 1966)
Middle Eocene of Egypt and Syria (Pfender, 1940; Massieux, 1966)
Middle Eocene of Austria (Pia, 1918).

Figured Specimens:


Genus—**Hamulusella** Elliott, 1978

Type species—**Hamulusella medalenensis** Elliott, 1978

Diagnosis (after Elliott, 1978):

“Calcified truncated-cone-shaped serial segments, the distal ends wider; each with about twelve primary branches showing a short proximal portion below connection with the stem-cell and a longer distal portion above it; branches opening to apertures at the distal edge”.

Remarks:

In general appearance this new little dasyycladacean reminds one of a *Clypeina*. But the presence of 'hook-like' primaries in it is distinctive.

This Tethyan alga was described by Elliott from the Palaeocene of northeastern Iraq and western Iran.
Hemulussella cf. H. medallanensis Elliott, 1978

(cf. 20, figs. 2-3; Pl. 39, figs. 9-11)

cf. 1978-Hemulussella medallanensis Elliott, p. 687-691, pl. 73, fig. 1-4

Description:

Uniserial thallus; two conjoined segments in two specimens, and five conjoined segments in another specimen; specimens show aspects similar to Clypeina elliottii Beckmann and Beckmann described in this chapter. But the presence of 'hook-like' primaries appear to distinguish it from a Clypeina.

Measurements

Height of segments

Diameter at the top of verticils

Diameter at the base of verticils

d

v

Diameter $R_1$ distal

Diameter $R_1$ proximal

Length $R_1$

: 0.400 mm ; 0.375 mm ; 0.500 mm
: 0.625 mm ; 0.500 mm ; 1.000 mm
: 0.375 mm ; 0.250 mm ; 0.500 mm
: 0.262 mm ; 0.187 mm ; -
: - ; - ; 12-16?
: - ; - ; 0.062 mm ; 0.100 mm
: - ; - ; 0.062-0.075 mm
: - ; - ; 0.375 mm ; 0.437 mm.
Remarks:

The described specimens are placed in *Hemulisella* because of the general character of the thallus and the special character of the primaries. The incompletely known dimensional values fall within the known ranges of variations in *H. endalavensis* Elliott.

Associations and Microfacies:

Biosparites with abundant *Distichocladus biseriatus*, rare *Metagoniolithon (?) mochalesensis* n. sp., rare *Ovulites*, common *Clypeina elliotii*, *Acrocoralla anceps*, *Triplocoralla* sp., *Angiopora (?)* sp. Foraminifera such as *Miscellaneous miscella*, *Lockhartia* cf. *L. bainsei*, *Discocyclina*, *Sperrculina* and rare *Hemulisella* constitute the important faunal association.

Horizon and Locality:

Subzone IIc, Lakadong Limestone Member, Upper Palaeocene, Section E and G, Lushnong vicinity.

Stratigraphic and Geographic Distribution:

Palaeocene of Kurdistan (Elliott, 1973)

Figured Specimens:

Slides, CASGME 1976, 1909.
Family ACETABULARIACEAE Valet, 1969

Alternating fertile and sterile whorls or only one whorl of fertile laterals are produced in its genera which are regarded as more advanced than those of the Dasyycladaceae. The Tertiary period witnessed a great development of the extant family Acetabulariaceae.

Subfamily ACETABULARIOIDEAE Reuss, 1842

Genus Clypeina Michelin, 1945 emend. Razak, 1957 emend Bassouillet et al., 1978
Type species: Clypeina granuliporella Michelin, 1945

Diagnosis:

Thallus cylindrical, non-articulated. Fossil fragments are mostly flat saucer, bowl-, or funnel-shaped calcareous discs. Fertile phloiophorous primary ramifications in regular widely spaced verticils are inclined to the principal axis and proximally fused together by calcareous envelop. They communicate with the axial cavity by a single pore. Sterile ramifications are not generally seen in fossils.

Remarks:

Whereas much variations are now known in the different species of Clypeina. Plate II, figure 1 shows a generalized structure and appearance of the plant (after Morellest and Morellest, 1918). The alternate pinching and swelling of the
thallus due to widely spaced verticils of the primaries lead to the disintegration of the plants into "bowl-shaped" discs as mentioned above.

Species of this genus seem to have existed from the Permian (cf. Elliott, 1960) and according to Kemptner (1958) no direct descendants of Clypeina are known after the Eocene.

**Clypeina elliotti** Beckmann and Beckmann, 1966

(Pl. 39, figs. 5-8)

1966-*Clypeina elliotti* Beckmann and Beckmann, p. 37, pl. 11, fig. 155-59

1976-*Clypeina elliotti* Beckmann and Beckmann-SEGONZAC, p. 130-13, pl. 2, fig. 8; pl. 3, fig. 11.

Description:

Several longitudinal sections show fertile verticils, isolated or in groups of up to 4 or 5 in succession. Certain tangential or oblique longitudinal cuts show pores belonging to 14/15 verticils. Transverse circular cuts with rounded sections of sporangial chambers (fertile ramifications) and oblique transversal sections with ray-like arrangement of tubular fertile primary ramifications are also present. In other random sections various combinations of these views are seen. Stipe cylindrical. The fertile verticils are more or less funnel-shaped. In the specimens from
Meghalaya, the ramifications, below their insertion on the axial cavity are straight and envelop the shaft towards the summit of the verticiles where they splay out towards the exterior with upturned rims. One or two sections suggest stellate outline at the distal periphery due to slight external vertical fluting of the segments.

Measurements

Max. length of fragments : upto 2.250 mm

Diam. at the top of verticiles : 0.150-0.750 mm

Diam. at the base of verticiles : 0.216-0.336 mm

Diam. of the central cavity : 0.080-0.250 (0.275) mm

Thickness of calc. wall : 0.063-0.100 (0.125) mm

Distance between successive verticiles
at the centre : 0.216-0.336 (0.350) mm
at the sides : 0.375-0.463 mm

No. of fertile ramifications per verticil : 12-20 ?

Diam. of ramifications at the distal end : 0.050-0.100 mm
(T.s. of ramifications 0.030-0.088 mm)

Length of ramifications : 70.250-0.380 + mm.

Remarks:

The general morphology and the measurements are similar
to those of *Glycoina elliotti* described from the Palaeocene-
Lower Eocene of Cuba (Beckmann and Beckmann, 1966) and
Upper Thanetian of Pyrenees (Segonzac, 1976). Though plate
11, figure 155-159 of Beckmann and Beckmann do not very
clearly show the form of the ramifications, the canals
described in their text (p. 37) indicates that the rami-
fications are partially enveloping the shaft of the axial
cavity. In this respect the present specimens very closely
resemble those figured by Segonzac (pl. 2, fig. 3). Also
the sporangial discs are less stellate than those of Cuba
and similar to those of Pyrenees. Compared to the present
form, *C. sehni* Varma, 1952, described from the Denian of
South India has more strongly inclined rays and greater
spacing between verticils in axial sections, and *C. saccata-
Sia* Sioffre and Radoicic, 1978, described from the Palaeocene
of Yugoslavia has different values for the various parameters
and different form and arrangement of the branches.

Associations and Microfacies:

Same as, for example, in the cases of *Acrorhalla ancore*
and *Hemulamella cf. H. pedalanesis* described in the foregoing
pages.

Horizon and Locality:

Subzone IIC, Lekadong Limestone Member, Upper
Palaeocene: Sections D, E, F and G, Lunshong and vicinity.

Stratigraphic and Geographic Distribution:

Palaeocene/Lower Eocene of Cuba (Beckmann and Beckmann, 1966)

Upper Thanetian of Pyrenees (Segonzac, 1976).

Figured Specimens:

Slides, CASGIF 1876, 1908, 1909.

Genus - Acicularia d'Archiac, 1843

Type species - Acicularia schenckii (Mobius) Solms-Laubach, 1895

Diagnosis (after Elliott, 1968):

Calcereous spicules, typically elongate-cuneiform, circular or flattened in cross sections, set peripherally with small spherical cavities.

Remarks:

The individual calcareous rays or spicules as commonly found in the fossil specimens are fragments of the inverted umbrella-shaped apical discs borne on the slender central stem of the delicate plant. Recently Segonzac (1970) proposed a classification of the spicules of Acicularia into several groups, but she indicated no particular systematic value of these groups.
Acicularia, an extant genus, is distinguished from the closely related extant genus Actinostylophora in having a very important calcification which permits its preservation through geological times — Lower Lias to Recent.

Acicularia sp. A

(Pl. 38, fig. 10-12)

Description:

One acicular longitudinal-tangential section of a spicule enlarged at one end and two circular transversal sections of spicules show the loci of numerous spherical sporangial cavities uniformly arranged around the calcified surface.

Measurements

Length of spicule (incomplete) : 0.875 mm
Max. diam. of spicules : 0.350-0.425 mm
Diam. of sporangial cavities : 0.025-0.050 mm
No. of sporangial cavities in transverse sections : 12-15

Remarks:

With the meagre data available it did not seem wise to attempt a specific determination.
Associations and Microfacies:

Bioseparites with recrystallized oolites and with Teromella sp., fragments of Marinella awasomi, Ovulites
morelleti and rare Furcoporella diplomora. Foraminifersa
seen in the microfacies are rare Operculina and miliolids.

Horizon and Locality:

Zone III, Lakadong Limestone Member, Upper Palaeocene,
Section D, Lumshnong.

Figured Specimens:

Slide, CASGHF 1869.

Acicularia sp. B
(Pl. 38, fig. 13-14)

Description:

Only a few oblique sections of spicules are seen; circular spore cavities arranged around the periphery of
the sections.

Measurements:

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of sections</td>
<td>0.500-0.575 mm</td>
</tr>
<tr>
<td>Thickness of spicules</td>
<td>0.189-0.237 mm</td>
</tr>
<tr>
<td>Diam. of spore cavities</td>
<td>0.025-0.050 mm</td>
</tr>
</tbody>
</table>
Remarks:

While most of the dimensional values are similar to those of A. sp. A., the present form can be distinguished from the former thinner spicules.

Associations and Microfacies:

Biomicrскопarites with *Purcoraella diplocora*, *Oxitis*, *Halimeda praemontuia* and *Solenoporaesae* (?). Foraminifera such as *Discomyclina*, *Lockhartia*, *Alveolina*, miliolids, as well as gastropods and echinoid spines are also associated in the microfacies.

Horizon and Locality:

Zone IV, Umatlah Limestone Member, Lowerocene, Sections C and D, Lamahpong and vicinity.

Figured Specimen:

Slide, CASMP 1997.