FOSSIL ALGA FROM THE MIOCENE OF CUTCH, INDIA

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ABSTRACT

Coralline algae from the Khari Series of Cutch are recorded. Five species (two of them new) belonging to four genera (one new) are described. These are *Lithophyllum* aff. *L. kladosum* Johnson, *Mesophyllum commune* Lemoine, *Aethesolithon problematicum* Johnson, *A. cutchensis* sp. nov. and *Archaeoporolithon miocenicum* gen. et sp. nov. The algal evidence suggests a Lower Miocene age for the formation containing them.

INTRODUCTION

IN course of micropaleontological investigation of the Tertiary rocks of Cutch, a rich algal flora was discovered. Cutch area may be regarded as the type area for the marine Tertiary rocks of India as this is the only area where a complete sequence from Paleocene to Pliocene is found (Biswas, 1965, 1970). Systematic study of the fossil algae in these rocks will be of value in the stratigraphic and paleoecological interpretation of these formations.

In the present paper, the coralline algae are reported from the Khari series (L. Miocene) exposed near Waior (23°25′:68°41′) in south-western Cutch.

STRATIGRAPHY, LITHOLOGY AND SAMPLING LOCALITIES

Lower Tertiary rocks are exposed along 'nala' sections in and around the village Waior and Cheropodi. The formation serving as the host of the algal forms, constitute a distinct lithological unit. This is named as 'Ochreous marls'. It is underlain by a compact white limestone containing foraminifers like *Spiroclypeus ranjanae* and *Lepidocyclina* (*Nephrolepidina*) sp. and is overlain by a 'yellowish brown marl' containing distinct Lower Miocene foraminifera like *Miogypsina dehartii, Austrotrillina howchini* associated with *Nephrolepidina* sp.

This Ochreous marl is variable in thickness, the maximum thickness being nearly 150 ft. It is brown in colour with inpersistent iron-stained bands. The rock is composed of fossil fragments of various sizes (mostly foraminifera, algal bodies and worm tubes), the cementing material being calcareous mud. Under the microscope the fragments constitute up to 60% of the rock. Besides, there are also angular grains of quartz (medium to fine sand-sized, poorly sorted and rounded). The ferruginous staining may be the result of strong oxidation under subaerial condition.

SYSTEMATIC DESCRIPTION

Phylum — RHODOPHYCOPHYTA
Order — CRYPTONEMIALES
Family — CORALLINACEAE
Subfamily — MELOBESIOIDEAE

Genus — Lithophyllum Philippi 1837

Lithophyllum aff. *L. kladosum* Johnson, 1954
Pl. 1, Figs. 1,2

L. kladosum Johnson, 1954, U.S.G.S. Prof. Paper 260-M, p. 539, Pl. 192, Figs. 1-8, 403-G, p. 21. L. cf. *kladosum* Johnson, Johnson, 1964, U.S.G.S. Prof. Paper 403-G, p. 21.

Description — Fragments of long slender branches showing well developed medullary hypothallus and marginal perithallus. Hypothallus formed of arched layers of cells, length 16-40 μ, width 12-20 μ. Perithallic cells nearly square or rectangular, length 16-20 μ, width 10-16 μ. Conceptacles of moderate size, diameter 280-320 μ, height 136-160 μ. Conceptacles show single aperture.

Remarks — The present materials closely resemble *L. kladosum* described by Johnson from the Lower Miocene of Bikini (Johnson, 1954) and Guam (Johnson, 1964). The dimensions of the cells and of the sporangia are well within the range observed in *L. kladosum*. However, the latter has, in general, somewhat longer hypothallic cells and a bit larger sporangia.

Figured Slide — C/05.

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Genus — *Mesophyllum* Lemoine, 1928

Mesophyllum commune Lemoine, 1939
Pl. 1, Figs. 3-4; Pl. 2, Fig. 5

M. commune Lemoine 1939, Mat. Carte geol. de l'Algerie, ser. 1, Paleont., no. 9, p. 86, Figs. 55-57.

M. commune Lemoine Johnson, 1964, U.S.G.S. Prof. Paper 403-G, p. 14-15, Pl. 2, Fig. 7.

Description — Thallus develops short, thick branches probably from basal crust. Branches composed of medullary hypothallus and marginal perithallial tissue showing pronounced growth zones, each zone formed of 6-8 layers of rectangular cells. The hypothallial cells are 16-24 μ long and 12 μ wide. The perithallial cells are squarish to rectangular, 12-16 μ×10-12 μ. Conceptacles numerous, 136-140-160 μ in height and 320-360-800 μ in diameter.

Remarks — The material from Cutch exactly fits the description of Lemoine (1939) for the type from the Miocene of Algeria. The sporangial diameters in the present material are sometimes larger than the type. The material described by Johnson (1964) from the Maemong Limestone Member (L. Miocene) of the Umatac Formation of Guam closely resembles the present material.

Figured Slide — CF/03, CF/05.

Genus — *Aethesolithon* Johnson, 1964

Aethesolithon problematicum Johnson, 1964
Pl. 2, Figs. 2-3

A. problematicum Johnson, 1964, U.S.G.S. Prof. Paper 403-G, p. 27-28, Pl. 1, Figs. 1-3.

Description — Plant starts as irregular crust with warty protuberances or small mammillae and develops branches. Branches are 5 cm or more in length and show well-developed medullary hypothallus and marginal perithallus. Thickness of medullary hypothallus 1200-1500 μ; strongly arched layers arranged in definite growth zones which in some specimens appear as vertically elongated hexagons; cells alternate in position in successive rows so that one cell fits between the points of those above and below. Usually the lowest layer in a zone contains largest cells, uppermost the smallest. In a given layer, cells also decrease in size from centre to margins. Cells are usually 40-56 ×20-40 μ.

Marginal perithalus of branches formed of very irregular layers, commonly 2 or 3 layers to a growth zone. Cells rounded to polygonal. Cells are 16-20 ×8-20 μ.

Conceptacles develop in outer layers of crusts and in perithallic tissue of branches, small and highly arched. Number of opening not very clear but arching suggests a single opening. Conceptacles are 160-200 μ in length and 96-112 μ in diameter.

Remarks — The present specimen shows essential similarity with *A. problematicum* Johnson from the Bonya Limestone (L. Miocene) of Guam. The tissue of the hypothallium and perithallium are essentially similar and the dimensions are within the range observed in *A. problematicum*. However, the hypothallic cells are, in general, short in the present material. *A. grandis* Johnson resembles the present material in general appearance and growth habit; it differs by having larger cells, longer and thicker branches, and larger conceptacles. *A. guatemalaensum* Johnson differs from the present material in having larger hypothallic cells and smaller sporangial conceptacles.

Figured Slide — CF/03.

Aethesolithon cutchensis sp. nov.
Pl. 2, Fig. 8; Pl. 3, Fig. 9

Diagnosis — Branches develop from a basal crust. Tissue irregular with lenses of cells. Branches with medullary hypothallus of large polygonal cells 16-40 μ×16-24 μ, cells largest at the bottom of each layer and progressively smaller upwards and laterally. Marginal perithallus of nearly rectangular cells, 16-32 ×12-24 μ, with lenses of larger polygonal cells 24-32 ×16-24 μ. Conceptacles arched, probably with a single aperture, height 160 μ and diameter 640 μ.

Description — Plant starts as irregular crust and then develops branches. Branches attain 3-4 mm in length with diameter of about 1200 μ. Thickness of medullary hypothallus 800-1000 μ. Strongly arched layers arranged in definite growth zones which appear like thick lenses, each zone with 3-5 layers of large polygonal cells which appear as vertically elongated hexagons. The lowest layer in a zone shows largest cells, and the uppermost the smallest. Thus the variation in size of cells in a zone from bottom upwards is as follows:

40×32 μ, 32×24 μ, 24×16 μ

Marginal perithallus of branches formed of very irregular layers, commonly 2 or 3 layers to a growth zone. Cells rectangular, 16-32×8-20 μ. Cells in lenses larger and polygonal, 24-32×16-24 μ. Conceptacles arched, 160 μ in height and 640 μ in diameter. Conceptacles probably open with a single aperture.

Remarks — This species closely resembles the genotype, *A. problematicum* Johnson, but differs from it in having smaller cells in the hypothallial tissue. Also, the conceptacles in the present species have larger diameter.

Figured Slides — C/03, C/04.

Genus — *Archaeoporolithon* gen. nov.

Genotype — *Archaeoporolithon miocenicum* sp. nov.

Generic Description — Plants crustose, mammillate, sometimes branching upward; basal hypothallus of curved rows of cells, perithallus of horizontal rows of cell; megacells occur in the perithallic tissue, in lenses up to 8 cells high, often extending as layers parallel to the substrate; conceptacle with a single aperture.

Comparison — The nature of the tissue and the conceptacles with single aperture place the alga under the tribe Lithophylleae. It differs from *Lithophyllum* primarily in the possession of thick lenticular groups of megacells in the perithallial tissues, a unique character that envisages the creation of new genus, *Archaeoporolithon*. Of the closely allied genera, the horizontal grouping of megacells distinguish *Archaeoporolithon* from *Goniolithon* in which they occur singly or in short vertical columns. In *Paraporolithon* the megacells occur in both horizontal and vertical clusters (Johnson, 1957, p. 233). The only other genus having horizontal grouping of megacells is *Porolithon*, known from Pleistocene to Recent, but the latter differs in the fact that the lenticular groups of megacells are only one cell high. Further, the multi-cell high lenses often extend with diminutive height as layers parallel to the substrate. Regarding phylogenetic relationship, Johnson (in Johnson & Adey, 1965, p. 12) noted that "*Porolithon* and *Goniolithon* appear to have developed from *Lithophyllum* during the Miocene". From the present study it appears that *Archaeoporolithon* evolved from *Lithophyllum* in Lower Miocene time and possibly it is ancestral to *Goniolithon*, *Paraporolithon* and *Porolithon*. The lineage may be represented as:

Archaeoporolithon miocenicum gen. et sp. nov.

Pl. 3 Figs. 10-11

Diagnosis — Plants crustose, branching upwards; basal hypothallus of curved rows of cells, perithallus of horizontal threads; megacells in the perithallic tissue, 3-5 cells high; megacells occur in lenses, often extending as layers parallel to the substrate; conceptacle with a single aperture.

Description — Plants crustose, often branching upwards. Crusts show basal hypothallus of curved rows of cells, 12-29 ×12-18 μ. Hypothallus is sometimes thin, the cells appearing as irregularly arranged. The perithallus with heterocytes. The perithallial cells are 16-32×18-24 μ. The megacells occur in lenses up to 5 cells high. These sometimes occur as layers parallel to the perithallial cell threads. Often the lenses extend with decreased height on either side parallel to the substrate.

Conceptacles are small with a single opening, usually 80-96 μ high and 272-280 μ in diameter.

Figured Slide — F/C/1; FC/2.

DISCUSSION

Of the 5 species described *L.* aff. *L. kladosum* Johnson is closely allied to *L. kladosum* described by Johnson from the Lower Miocene of Bikini (Johnson, 1954) and Guam (Johnson, 1964). *Mesophyllum commune* Lemoine is known from the Miocene of Algeria. More recently it was reported by Johnson (1964) from the Maemong Limestone Member (L. Miocene) of the Umatac Formation of Guam. *Aethesolithon* Johnson is so far known only from the Miocene. *A. problematicum* Johnson is known from

the Bonya Limestone (L. Miocene) of Guam. *A. cutchensis* sp. nov. is a new one but with clear affinities to the genotype. As for the new genus *Archaeoporolithon*, it evolved from *Lithophyllum* in L. Miocene and is ancestral to *Goniolithon*, *Paraporolithon* and *Porolithon*. All these suggest a Lower Miocene age for the 'Ochreous marls' where the absence of characteristic foraminifers prohibits an exact age determination.

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EXPLANATION OF PLATES

Plate 1

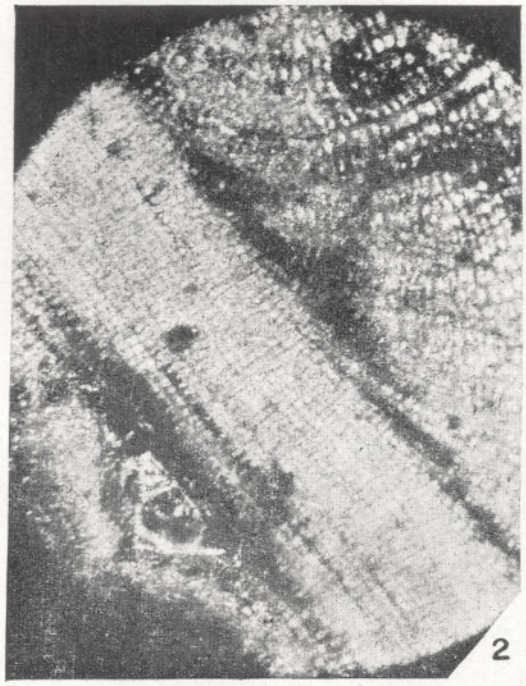
1-2. *Lithophyllum* aff. *L. kladosum* Johnson:
1. Showing part of the hypothallus, perithallus and conceptacle (150 ×).
2. Perithallial tissue and conceptacle with a single aperture (300 ×).
3-4. *Mesophyllum commune* Lemoine: 4. Enlargement showing the conceptacle (300 ×).

Plate 2

5. *Mesophyllum commune* Lemoine (75 ×).
6-7. *Aethesolithon problematicum* Johnson (70 ×).
8. *Aethesolithon cutchensis* sp. nov. (50 ×).

Plate 3

9. *Aethesolithon cutchense* sp. nov. (150 ×), enlargement showing the nature of the cells.
10-12. *Archaeoporolithon miocenicum* gen. et sp. nov.
10. Showing the hypothallus (h), perithallus (p) and the megacells in the perithallial tissue (70 ×).
11. Showing the arrangement of the megacells (150 ×).
12. Showing the arrangement of the megacells (100 ×).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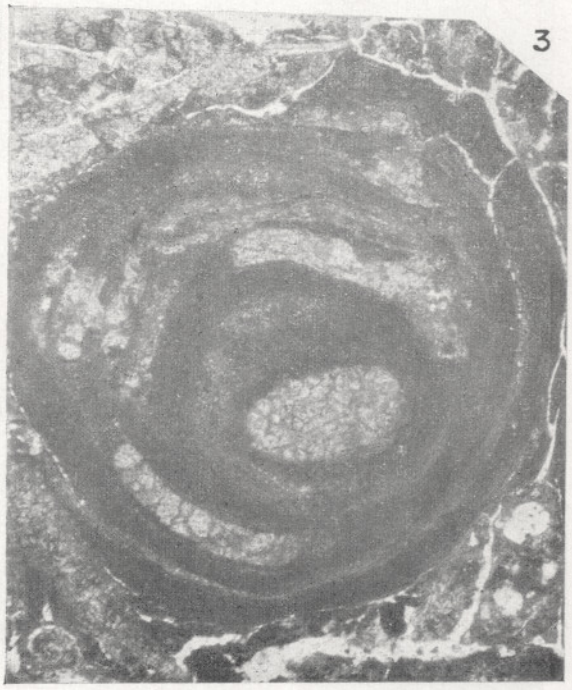
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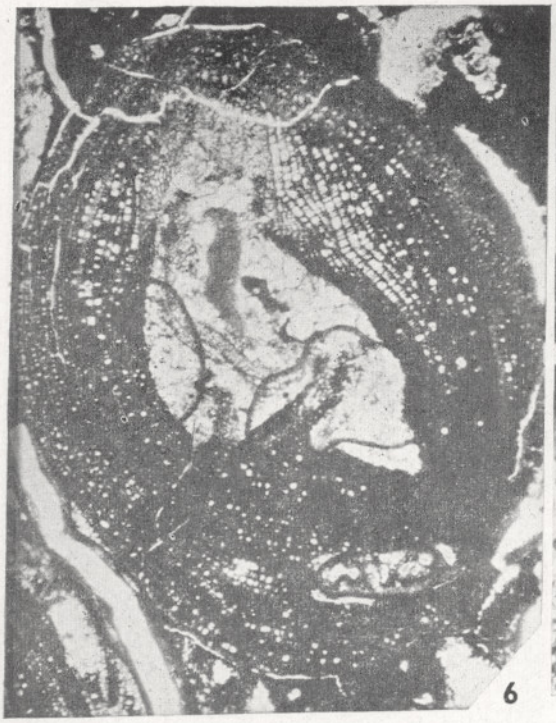
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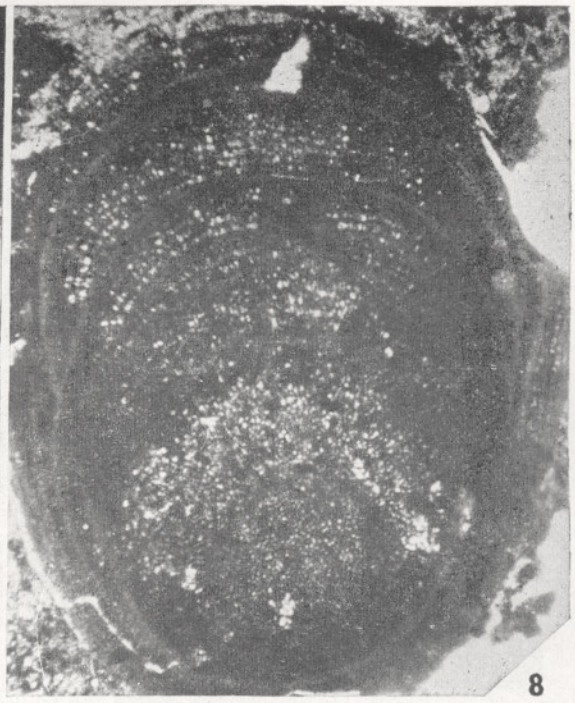
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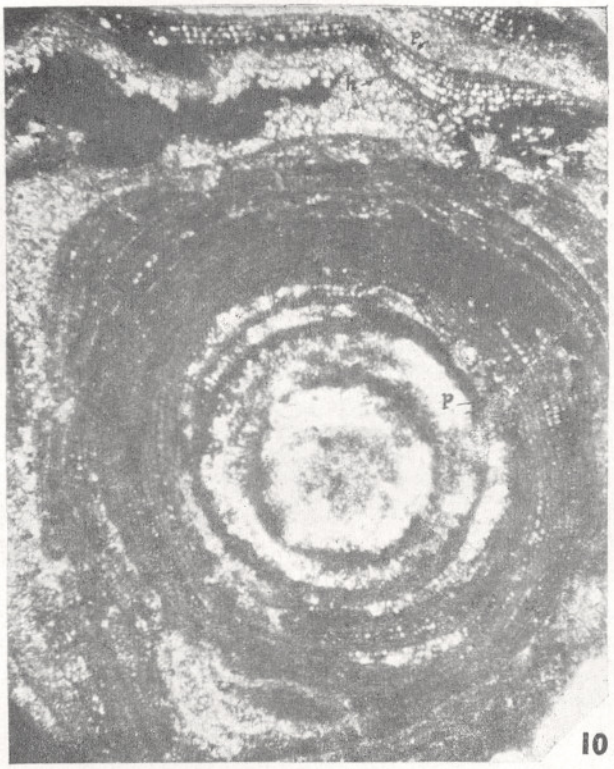
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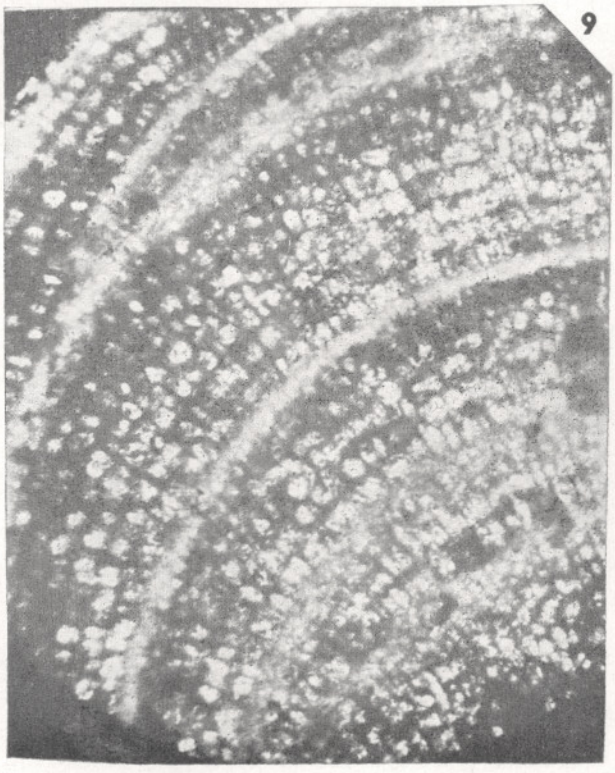
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