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Calcareous Green Algae from the Umlatdoh Limestone belonging to Shella Formation (Jaintia Group) of South Jaintia Hills, Meghalaya, India

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ABSTRACT

Sarma A & Ghosh AK 2007. Calcareous Green Algae from the Umlatdoh Limestone belonging to Shella Formation (Jaintia Group) of South Jaintia Hills, Meghalaya, India. The Palaeobotanist 56(1-3) : 21-28.

Thin section analysis of Umlatdoh Limestone belonging to Shella Formation exposed in the southern part of Jaintia Hills yielded well preserved calcareous algae. Detailed taxonomical analyses of the algal forms reveal the existence of udoteacean and halimedacean green algae that includes three species of the genus *Ovulites* Lamarck belonging to family Udoteaceae. One species of *Halimeda* Lamouroux belonging to family Halimedaceae also has been described in the present paper. Based on the algal assemblage along with sedimentological and micropalaentological observations interpretations on palaeoenvironment and palaeobathymetry have been made.

Key-words—Calcareous algae, Udoteaceae, Halimedaceae, Taxonomy, Palaeoenvironment, Umlatdoh Limestone, Shella Formation, Meghalaya, India.

भारत में मेघालय की दक्षिणी जैंतिया पर्वतश्रेणियों के शैल्ला शैलसमूह (जैंतिया समूह) से सम्बन्धित उम्लाटडोह चूनापत्थर से प्राप्त चूनेदार हरित शैवाल

अजंता शर्मा एवं अमित के. घोष

सारांश

जैंतिया पर्वतश्रेणियों के दक्षिणी भाग में अनावरित शैल्ला शैलसमूह से सम्बन्धित उम्लाटडोह चूनापत्थर के पतले खंड विश्लेषण से भली-भाँति परिरक्षित चूनेदार शैवाल मिली है। शैवाल प्रारुपों के विस्तृत वर्गिकीय विश्लेषण से यूडोटिएसियन व हैलीमेडेसियन हरित शैवाल की विद्यमानता प्रकट होती है जो यूडोशिएसी कुल से सम्बन्धित *ऑवुलाइट्स* वंश लैमार्क की तीन प्रजातियों को सन्निहित करती है। वर्तमान शोध-पत्र में हैलीमेडेसी कुल से सम्बन्धित *हैलीमेडा* लैमौरॉक्स की एक प्रजाति का भी वर्णन किया गया है। अवसादकीय व सूक्ष्मजीवाश्मकीय प्रेक्षणों सहित शैवाल समुच्चय के आधार पर पुरापर्यावरण और पुराअनुगभीर व्याख्याएं की गई हैं।

संकेत-शब्द—चूनेदार शैवाल, यूडोटिएसी, हैलीमेडेसी, वर्गिकी, पुरापर्यावरण, उम्लाटडोह चूनापत्थर, शैल्ला शैलसमूह, मेघालय, भारत।

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INTRODUCTION

FROM the Palaeogene sequence of East Khasi Hills of Meghalaya shelf some contributions on calcareous algae have been made by Rao (1943), Pal and Dutta (1979), Boruah and Dutta (2001), Misra *et al.* (2002), Ghosh (2003), Gogoi *et al.* (2003). However, till date there is only one record of calcareous algae from the Palaeogene carbonates exposed along the southern fringe of Meghalaya Plateau belonging to Shella Formation of Jaintia Group (Sarma & Ghosh, 2006). Samples for the present study were collected from the Umlatdoh Limestone belonging to Shella Formation (Jaintia Group) of South Jaintia Hills (23°40'-25°9'N and 92°20'- 92°35'E). From the three limestone units, i.e. Lakadong, Umlatdoh and Prang Limestone units of Shella Formation (Jaintia Group) Sarma and Ghosh (2006) recorded an assemblage of calcareous algae comprising coralline red algae belonging to families Sporolithaceae and Corallinaceae along with some green algal forms. Detailed taxonomic analysis of the green algal forms recovered from the Umlatdoh Limestone Unit has been done in the present paper.

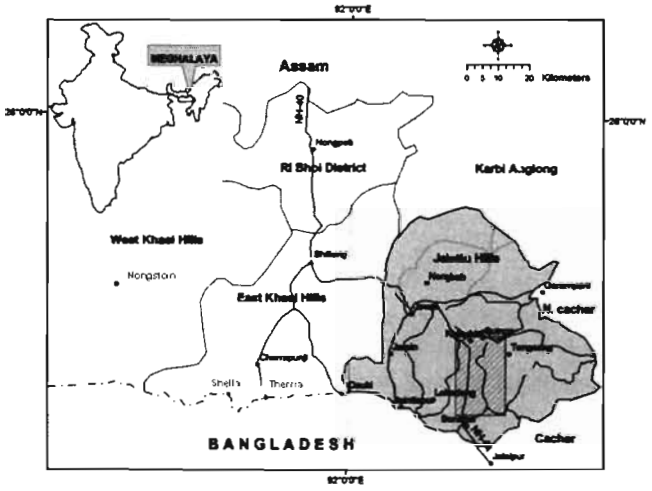

Fig. 1—Location map of the study area.

GEOLOGICAL SETTING

The Jaintia Group of South Jaintia Hills, Meghalaya is subdivided into two broad divisions, i.e. Shella Formation and Kopili Formation (Murthy *et al.*, 1976). The Shella Formation is the lowermost lithounit of the Jaintia Group. The Palaeogene carbonates exposed along the southern fringe of Meghalaya Plateau belong to the Shella Formation (Jaintia Group) and represented by three sandstone units in alternation with three limestone units, viz. Lakadong Limestone, Umlatdoh Limestone and Prang Limestone respectively in chronological order.

Stratigraphy and Lithology

In the study area (Fig. 1) the Umlatdoh Limestone, the middle member of the Shella Formation is conformably underlain by Lakadong Sandstone and overlain by Narpuh Sandstone (Fig. 2). This limestone is exposed extensively in the flanks of a low lying hill between Sutnga and Litang valleys, between 126-129 km posts, 124-125 km posts and around the 119 and 121km posts along NH-44 (Fig. 1). Thin beds of this limestone are also exposed around Musianglamare Village. In the study area, the limestone is distinctly wavy bedded (Pl. 1.1, 2), dark grey in colour and shows a variable thickness of 5-40 m (dip 6°-8° toward SE). The thickness of this Limestone unit decreases towards north up to Siropi Village. The limestone shows prolific occurrence of larger foraminifera as the framework grains. Thin argillaceous bands are found at places, which facilitates weathering. In general, the rocks are found to occupy topographically higher position in west of Sutnga and around Lumshnong. This limestone unit is well developed in Shella area of East Khasi Hills, but in West Khasi Hills and Garo Hills this unit does not crop out. The fossiliferous Umlatdoh Limestone unit can be correlated with the Kakdian Stage of Kachchh (Biswas, 1992). Thin section analysis of the samples collected from the study area (Figs 1-2; Pl. 1.1, 2) yielded green algal forms, which are systematically described as follows.

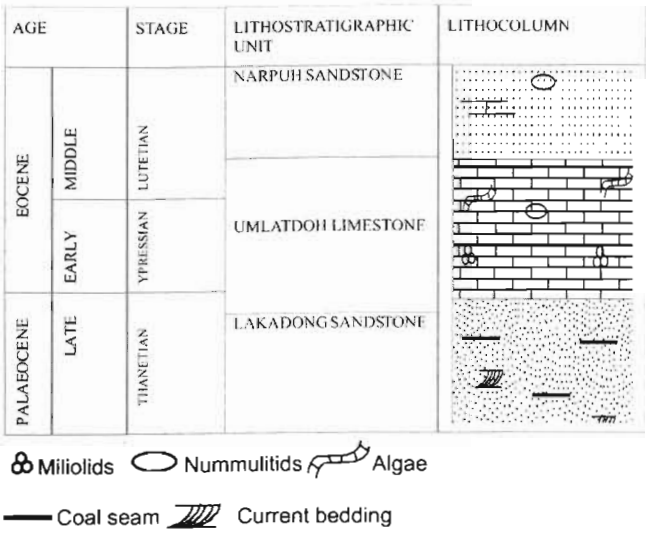

Fig. 2—Lithostratigraphy and Lithocolumn of the studied section (Figure not to scale).

SYSTEMATICS

The systematics of the order Bryopsidales followed here has been adopted from Silva *et al.* (1996), Littler and Littler (2000), Dragastan *et al.* (1997) and Hillis (1984, 1991, 2001).

Division—CHLOROPHYTA

Class—BRYOPSIDOPHYCEAE Round 1963

Order—BRYOPSIDALES Schaffiner 1922

Suborder—HALIMEDACEAE Hillis-Colinvaux 1984

Family—UDOTEACEAE Endlicher 1843 emend, Agadh 1887

Genus—OVULITES LAMARCK 1816

Remarks—Morphology of the fossil segments of the genus *Ovulites* Lamarck is very closely comparable to the Recent genus *Penicillus*. According to Elliot (1978) species of *Ovulites* known from Cretaceous to Eocene Period resemble the Recent species of *Penicillus* in their morphology and ecology. Segments of *Ovulites* were compared with the Recent species of the genus *Penicillus,* e.g. *P. arbuscula* Montagne and some other species of *Penicillus* (Massieux, 1966). Dragastan *et al.* (1997) opined that the species of *Ovulites* are morphologically very close and sometimes identical to those of the recent species of *Penicillus.*

Ovulites morelletti Elliot, 1955

(Pl. 1.3-5)

1955 *Ovulites morelletti* Elliot, p. 126-127, pl. 1, figs. 4-6.

1989 *Ovulites morelletti* Elliot-Kuss & Leppig, p. 323, figs 10 f, g.

1993 *Ovulites morelletti* Elliot-Kuss & Herbig, p. 277, pl. 5, figs 9, 12.

Description—Segments of thallus are club shaped, elongate, measuring 1.18 to 2.0 mm in diameter (D) and 0.65 to 0.72 mm in height (H). The segments are crossed by a hollow medullary space/cavity measuring 0.48 to 0.63 mm in diameter (d). Cortical region finely perforated with straight and radial pores measuring 15 to 20 μm.

Remarks—*Ovulites morelletti* described here are akin to those of Kuss and Herbig (1993) illustrated (pl. 5, figs 9, 12) from the Thanetian-Ilerdian limestones of NE Egypt. *Ovulites morelletti* has been frequently reported from the Palaeocene of Iraq (Elliot, 1955) and Egypt (Kuss & Leppig, 1989).

Ovulites arabica (Pfender, 1938) Massiex, 1966

(Pl. 1.6)

1938 *Griphoporella arabica*-Pfender in Moret, p. 69-70, figs 5-8.

1966 *Ovulites arabica* (Pfender) Massieux, p. 240-243, table 1.

1968 *Ovulites arabica* Pfender-Elliot, p. 51, pl. 12, figs 1, 3.

1989 *Ovulites arabica* (Pfender)-Massiux-Kuss & Leppig, p. 323, fig. 11a.

1991 *Ovulites arabica* (Pfender)-Herbig, p. 33, pl. 8, fig. 5.

1992 *Ovulites* sp.-Radoicic, pl. 8, fig. 10.

1993 *Ovulites arabica* (Pfender)-Kuss & Herbig, p. 277, pl. 5, figs 10, 13-14.

2002 *Ovulites arabica* (Pfender)-Dragastan & Soliman, p. 12, 14, pl. 4, figs 1-6.

2006 *Ovulites* sp.-Sarma & Ghosh, p. 1280, fig. 3k.

Description—Segments are club shaped to oval in outline, measuring 0.84 mm in diameter (D) and crossed by a large hollow medulla measuring 0.68 mm in diameter (d). Medullary hollow space is filled with microcrystalline and sparry calcite. Cortical wall is thinly calcified measuring 70 to 85 μm in width and perforated by perpendicularly crossed tiny primary cylindrical siphons/canals having more or less constant diameter of 18 to 20 μm. The cylindrical siphons/canals have a tendency to increase in diameter towards the distal end.

Remarks—Pfender (1938) first described *Ovulites arabica* (=*Griphoporella arabica*) from the Lower Eocene of Morocco. Later on, Pfender (1940) described the taxon from the Middle Eocene of Egypt and Syria. *O. arabica* has also been recorded from the Palaeocene of Egypt (Kuss & Leppig, 1989) and Morocco (Herbig, 1991). *O. arabica* has been noticed by Kuss and Herbig (1993) in the late Paleocene and early Eocene limestones of Egypt. Our specimens also resemble *O. arabica* described by Dragastan and Soliman (2002) from the early Eocene limestones of Drunka Formation, Egypt.

Ovulites sp.

(Pl. 1.7-8)

Description—Thallus segments are typically oval to pear shaped in outline. Outer diameter (D) of the segments measure 1.45 to 1.65 mm and height (H) of the segments are 0.8 to 1.15 mm. Segments are crossed by large medullary hollow measuring 1.25 to 1.35 mm in diameter (d) and 0.65 to 0.95 mm in height. The medullary hollow is infiltrated with a lower layer of micrite that settled down on the cavity floor and the upper part is filled with sparry calcite resembling geopetal structure. The cortical layer is considerably thick measuring 85 to 125 μm in width. The cortex is pierced by tiny primary canals/siphons having a more or less uniform width of 20 to 25 μm.

Comparison—Owing to somewhat oblique nature of the section, the presently described species is not confidently assignable to any known species of the genus *Ovulites* Lamarck. The taxon described here as *Ovulites* sp. is comparable to three known species of the genus *Ovulites*, viz., *O. arabica, O. margaritula* and *O. pyriformis*. The presently described form is comparable to *O. arabica* and *O. margaritula* by the oval shape of thallus segments. However, *O. arabica* is readily distinguishable from the present one in having thin cortical walls that is pierced by primary cylindrical siphons that possess a tendency to increase in diameter towards the distal end. On the other hand, unlike the present species tangential section of the cortical layer of *O. margaritula* shows a regular intercalary deposition of siphon rows (Dragastan & Soliman, 2002). Occasionally the pear shaped outline of the thallus segments of the presently described species is also comparable to *O. pyriformis*. But *O. pyriformis* differs from the other species of the genus *Ovulites* by its constant pear shape (Kuss & Herbig, 1993). Moreover,

PLATE 1 →

All the figured slides are stored in the Repository of the Department of Geological Sciences, Gauhati University, Guwahati, Assam, India.

1, 2. Wavy bedded limestone in the studied section.
3-5. *Ovulites morelletti* Elliot. 3. Slide No. AS/L2 5.1a. 4. Slide No. AS/ L2 5.1b. 5. Slide No. AS/ L2 5.1c.
6. *Ovulites arabica* (Pfender) Massiex, Slide No. AS/L2 5.1.
7-8. *Ovulites* sp., 7. Slide No. AS/L2 5.1d. 8. Slide No. AS/L2 5.1e.
9. *Halimeda* sp. Slide No. AS/L2 5.1f.

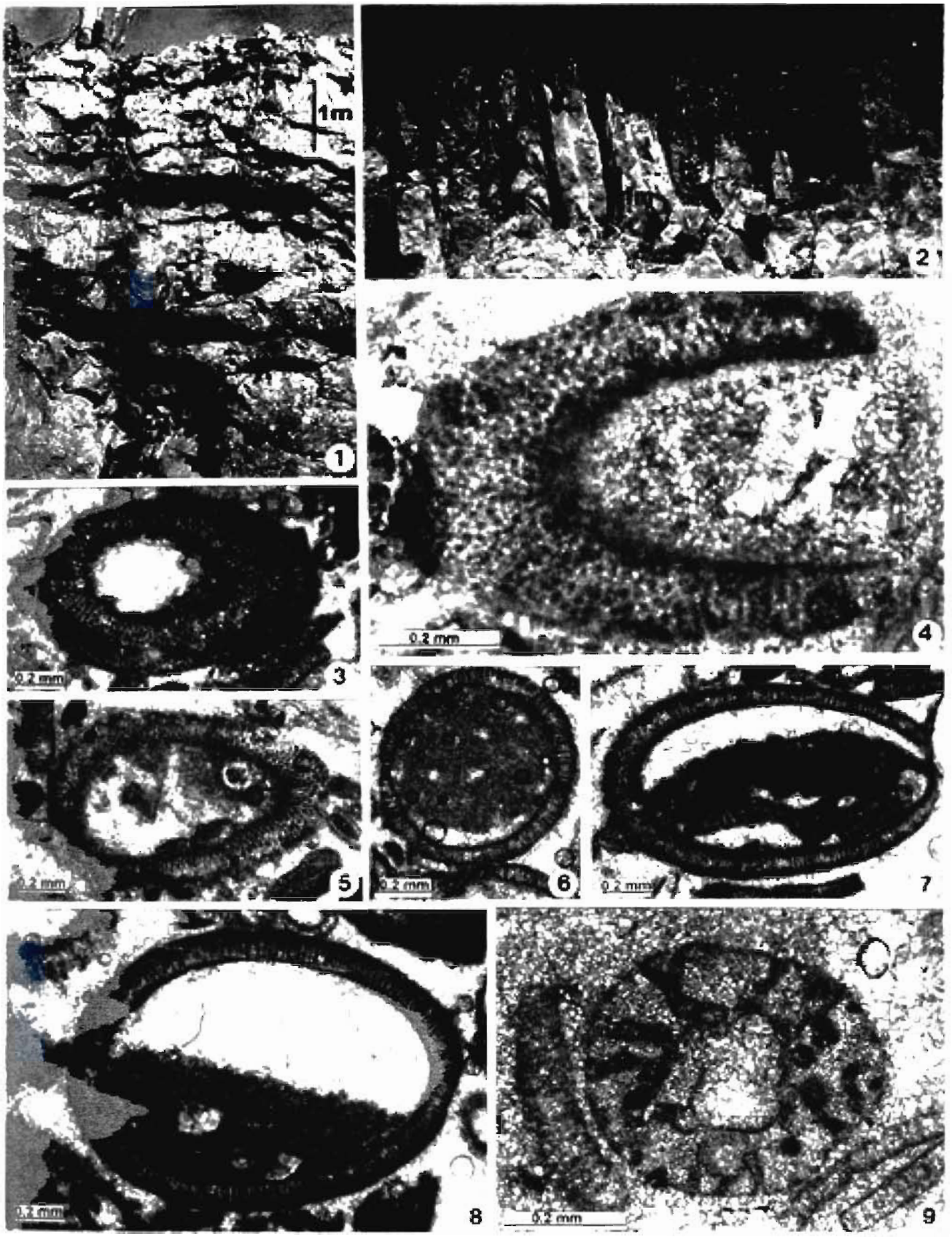

PLATE 1

in the presently described species the cortical layer is considerably thick in comparison to *O. pyriformis*.

Family—HALIMEDACEAE Link 1832

Genus—HALIMEDA Lamouroux 1812

Remarks—The most diversified genus of the family Halimedaceae is *Halimeda* with more than 33 species. The genus has a wide geological range extending from Mesozoic to Recent. In thin section analysis, fossil *Halimeda* segments exhibit random cuts through different regions of the thallus and it is indeed very difficult to distinguish the intraspecific variations. Recently, Dragastan *et al.* (2002) studied the segmental morphology of 33 Recent species of *Halimeda* based on the collections of Littler and Littler (housed in Smithsonian Institution, Washington, D.C.), Hillis (housed in Smithsonian, STRI, Panama) and Silva (housed in University Herbarium, University of California, Berkley). Dragastan *et al.* (2002) opined that large number of fossil species of *Halimeda* described earlier is based upon insufficient material and as a matter of fact they re-assessed and re-evaluated the validity of number of species of the genus *Halimeda*. Study of Dragastan *et al.* (2002) revealed wide variations of the segmental morphology of *Halimeda* species from base to apex. Dragastan and Soliman (2002) recognized three evolutionary lineages arose during Mesozoic and early Cenozoic, viz. *Halimeda cylindracea* lineage (Late Triassic-Recent), *Halimeda incrassate* lineage (Cretaceous-Recent), *Halimeda opuntia* lineage (Cretaceous/Palaeocene-Recent).

***Halimeda* sp.**

(Pl. 1.9)

Description—Transverse section of the segment of thallus more or less circular to spheroidal (measuring 0.5 mm in diameter) with slight lateral compression. Possibly the section is from the basal zone of the thallus. Siphons in the medullary region are ill preserved. Filaments/utricles in the cortical region are well developed, bifurcated, measuring 15 to 25 μm.

Remarks—Solitary transverse section of the segment recovered in the present study has been described as *Halimeda* sp., because based only the transverse section it can not be safely assigned to any particular species. However, the presently described form resembles *Halimeda cylindracea* Decaisne figured by Dragastan and Soliman (2002, text-fig. 15, no. 4). *Halimeda* segments of similar affinity were reported earlier by Pia (1932) from the Palaeocene of Morocco and Kuss and Herbig (1993) from the Thanetian-Ypresian of NE Egypt. Dragastan and Soliman (2002) included nineteen fossil species (known from late Cretaceous to Pleistocene) of *Halimeda* under the taxon *H. cylindracea* Decaisne and considered them synonymous.

SEDIMENTOLOGICAL AND MICROPALAEONTOLOGICAL OBSERVATION

Thin section analysis of Umlatdoh Limestone shows development of two different lithofacies. The lower part of the unit is dominated by grainstone that grades to packstone and wackestone towards the upper part. Top part of the limestone is arenaceous at places with development of thin sand beds showing current bedding. Presence of current bedding in the intervening sandstone, asymmetric ripples in limestone beds imply a shallow water regime during deposition of Umlatdoh Limestone. The fossil grains occur as framework and the larger fossil grains occur as floating grains in a sparry crystalline groundmass towards the lower half and towards the upper part the fossils are found to be bounded by microcrystalline calcite. The fossil interiors are filled with sparry crystalline as well as microcrystalline calcite. Towards the lower half green algae are dominant. The medullary portion of some *Ovulites* species is found to be filled in sequential episodes with a lower layer of mud (micrite) infiltrated and settled down on the floor of the cavity and the upper portion is filled by sparry calcite cement (Pl. 1.7, 8) resembling geopetal structure. The contact between the two calcite surfaces marks the bedding surface. The medullary portions of some *Ovulites* species are also

filled completely by micrite. Replacement by drusy sparite through solution and later precipitation is very common. Both oriented and random thin sections show that fossils present as framework grains in Umlatdoh Limestone and is represented by larger foraminifera and calcareous algae. Two distinct foraminiferal-algal associations have been recognized. The lower part is dominated by larger species of *Alveolina*, along with few smaller miliolids (Sarma, 2005, 2006) and calcareous green algae, viz. species of *Halimeda*, *Ovulites*, etc. The upper part shows preponderance of larger species of *Nummulites*. Larger foraminifers are represented by *Alveolina*, *Orbitolites*, *Lockhartia*, *Rotalia*, *Miliolids*, *Nummulites*, *Assilina*, *Discocyclina*, and agglutinated forms (Sarma, 2005, 2006). The algal assemblage includes both red and green algal forms (Sarma & Ghosh, 2006 and present work). The *Alveolina levis - Alveolina oblonga* association in the lower part indicate late Late Palaeocene to Early Eocene age. However, based on the foraminiferal assemblage it can be assumed that the upper part extends its age up to early Middle Eocene.

CONCLUSIONS

In the Umlatdoh Limestone member, the algal forms constitute only ~1% of the total allochems. Non-geniculate corallines, viz. Lithophylloid (*Lithophyllum* sp.), Melobesioid (*Lithothamnion* sp.) along with geniculate forms (*Corallina* sp.) have been recorded earlier by Sarma and Ghosh (2006) from this section. Present taxonomical analyses of the algal forms reveal the existence of udoteacean and halimedacean green algae that includes three species of the genus *Ovulites* Lamarck belonging to family Udoteaceae. One species of *Halimeda* Lamouroux belonging to family Halimedaceae also has been described in the present paper. However, paucity of algal forms is the characteristic feature of the Umlatdoh Limestone. The generic variation may be due to variation of salinity. Variable salinity condition of sea is also supported by the high diversity of foraminifers that possibly suppressed the growth of algae. Udoteacean and halimedacean green algae generally prefer shallow water depth. Therefore, it can be concluded that the Umlatdoh Limestone Unit was deposited under shallow, tropical environment with variable salinity condition.

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