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Recognition of algal rich facies from the Umlatdoh Limestone of Shella Formation, Jaintia Group, Meghalaya

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ABSTRACT

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The carbonate rocks of the Shella Formation (Middle Eocene) belonging to the Jaintia Group in the Jaintia Hills of Meghalaya are represented by two sandstone units in alternation with three limestone units, viz. Lakadong Limestone, Umlatdoh Limestone and Prang Limestone respectively in chronological order. Umlatdoh Limestone, the middle limestone unit of Shella Formation is conformably underlain by the Lakadong Sandstone and overlain by Narpuh Sandstone. Samples from the Umlatdoh Limestone were collected from the outcrop on the Jowai – Badarpur Road, about 1 km southwest of Lumshnong. Calcareous algae have been recovered from four samples and two distinct facies have been recognized. One of the facies is dominated by non-geniculate coralline red algae and benthic foraminifera. The non-geniculate corallines are represented by *Lithothamnion* and *Mesophyllum* (Family Hapalidiaceae), *Lithoporella* (Family Corallinaceae) and *Sporolithon* (Family Sporolithaceae). The other facies is rich in calcareous green algae along with benthic foraminifera. The green algal genera belong to families Dasycladaceae, Udoteaceae and Halimedaceae. Previously, a green algal assemblage was recorded from the Umlatdoh Limestone Member of Shella Formation exposed in the low lying hills between Sutnga and Litang valleys of Jaintia Hills. However, this is the first report on the occurrence of non-geniculate coralline red algae from the Umlatdoh Limestone Member of the Shella Formation. Based on the algal-foraminiferal assemblages, interpretation has been made on the palaeoenvironment and palaeobathymetry.

Key-words—Algal rich facies, Growth-form, Taphonomy, Umlatdoh Limestone, Shella Formation, Jaintia Hills, Middle Eocene.

जैंटिया समूह, मेघालय के शैल्ला शैलसमूह के उम्लटदोह चूनापत्थर से प्राप्त शैवाल प्रचुर संलक्षणियों की पहचान

सुमन सरकार, अमित के. घोष एवं माधव कुमार

सारांश

मेघालय की जैंटिया पहाड़ियों में जैंटिया समूह के शैल्ला शैलसमूह (मध्य आदिनूतन) की पैलियोजीन कार्बोनेट चट्टानें कालानुक्रमी क्रम में क्रमशः तीन चूनापत्थर एकांशें नामतः लाकाडाँग चूनापत्थर, उम्लटदोह चूनापत्थर एवं प्रंग चूनापत्थर सहित एकांतरण में तीन बलुआ पत्थर एकांशों द्वारा रूपायित हैं। उम्लटदोह चूनापत्थर, शैल्ला शैलसमूह की मध्य चूनापत्थर एकांश लाकाडाँग बलुआपत्थर से अधःशायी और नरपुह बलुआपत्थर से उपरिशायी के समविन्यासी है। मौजूदा अध्ययन हेतु उम्लटदोह चूनापत्थर के नमूने लम्शनाँग से लगभग 01 किमी दक्षिण- पश्चिम जॉवइ-बदरपुर मार्ग के बांए हाथ की तरफ दृश्यांश से संगृहीत किए गए थे। चार नमूनों में से चूनेदार शैवाल मिली हैं तथा वर्तमान तनु खंड विश्लेषण में दो सुस्पष्ट संलक्षणियां प्ररूप पहचानी गई हैं। एक संलक्षणी गैर-जानुनत प्रवाली रक्त शैवाल और नितलस्थ फोरैमिनीफेरा से मुख्यतः प्रभावी है। गैर-जानुनत प्रवाली हेपलीडिएसी कुल के *लिथोथेम्नियन* व *मीसोफायल्लम* की जाति, कोरलीनाएसी कुल के *लिथोपोरेल्ला* तथा स्पोरोलियाएसी की जाति के *स्पोरोलिथॉन* की जाति द्वारा निरूपित हैं। अन्य संलक्षणी प्ररूप नितलस्थ फोरैमिनीफेरा सहित चूनेदार हरित शैवाल में प्रचुर है। हरित शैवाल वंश डेसीक्लेडेसी, उडोटीएसी एवं हलीमेडेसी के सदस्य हैं। पहले जैंटिया पहाड़ियों की सुतंग एवं लितंग घाटियों के मध्य निचली पहाड़ियों में अनावरित शैल्ला शैलसमूह के उम्लटदोह चूनापत्थर सदस्य से एक हरित शैवाल समुच्चय अभिलिखित की गई थी। फिर भी, यह शैल्ला शैल समूह के

उम्लटदोह चूनापत्थर से प्राप्त गैर-जानुनत प्रवाली रक्त शैवाल की प्राप्ति पर पहली बोधशील रिपोर्ट है। शैवाल-फोरैमिनीफेरीय समुच्चयों के आधार पर, दो संलक्षणी प्ररूप विश्लेषित किए गए हैं तथा पुरापर्यावरण व पुरागांभीर्यमितिविज्ञान की व्याख्या की गई है।

संकेत-शब्द—शैवाल प्रचुर संलक्षणियां, वृद्धिरूप, जैवसादिकी, उम्लटदोह चूनापत्थर, शैल्ला शैलसमूह, जैंटिया पहाड़ियां, मध्य आदिनूतनए।

INTRODUCTION

Contributions on calcareous algae from the Palaeogene sequence of East Khasi Hills have been made by Rao (1943), Pal and Dutta (1979), Boruah and Dutta (2001), Misra *et al.* (2002), Ghosh (2003) and Gogoi *et al.* (2003). However, there are very few records of calcareous algae from the Eocene carbonates exposed along the southern fringe of Meghalaya Plateau belonging to the Shella Formation of Jaintia Group (Sarma & Ghosh, 2006, 2007). Algal rich facies represented by coralline red algae belonging to families Hapalidiaceae, Corallinaceae and Sporolithaceae have been recorded for the first time from the Umlatdoh Limestone. In addition, some green algal forms belonging to families Udoteaceae, Halimedaceae and Dasycladaceae also have been recognized. The two facies recognized in the present study are also rich in benthic foraminifers. Detailed analyses of the facies types and algal forms have been done to interpret the palaeoenvironment and palaeobathymetry.

GEOLOGICAL SETTING

The Jaintia Group developed in the southern part of Jaintia Hills, Meghalaya is divided into two broad divisions, i.e. Shella Formation and Kopili Formation (Murthy *et al.*, 1976). The lowermost lithounit of Jaintia Group, i.e. the Shella Formation is well exposed along the Jowai - Badarpur Road section and represented by two sandstone units in alternation with three limestone units, viz. Lakadong Limestone, Umlatdoh Limestone and Prang Limestone respectively in ascending order (Fig. 1).

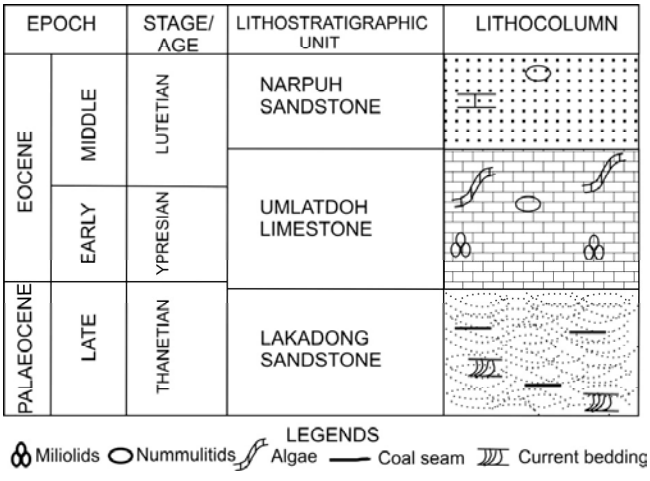

Fig. 1—Lithostratigraphy and lithocolumn of the studied section (Figure not to scale).

In the study area, Umlatdoh Limestone, the middle member of the Shella Formation is conformably underlain by Lakadong Sandstone and overlain by Narpuh Sandstone. Thin beds of limestones are very well exposed in the outcrop on the left hand side of the Jowai – Badarpur Road, about 1 km southwest of Lumshnong (25º10'0.6"N and 92º23'9.8"E). The exposed section of Umlatdoh Limestone Member is about 10 m thick. The limestone shows abundance of larger foraminifera as the framework grains. Thin argillaceous bands are found at few places which facilitate weathering. 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 yielded green and red algal forms apart from of benthic foraminifera.

MATERIAL AND METHODS

Samples for the present study were collected from the outcrop section on the left hand side of the Jowai – Badarpur Road, about 1 km southwest of Lumshnong (Fig. 2). Thin sections were prepared following conventional method. A total of 16 productive thin sections were analysed using light microscope. Qualitative as well as quantitative assessments (especially for the growth-forms) were made for the study of coralline algal diversity. Species taxonomy is a major barrier in palaeobiological analysis based upon coralline algae (Bosence, 1991; Braga *et al.*, 1993; Braga & Aguirre, 1995; Aguirre & Braga, 2005; Aguirre *et al.*, 2007). In the present study an open specific nomenclature has been adopted (where no appropriate species names are available) following the systematics proposed by Woelkerling, 1988; Braga *et al.*, 1993; Aguirre & Braga, 1998; Braga, 2003 and Harvey *et al.*, 2003. The concept of fabric analysis (Fig. 3) has been adopted after Nebelsick and Bassi (2000).

ALGAL ASSEMBLAGE

Division RHODOPHYTA Wettstein
Order CORALLINALES Silva and Johansen
Family HAPALIDIACEAE Grey emend. Harvey *et al.*
Subfamily MELOBESIOIDEAE Bizzozero
Genus *Mesophyllum* Lemoine
Mesophyllum sp. (Pl. 1.1-2)
Genus *Lithothamnion* Heydrich
Lithothamnion sp. (Pl. 1.3)

Melobesioideae gen. et sp. indet. with encrusting *Lithoporella* (Pl. 1.6)
Family SPOROLITHACEAE Verheij
Genus *Sporolithon* Heydrich
Sporolithon sp. (Pl. 1.4-5)
Family CORALLINACEAE Lamouroux
Subfamily MASTOPHOROIDEAE Setchell
Genus *Lithoporella* (Foslie) Foslie
Lithoporella melobesioides (Foslie) Foslie (Pl. 1.7)
Division CHLOROPHYTA
Class BRYOPSIDOPHYCEAE Round
Order BRYOPSIDALES Schaffiner
Suborder HALIMEDINEAE Hillis-Colinvaux
Family UDOTEACEAE Endlicher emend. Agardh
Genus *Ovulites* Lamarck
Ovulites arabica (Pfender) Massiex (Pl. 1.8-9)
Family HALIMEDACEAE Link
Genus *Halimeda* Lamouroux
Halimeda sp. (Pl. 2.1-3)
Class CHLOROPHYCEAE Kützing
Order DASYCLADALES Pascher
Family DASYCLADACEAE Kützing
Genus *Salpingoporella* (Pia) in Trauth
Salpingoporella sp. (Pl. 2.4)

BENTHIC FORAMINIFERA

Discocyclina (Pl. 2.5)
Nummulites (Pl. 2.6)
Assilina (Pl. 2.7)
Biseriate and uniseriate textularids (Pl. 2.8-9)
Lockhartia (Pl. 2.10)
Quinqueloculina (Pl. 2.11).

FACIES ANALYSIS

Thin section analysis of the Umlatdoh Limestone reveals two different MFTs (Major Facies Types) in an alternate sequence. Two different algal-foraminiferal associations have been recognized. The grainstone facies is largely dominated by calcareous green algae represented by *Halimeda*, *Ovulites* along with some dasycladacean forms in association with benthic foraminifera, viz. *Alveolina*, some smaller miliolids. The packstone-wackestone facies is delineated by a high percentage of non-geniculate coralline red algae, e.g. *Lithothamnion*, *Lithoporella*, *Sporolithon*, *Mesophyllum* and some other melobesioid forms in association with *Nummulites* and other larger foraminifera like *Alveolina*, *Orbitolites*, *Lockhartia*, *Assilina*, *Discocyclina*, etc.

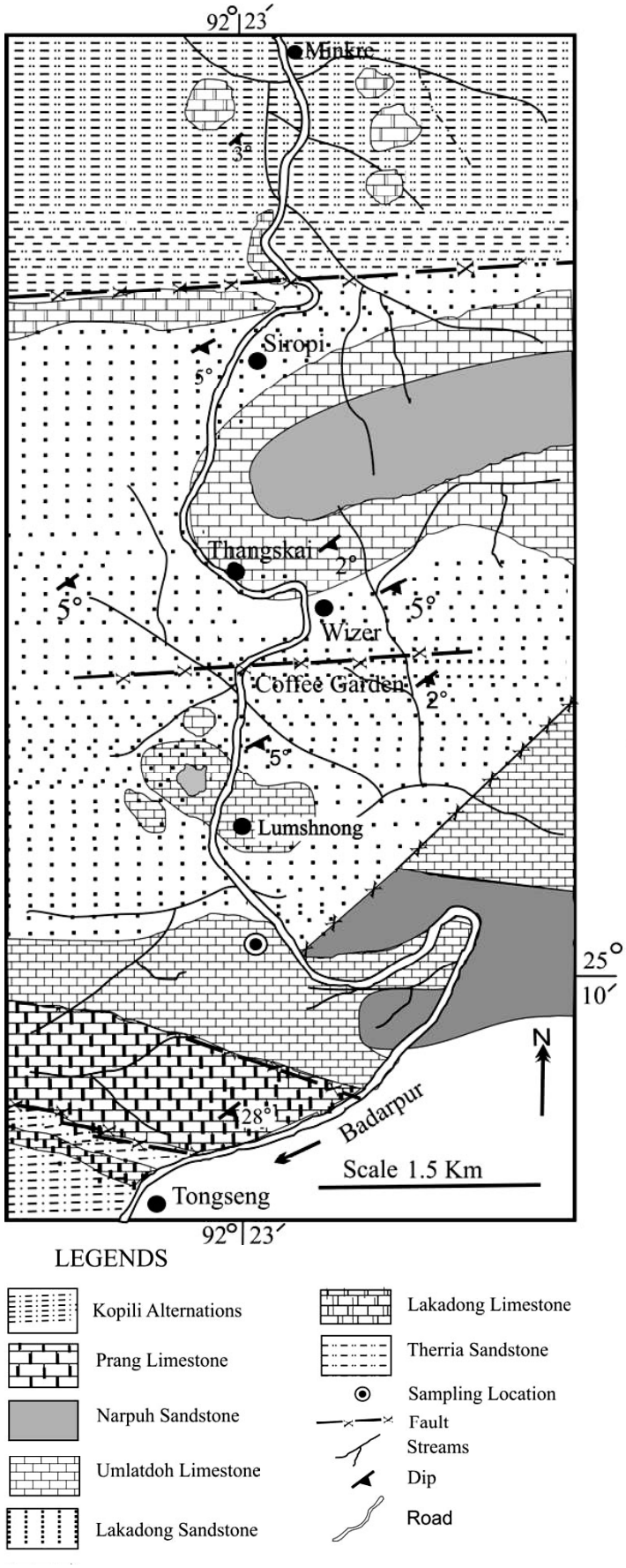

Fig. 2—Geological map of a part of Jaintia Hills showing the study area (after Dutta & Jain, 1980)

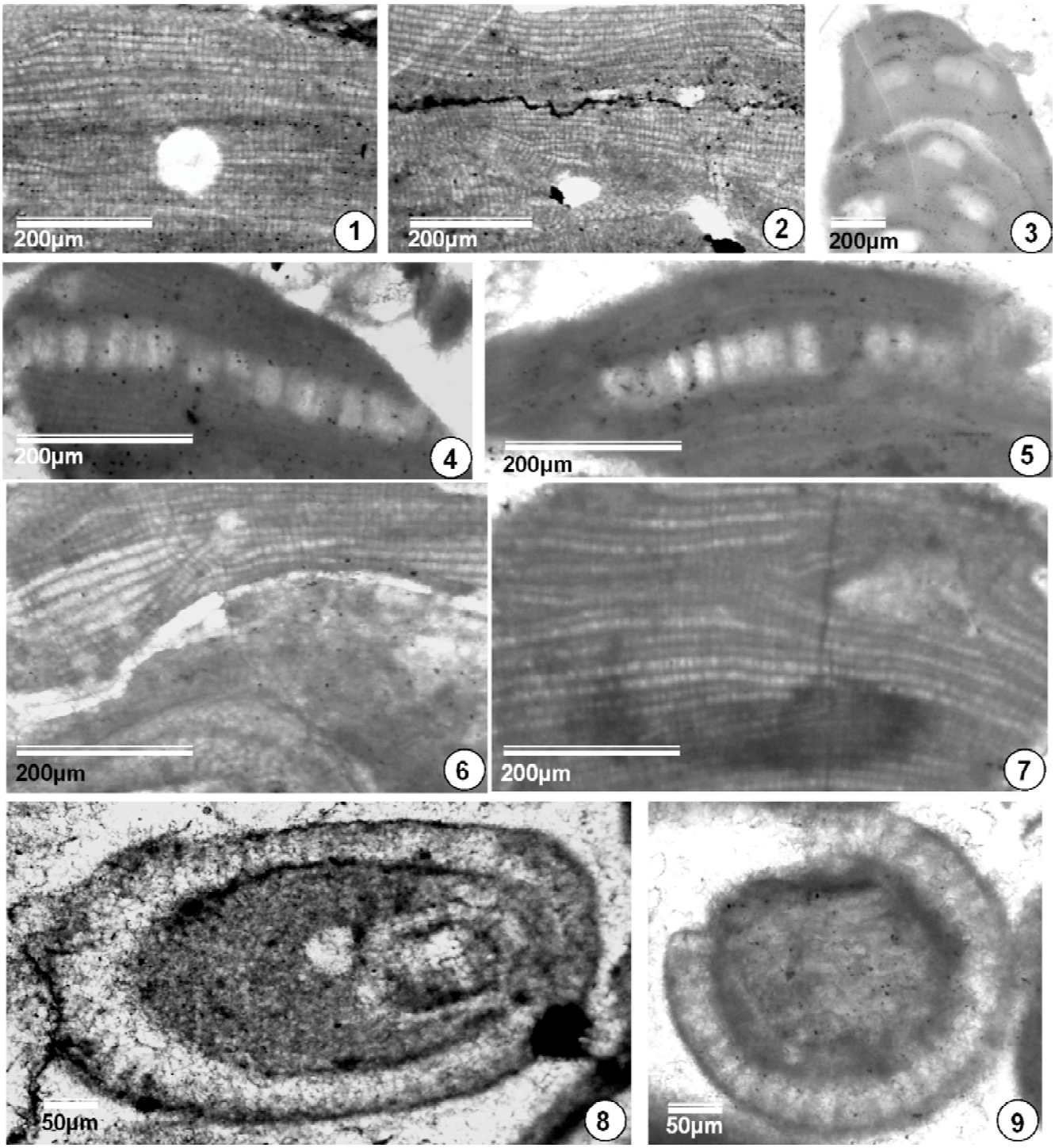

PLATE 1

1-2. *Mesophyllum* sp.; 1. *Mesophyllum* sp. showing multiporate sporangial conceptacle and coaxial filaments, BSIP Slide No. 14108214119; 2. *Mesophyllum* sp. showing vegetative thallus with characteristic coaxial filaments, BSIP Slide No. 14108214119.

3. *Lithothamnion* sp. showing multiporate sporangial conceptacle and characteristic growth form of the thallus, BSIP Slide No. 14108214120.

4-5. *Sporolithon* sp. thallus showing the growth form and sporangia grouped in sori, BSIP Slide No. 14108214120.

6. *Lithoporella* sp. encrusting a melobesioid form, BSIP Slide No. 14108214124.

7. *Lithoporella melobesioides*, BSIP Slide No. 14108214124.

8-9. *Ovulites arabica*, BSIP Slide No. 14108214118.

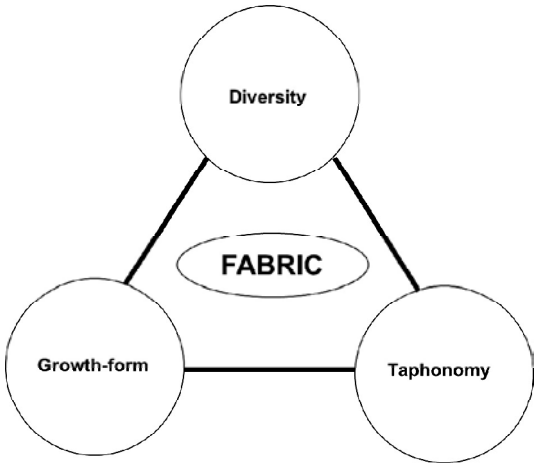

Fig. 3—Factors controlling the fabric of coralline algal limestone (Modified after Nebelsick & Bassi, 2000).

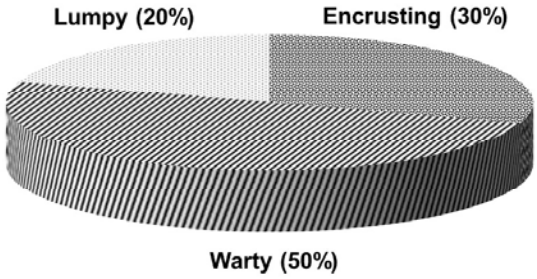

Fig. 4—Qualitative and quantitative growth form analysis of corallines.

GROWTH-FORM ANALYSIS

Variations of the growth-forms have been widely used for the purpose of delimiting and identifying genera and species of non-geniculate coralline algae (Lemoine, 1911, 1939; Adey *et al.*, 1982). Woelkerling *et al.* (1993) have initiated the determination of a range of growth-forms present amongst non-geniculate coralline algae. Factors like differences in hydrodynamic energy and substrate morphology have a key role in the variation of growth-forms within species (Johnson, 1961; Cabioch, 1969; Adey & Adey, 1973; Bosence, 1976; Dethier, 1994). Both orientations of thalli in the sediment and effect of thin sectioning control the conception of growth-forms of coralline algal thalli in thin sections. Concept of these growth-forms has been applied to fossil coralline algae in thin section analysis by Bassi (1998) and Rasser and Piller (1999). Three different growth-forms have been encountered in the present analysis. This is totally irrespective of their generic and specific delimitation. Quantitatively, encrusting, warty and lumpy growth-forms are represented by 30%, 50% and 20% respectively in the present analysis (Fig. 4).

TAPHONOMIC ANALYSIS

In spite of being a very important parameter, taphonomic aspects of fossil coralline algae have not been explored well enough except a few earlier investigations (Nebelsick & Bassi, 2000). Preservation potentials of coralline algae are affected by a variety of taphonomic features. Some of the taphonomic features can be observed directly, while some are inferred. Certain features however are indiscernible and are preserved as such in the fossil record. Nebelsick and Bassi (2000) and Nebelsick *et al.* (2000) have recognized various taphonomic features of coralline algae, viz. disarticulation, encrustation, bioerosion, fragmentation, abrasion and diagenesis in the Lower Oligocene Shelf carbonates of Gornji Grad beds of northern Slovenia. Some of these features have also been identified in the present study, namely encrustation, bioerosion, abrasion and diagenesis. These taphonomic features have a high potentiality in deciphering palaeoecological parameters.

CONCLUSIONS

Two entirely different algal - foraminiferal biofacies have been recognized in the Umlatdoh Limestone. The packstone-wackestone facies is dominated by non-geniculate corallines, viz. *Lithothamnion* sp., *Sporolithon* sp., *Mesophyllum* sp., *Lithoporella melobesioides* and foraminifera. The grainstone facies is represented by green algae, viz. *Ovulites*, *Halimeda* and dasyclads in association with foraminifera. Algal forms are comparatively less than benthic foraminifera in the studied facies. Amongst the corallines encrusting, warty and lumpy growth forms have been recognized (Fig. 4). Taphonomic analysis reveals four different features, viz. encrustation, bioerosion, abrasion and diagenesis. The generic variability of calcareous algae and foraminifers may be attributed to the variation in salinity levels. As udoteacean and halimedacean algae prefer shallow bathymetric levels therefore, it can be concluded that the Umlatdoh Limestone was deposited under shallow, tropical environment with variable salinity conditions.

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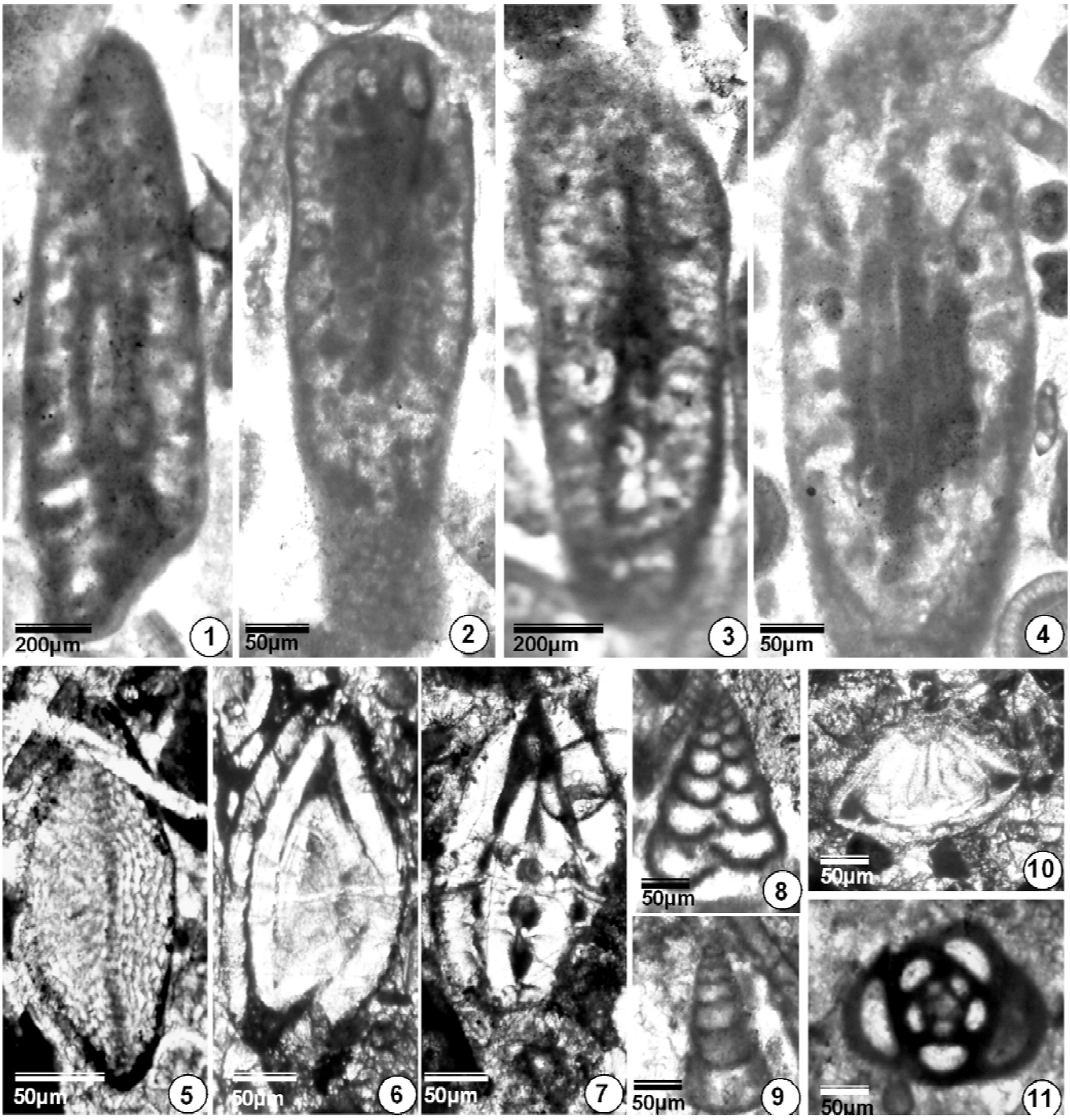

PLATE 2

1-3. *Halimeda* sp., BSIP Slide No. 14108214118; *Halimeda* sp. BSIP Slide No. 14108214121; *Halimeda* sp. BSIP Slide No. 14108214121.

4. *Salpingoporella* sp., BSIP Slide No. 14108214117.

5. *Discocyclina* sp. showing typical bilateral symmetry and discoid test, BSIP Slide No. 14108214119.

6. *Nummulites* sp., BSIP Slide No. 14108214124.

7. *Assilina* sp., BSIP Slide No. 14108214123.

8-9. Textularids; 8. Biseriate textularid showing elongate and wedge-shaped test and planispirally coiled chambers, BSIP Slide No. 14108214117; 9. Uniseriate Textularid, BSIP Slide No. 14108214117.

10. *Lockhartia* sp., BSIP Slide No. 14108214119.

11. *Quinqueloculina* sp. showing characteristic arrangement of chambers, BSIP Slide No. 14108214122.

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