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Research Paper

PALEOCENE-EOCENE PALYNOSTRATIGRAPHY OF THE NORTHERN MARGIN OF UPPER ASSAM BASIN, INDIA

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The palynofloral assemblage of a 3976 m deep well of Barekuri area, Northern part of Upper Assam Basin, India is studied. The study is confined to the 636 m thick Paleocene - Eocene sequence comprised of Langpar, Lakadong + Therria, Nurpuh, Prang and Kopili formations. The dinoflagellates and pollen grains of Palmae family belonging to genus Neocouperipollis together with the reported foraminifera from the neighbouring region indicate shallow marine condition/near shore environment during the deposition of the entire Upper Paleocene-Eocene sediments. The good representation of the Pteridophytic grains suggests prevalence of humid tropical climate at the time of deposition. The complete absence of marine elements after the deposition of Kopili Formation is indicative of regression of sea at the end of Eocene.

Keywords: Paleocene-eocene, Palynostratigraphy, Northern margin, Upper Assam basin, India

INTRODUCTION

The Barekuri oil field is in the Tinsukia district of Upper Assam Basin in the North-Eastern corner of the Indian subcontinent. About two decades back, the oil and gas fields of North-Eastern Basins were restricted to Barail Group and Tipam and Girujan formations in the shelf zone of eastern part of Upper Eocene-Oligocene and Miocene age. The recent discovery of commercial oil and gas fields in the Dibrugarh and Sivasagar (undivided) districts in the Paleocene-Lower Eocene rocks has heralded a new era for hydrocarbon exploration in Upper Assam Basin.

Mallet (1876) was the first to attempt a classification of the Tertiary sequence of the Assam valley. Later, the detailed classification of the Tertiary sequence of Assam including the hills bordering Assam valley, Central Assam ranges and the Surma valley was done by Evans (1932 and 1959) which is accepted till today as the basic classification. Mathur and Evans (1964) in their publication “Oil in India” have dealt the Upper Assam oil basin.

Palynological study of the prospective oil yielding rocks was attempted first by Professor Birbal Sahni together with Sitholey and Puri as

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early as in 1947 in India with the Tertiary sediments of Assam. Sah and Dutta (1967) first made the detailed palynological investigation of the complete Tertiary sequence of the Upper Assam Basin and prepared the distribution of various palynological assemblages of the region. Singh and Tiwari (1979) have studied the palynostratigraphy of the Tertiary sediments of Upper Assam. The study revealed that the Tertiary sediments of Upper Assam can be distinguished well on the basis of characteristic palynological assemblages. Handique and Dutta (1980) made a detailed investigation of the Surma-Tipam Groups of the Upper Assam Shelf. Sah *et al.* (1980) investigated the palynofossils of the Tipam Group of Naharkatiya and divided the Girujan Clay Formation into three distinct finer biozones. Dutta (1982) in his communication Tertiary stratigraphy of Upper Assam dealt with the distribution of significant palynomorphs and foraminifera in relation to their stratigraphical position and to the paleogeography of the Tertiaries of Upper Assam. Singh and Saxena (1984) studied the palynology of the Neogene sediments of Jorajan well-3 close to the area under study. Kar *et al.* (1994) carried out the palynostratigraphical studies on subsurface Tertiary sediments in Upper Assam. Bhuyan *et al.* (1997) for the first time recorded the Upper Paleocene-Eocene mioflora from the areas around Kathalani and Dikom of the study area. Kumar *et al.* (2001) studied in detail on the palynostratigraphy of subsurface post Eocene sequence of Upper Assam Basin.

Buzarbaruah *et al.* (1992) observed that "the established oil potential are mainly in thin sand beds (0.5 m-3 m) within Paleocene-Lower Eocene sequences. Based on basement configuration, depositional environment and known hydrocarbon occurrences, Paleocene-Lower Eocene prospects are expected to be bright around Central Basement High region and adjoining areas". They further pointed out that the hydrocarbon prospects in the Paleocene-Lower Eocene rocks along the basement ridge will play a major role for exploration within Upper Assam Basin in the immediate future.

MATERIALS AND METHODS

Altogether 54 subsurface samples have been collected from Oil India Limited ranging in age from Paleocene-Eocene between the depth from 3340 m to 3976 m of the studied well of Barekuri oil field. Standard method maceration process for palynological separation was followed with acid and alkali treatment of HF, HCL, HNO_3 and 5% KOH respectively. Microslides were prepared using PVA and Canada Balsam.

Lithostratigraphy

The areas around Barekuri present the following Paleocene–Eocene Succession (after OIL India Limited):

	6. Kopili Formation	Upper Eocene (Priabonian)
Sylhet Limestone Formation	5.Prang Limestone Member	Middle Eocene (Lutetian)
	4.Nurpuh Sandstone Member	
	3.Lakadong Sandstone Member	
	2. Therria Formation	Upper Paleocene (Thanetian)
	1. Langpar Formation	Lower Paleocene (Danian)

Langpar Formation

The general characters of the Langpar Formation in the type area are as follows:

Shales with thin limestone and argillaceous sandstone bands. Often yellow brown impure limestone with bands of sandy shales at the middle portion while at the top it comprises sandstone and sandy shales with thin sandy limestone (after Krishnan, 1968).

In the type area under review the Langpar Formation comprises hard compact fine to

Figure 1: Location Map of Tinsukia District

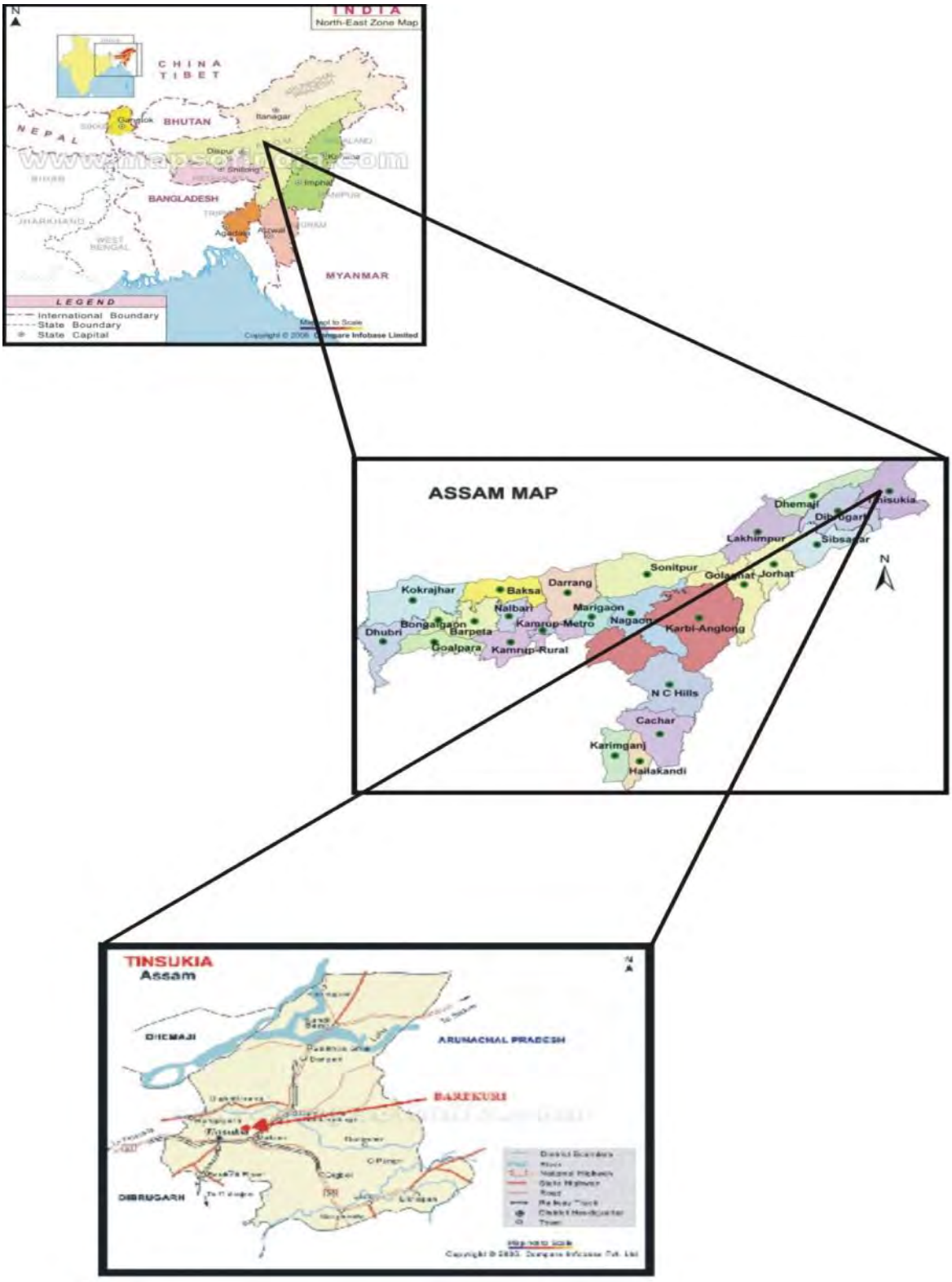
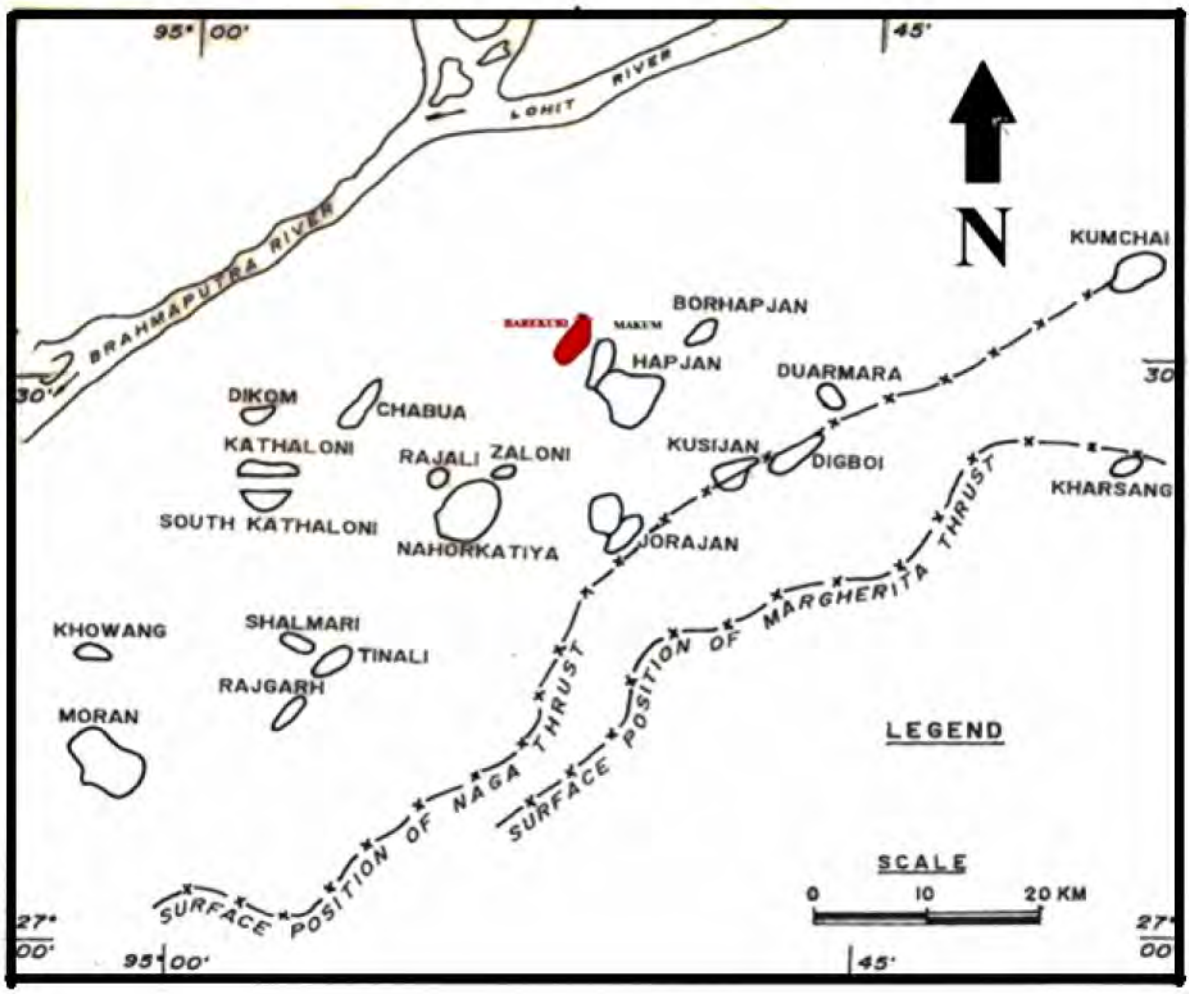


Figure 2: Oil Fields Explored by Oil India Limited (Courtsey OIL)



medium grained sandstone with shale partings.

Therria Formation

The Therria Formation in the type area is a hard, compact, fine to coarse grained dirty white with occasional ferruginous band shows well bedded sandstone, thickness of the beds varies between about 30 cm to 1 m thick. The dips are very gentle and varies between 4° to 7° with average dip 4° towards N 45° E.

Lakadong Sandstone Member

The generalized character of Lakadong Sandstone Member contains workable coal seams, and comprises carbonaceous shale, mudstone, clay and fine to coarse grained sandstone. The most significant character of this sediment is the presence of workable coal deposits with purple colour sandstone and pyritous shale at the base.

The Therria + Lakadong lithotypes in the areas under discussion are whitish grey silty shale and carbonaceous shale at the basal part while they show fine grained glauconitic calcareous sandstone and dark grey shale with limestone towards top.

The Umlatodoh Limestone Member of the Sylhet Formation has not been recorded from the areas under review which forms the base of the Lower Eocene in Shillong Plateau.

Nurpuh Sandstone Member

The next higher horizon is represented by Nurpuh Sandstone Member. It is generally light brown to ferruginous in colour but at the some places such as near the contact with Umlatodoh Limestone, it is almost black in colour. Another interesting feature in the type area is the occurrences of coaly layer around Lumshonong, Jaintia Hills, which has not been observed at any other places (Ph.D. thesis, unpublished).

In the areas under discussion the Nurpuh Sandstone comprises dark hard grey shale, calcareous sandstone, bluish compact fine to medium grained sandstone with fossils.

Prang Limestone Member

The Prang Limestone in the type area is generally grey in colour, occasionally brown, especially near the contact with the overlying Kopili Formation. The top of the limestone contains shale parting (around Lumshonong).

In the present areas the Prang Limestone comprises limestone, calcareous sandstone, dark hard grey shale, fine grained sandstone with prolific fossils.

Kopili Formation

The Kopili Formation is the topmost lithologic unit of the Jaintia Group, is the best developed in the southern and south-eastern parts of Shillong Plateau, i.e., Jowai–Badarpur road section in the Jaintia Hills and in the North–Cachar Hills. The formation consists of alternations of shales and sandstones with a number of thin limestone and calcareous bands and marls. The shales are generally black to grey in colour and are splintery in nature.

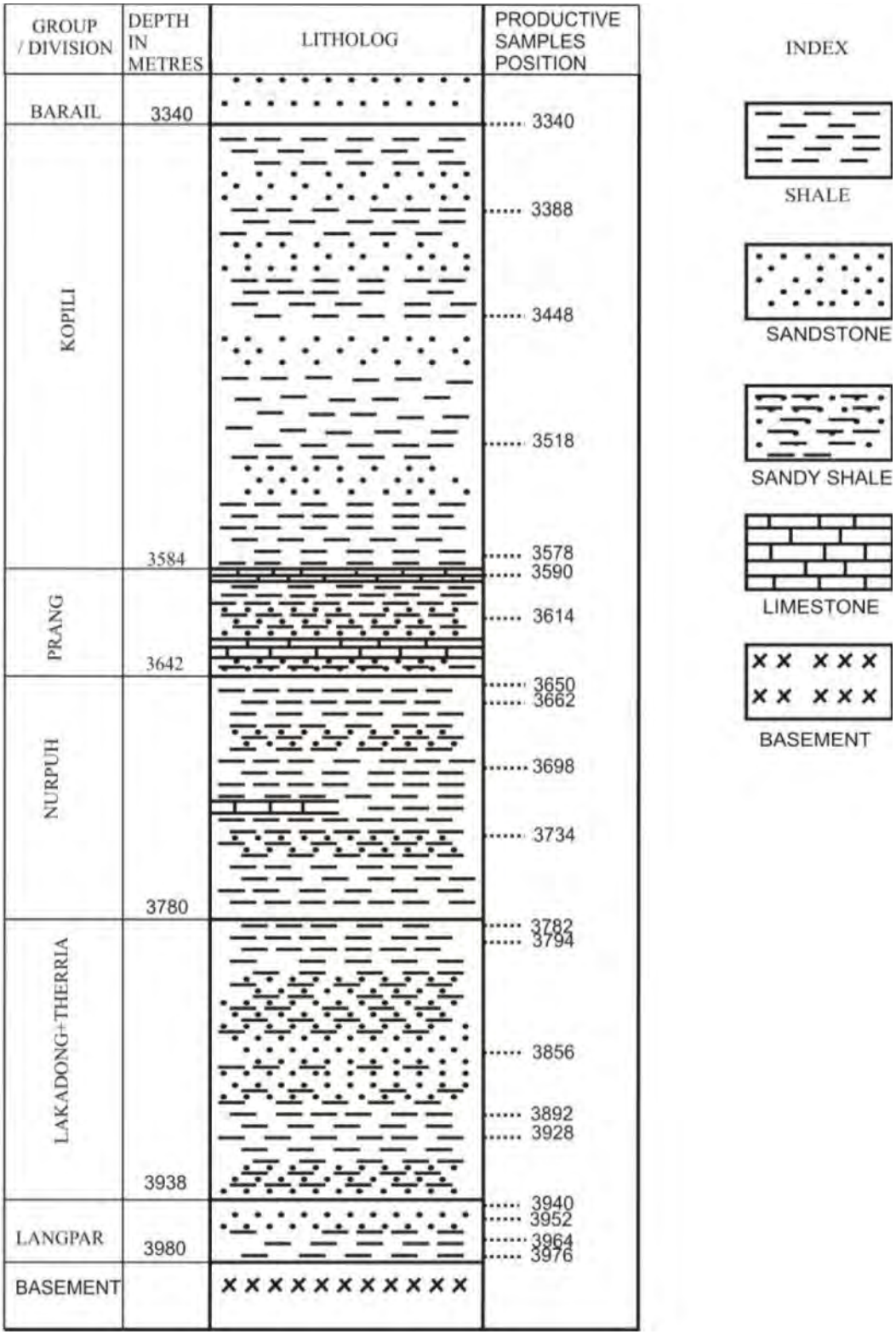
Palynological Analysis

The present well has penetrated through Eocene Kopili Formation encountering Prang, Nurpuh, Lakadong + Therria, Langpar and finally reached the basement rocks. The lowermost part of the sequence. The Langpar formation has yielded spores and pollens like *Lycopodiumsporites parvireticulatus, Lygodiumsporites eocenicus, Nymphaeacidites clarus, Polycolpites multirimatus, Polypodiaceaesporites haardti, Schizaeoisporites phaseolus, Talsiipites wodehousei, Tricolpites crassireticulatus, Araliaceoipollenites reticulates, Neocouperipollis wodehousei, Trifossapollenites constatus, Quilonipollenites ornatus*, etc.

The Lakadong Therria unit has produced prolific occurrences of spores and pollens like *Cupiliferoidaepollenites liblarensis, Dandotiaspora dilata, Ericipites laevigatus, Ilexpollenites ornus, Myricipites harrisii, Nymphaeacidites sphericus, Nymphaeacidites clarus, Palmaepollenites communis, Polycolpites cooksoni, Polygalacidites clarus, Reticulatisporites incompositus, Rhoipities nitidus, Tricolpites longicolpus, Triporopollenites vimalii, Liliacidites microreticulatus, Polypodiaceaesporites tertiarus, Corrugatisporites formosus, Corrugatisporites terminalis, Lakiapollis ovatus, Dictyophyllidites sp., Polyporina sp.,* etc.

The Nurpuh formation is also quite rich in palynomorphs. It produces good numbers of *Lygodiumsporites eocenicus, Palmaepollenites eocenicus, Talisiipites woodehousei, Palmaepollinites communis, Myricipites (Triorites) harrisii, Foveotriletes pachyexinous*

Figure 3: Lithosection of Barekuri Area



together with dinoflagellates like *Apectodinium parvum, Cordosphaeridium exilimurum* with fungal spores.

The Prang Limestone unit is quite rich in palynotaxa together with dinoflagellates. Some of the recovered fossils are *Ericipites laevigatus,*

Plate 1: 1. Lycopodiumsporites parvireticulatus, 2. L. eocenicus, 3. Polypodiaceaesporites haardti. 4. Schizaeoisporites phaseolus, 5. Proxapertites assamica, 6. P. crassimurus, 7. Dandotiaspora densicorpa, 9. D. dilata, 8. Schizaeoisporites crassimurus, 10. Assamealetes emandatus, 11. Reticulatisporites incompositus, 12. Schizaeoisporites eocenicus

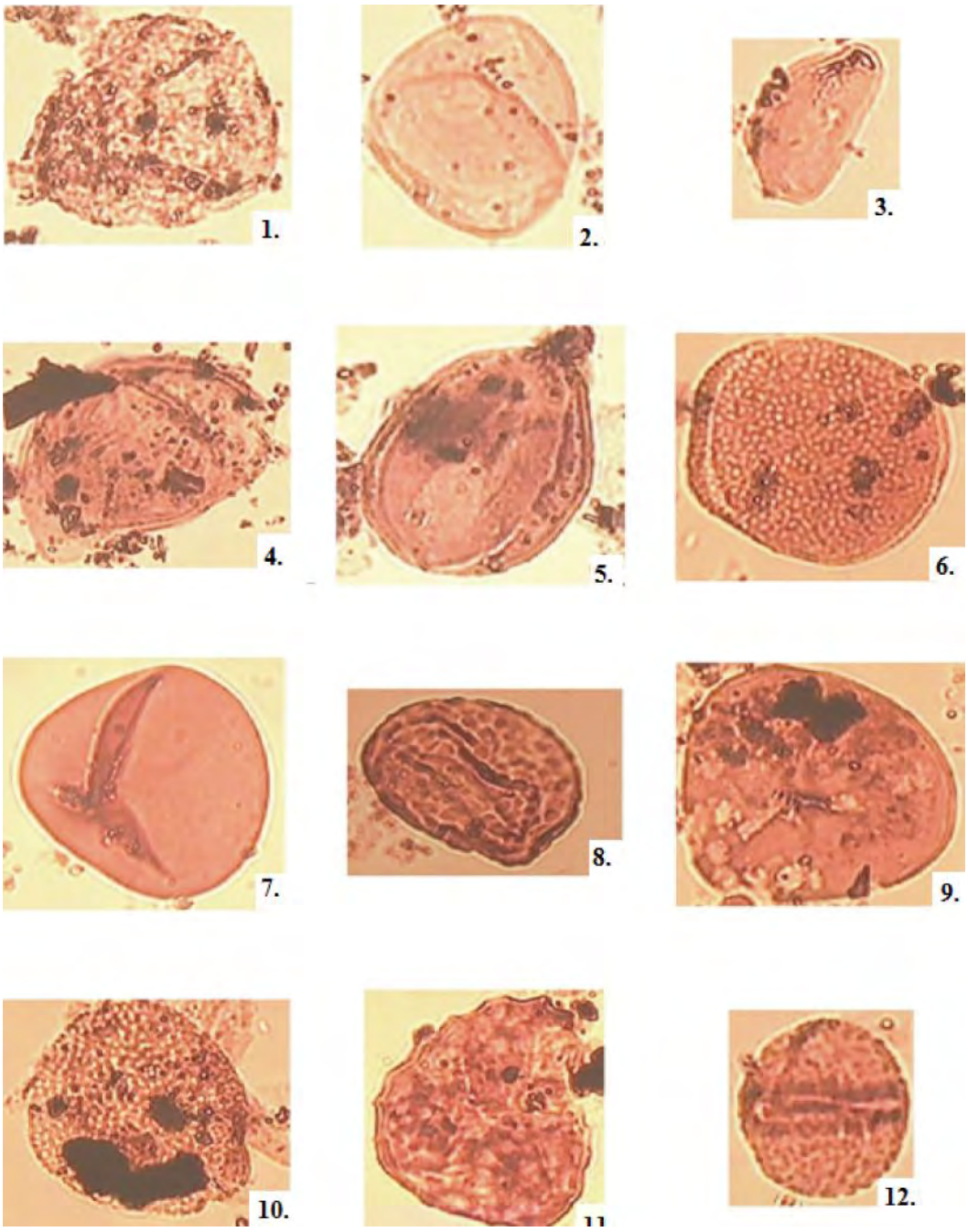


Plate 2: 1. Polypodiaceaesporites tertiarus, 2. Corrugatisporites formosus, 3. C. terminalis, 4. Lycopodiumsporites palaeocenicus, 5. Lygodiumsporites eocenicus, 6. Foveotriletes pachyexinous, 7. Polypodiisporites repandus, 8. Deltoidospora sp., 9. Foveosporites triangululus, 10. L. speciosus, 11. Microreticulatisporites densus, 12. Stereisporites assamensis

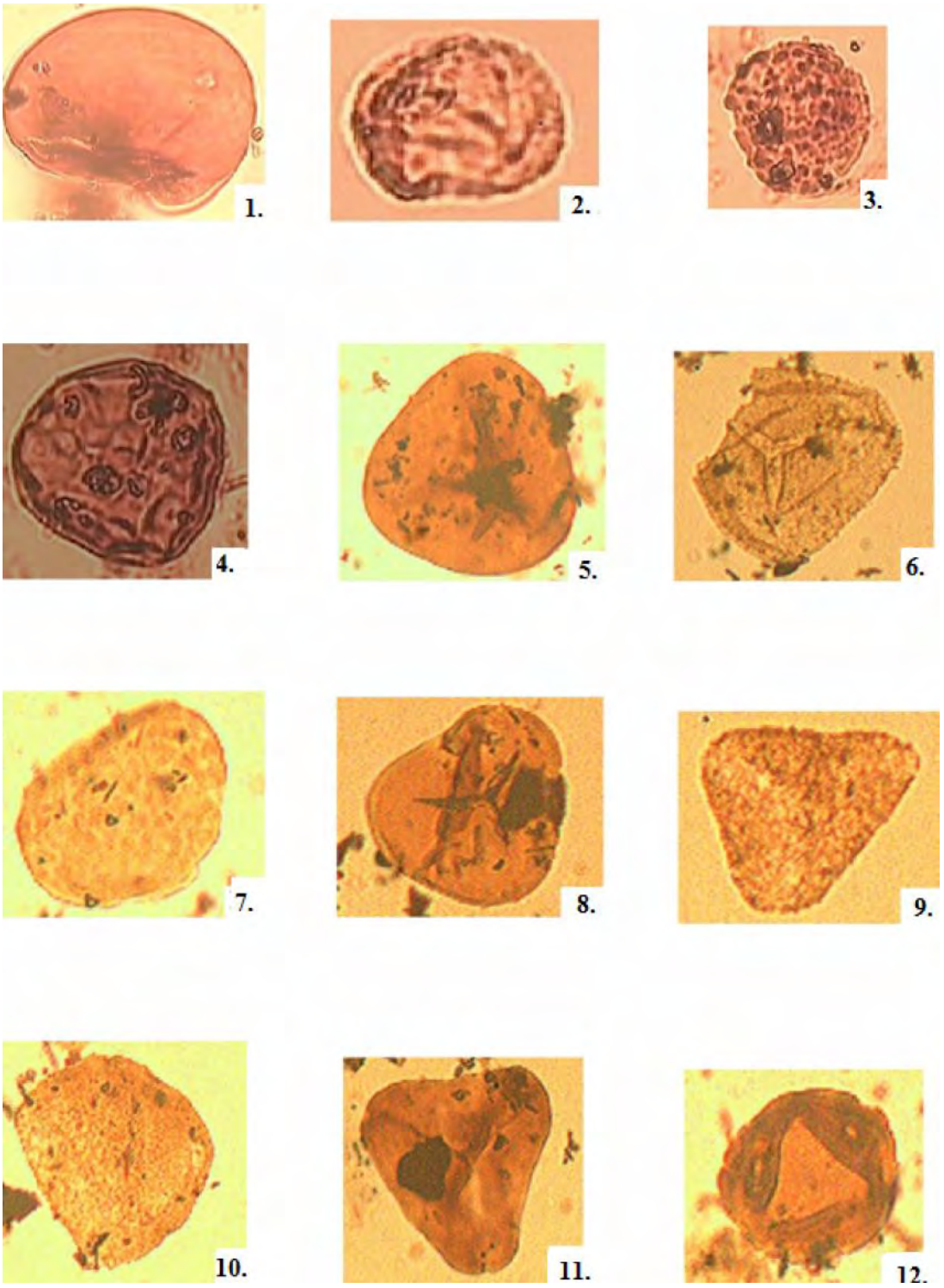


Plate 3: 1. Nymphaeacidites clarus, 2. Polycolpites multirimatus, 3. P. speciosus, 4. Talsiipites wodehousei, 5. Tricolpites crassireticulatus, 11. T. pachyexinous, 6. Araliaceoipollenites reticulatus, 7. Neocouperipollis rarispinosus, 8. N. brevispinosus, 9. Nymphaeacidites sphericus, 10. Polycolpites sp., 12. Palmaepollenites communis

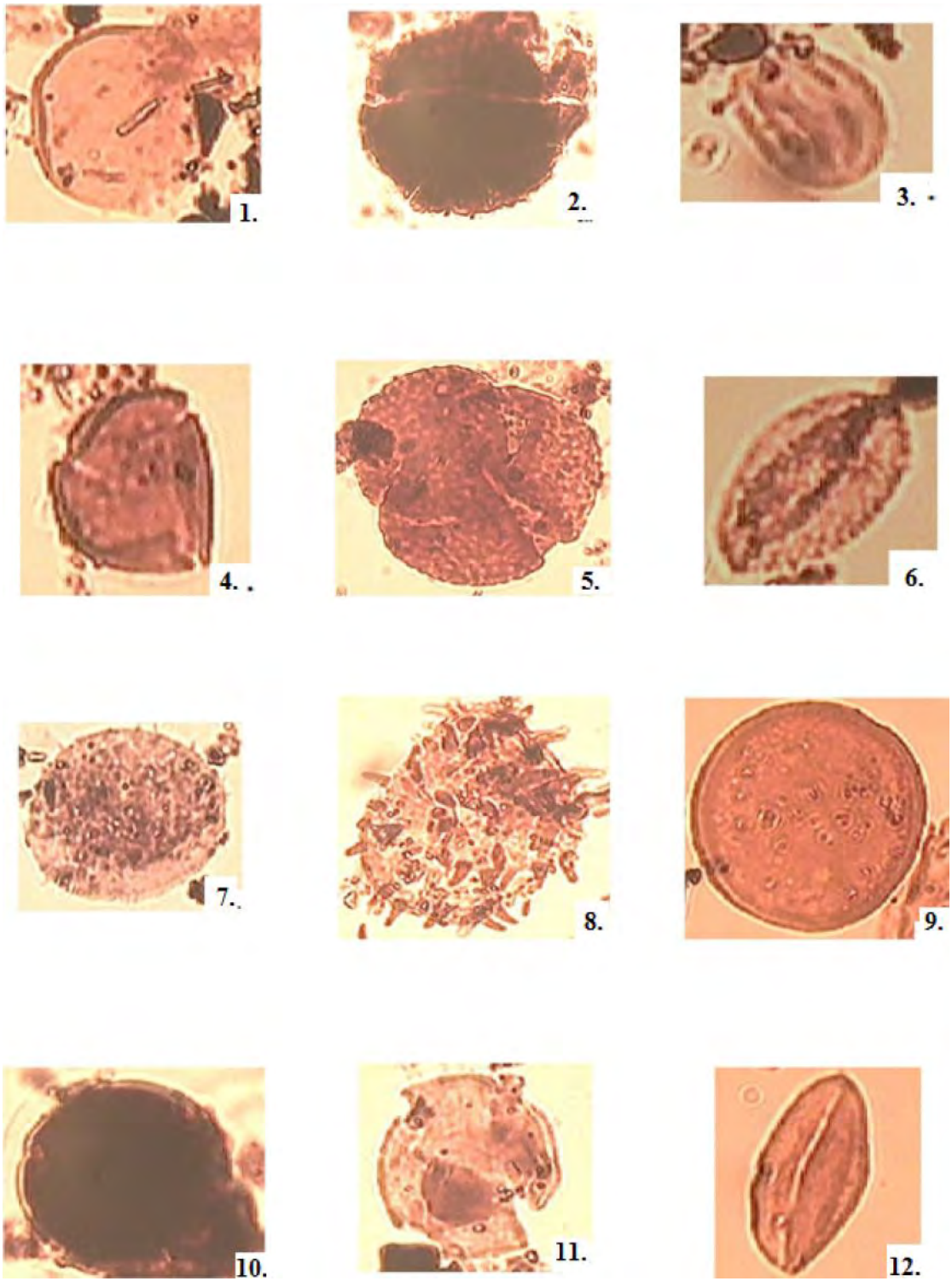


Plate 4: 1. Trifossapollenites constatus, 2. Unidentified palynomorph, 3. Quilonipollenites ornatus, 4. Cupiliferoidaepollenites liblarensis, 5. Ilexpollenites ornus, 6. Myricipites harrisii, 7. Nyssapollenites sp., 8. Polycolpites cooksonii, 9. Polycolpites obscurus, 10. Polygalacidites clarus 11. Rhoipites nitidus, 12. Tricolpites longicolpus

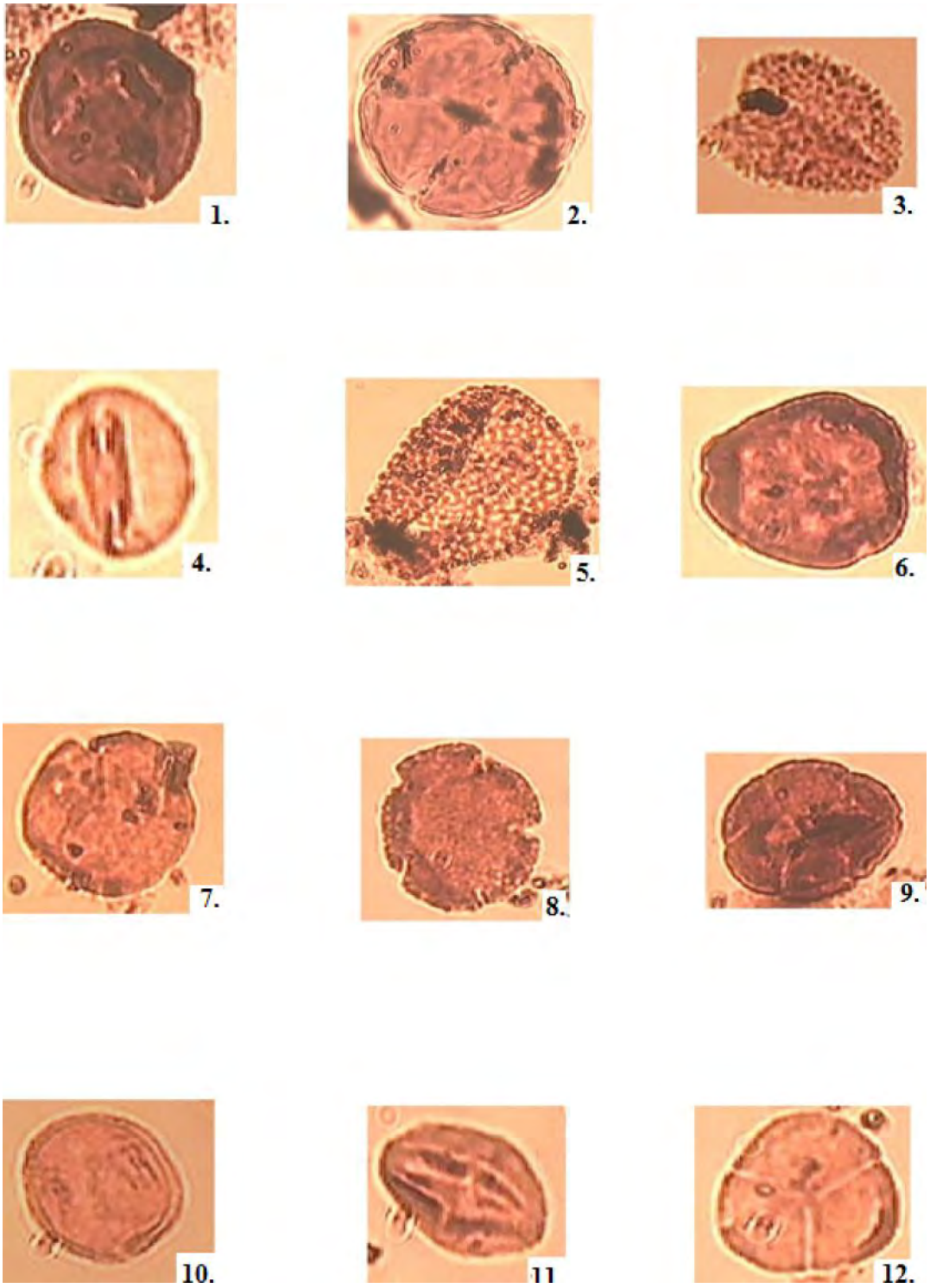


Plate 5: 1. Triporopollenites vimalii, 2. Liliacidites microreticulatus, 3. Lakiapollis ovatus, 4. Myrtacidites, 5,9. Neocouperipollis brevispinosus, 6. Palmaepollenites eocenicus, 7. P. verrucatus, 10. P. communis, 8. Retipilonapites cenozoicus, 11. Subtriporopollis reticulate, 12. Araliaceoipollenites reticulates

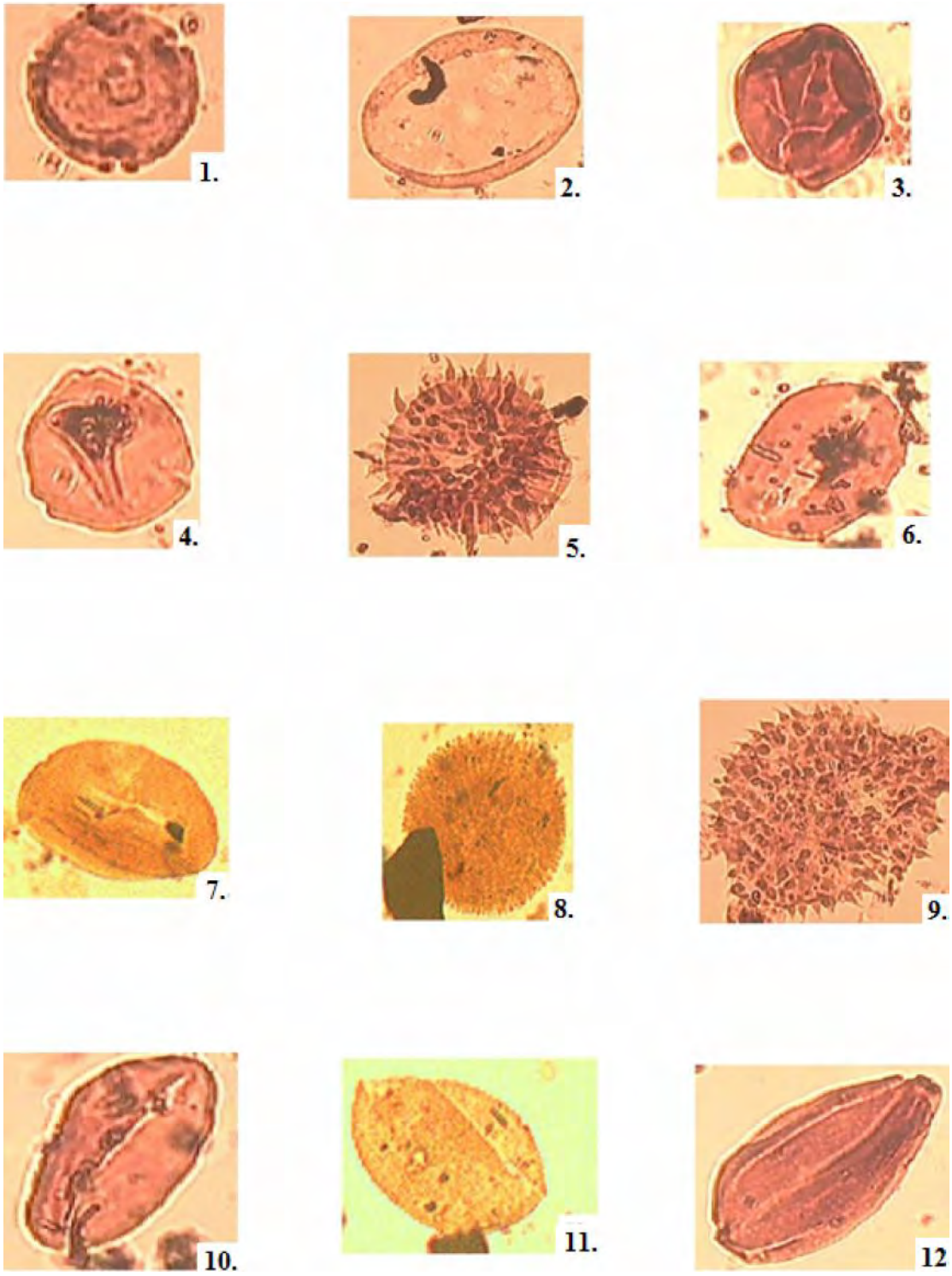
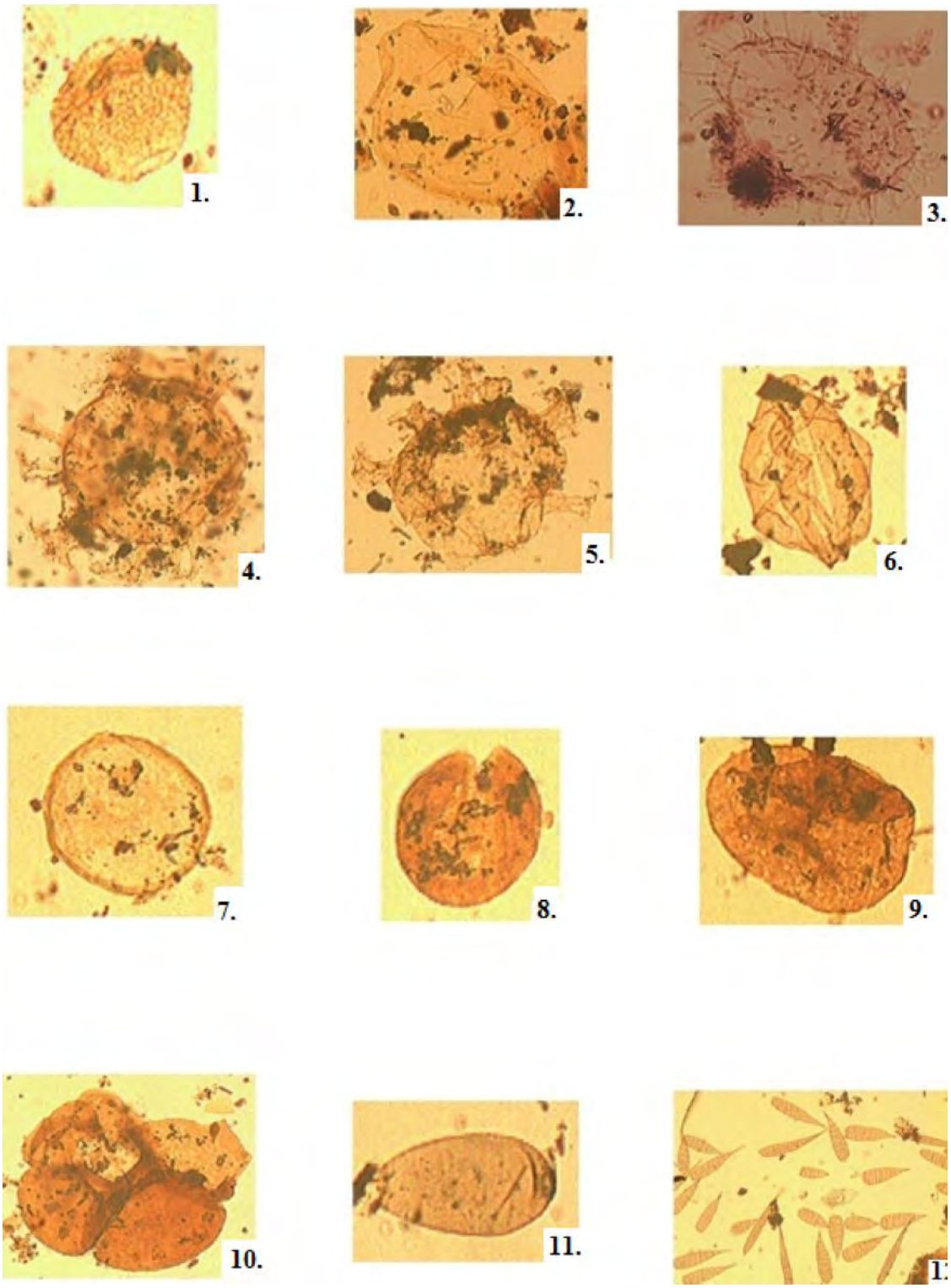


Plate 6: 1. Ascostomocystis sp., 2, 6. Apectodinium parvum, 3. Operculodinium major, 4. Cordosphaeridium cantharellus, 5. Cordosphaeridium exilimurum, 7. Collumosphaera fruticosa, 8-9. Dinoflagellate type, 10. Foraminiferal type, 11-12. Fungal spores



Lycopodiumsporites spactosus, Monolites mawkmaensis, Myricipites (Triorites) vulguris, Nymphaeacidites sphericus, Palmaepollenites communis, Palmaepollenites eocenicus, Palmaepollenites verrucatus, Retipilonapites cenozoicus, Polypodiisporites repandus, Apectodinium parvum, Collumosphaera fruticosa, etc.

The Uppermost Eocene lithotypes is represented by the Kopili Formation. This unit produces palynotaxa like *Neocouperipollis rarispinosus, Nymphaeacidites sphericus, Palmaepollenites communis, Subtriporopollis reticulate, Tricolpites reticulates, Polycolpites cooksonii, Polypodiaceasporites tertiarus, Trifossapollenites constatus, Polyporina excellens, Tricoloporpilites robustus,* etc., with Foraminiferal linings.

DISCUSSION AND CONCLUSION

The present study area comes under the Assam-Arakan geological province. The Belt of Schuppen runs in close proximity to the southern part of the area under review.

The region is, both , geologically and economically very significant as it presence one of the most representative and thickest Cenozoic section of North-Eastern region and its surroundings present major oil and coal fields of the state.

The objective of the present investigation is to study the subsurface palynology of the area. This includes the study of detail palynology of Paleocene-Eocene rocks types. The Oil India Limited has divided the Paleocene sediments into Langpar and Therria + Lakadong. The palynological investigation shows that no palynotaxa belonging to the Langpar Formation of Danian age is present. On the other hand, typical Upper Paleocene forms such as *Dandotiaspora dilata, Polypodiaceaesporites tertiarus, Triporopollenites vimalii, Proxapertites assamica, Proxapertites crassimurus, Neocouperipollis rarispinosus, Neocouperipollis brevispinosus, Neocouperipollis wodehousei, Tricolpites crassireticulatus, Assamealetes emandatus, Phragmothyrites eocenicus, Lycopodiumsporites parvireticulatus, Lycopodiumsporites eocenicus, Nymphaeacidites clarus, Nymphaeacidites sphericus, Polycolpites multirimatus, Polycolpites speciosus, Polypodiaceaesporites haardti, Schizaeoisporites phaseolus, Talsiipites wodehousei, Araliaceoipollenites reticulates, Tricolpites pachyexinous, Palmaepollenites communis, Trifossapollenites constatus, Dandotiaspora densicorpa, Quilonipollenites ornatus, Schizaeoisporites crassimurus, Schizaeoisporites eocenicus, Cupiliferoidaepollenites liblarensis, Ilexpollenites ornus, Myricipites harrisii, Nyssapollenites sp., Polycolpites cooksonii, Polycolpites obscures, Polygalacidites clarus, Reticulatisporites incompositus, Rhoipites nitidus, Tricolpites longicolpus, Liliacidites microreticulatus, Corrugatisporites formosus, Corrugatisporites terminalis, Lakiapollis ovatus, Myrtacidites, Dictyophyllidites* sp., etc., have been recorded in the present study. Further, it has been observed that the distribution of this mioflora is more or less identical in both the lithotypes and thus may be considered them as single unit and may be named as Basal Sandstone as has been called in the adjoining areas (Singh *et al.*, 1986).

The above mentioned palynological assemblage has been recorded in both Lakadong

Limestone Member and Tura Formation of Upper Paleocene (Thanetian) of Meghalaya. Although some workers regard these sediments as continuation of Tura Formation, they are possibly a continuation of Lakadong Sandstone Member as the nearest exposure of Lakadong Sandstone has been observed on the western part of the studied area around Koilajan of Delai Parvat of Sylbhetta, Karbi- Anglong district, Assam.

So far occurrence of Umlatodoh Limestone Member of Sylhet Limestone Formation of Lower Eocene age has not been recorded from the Upper Assam Basin. Middle-Eocene is represented by Nurpuh Sandstone Member and Prang Limestone Member of the Sylhet Limestone Formation while Kopili Formation forms the Upper Eocene. The mioflora such as *Liliacidites variegates, Lygodiumsporites eocenicus, Palmaepollenites eocenicus, Palmaepollenites communis, Talisiipites wodehousei, Foveotriletes pachyexinous, Lycopodiumsporites parvireticulatus, Myricipites harriisii, Nyssapollenites sp., Deltoidospora sp., Foveotriletes triangulus, Liliacidites microreticulatus, Lycopodiumsporites speciosus, Microreticulatisporites densus, Stereisporites assamensis, Trifossapollenites constatus,* etc., together with *dinoflagellates Cordosphaeridium cantharellus, Apectodinium parvum, Cordosphaeridium exilimurum,* etc., of the Prang Limestone Member have been recorded from the same basin.

The Kopili Formation is characterized by mioflora such as *Lycopodiumsporites parvireticulatus, Neocouperipollis rarispinosus, Nymphaeacidites sphericus, Palmaepollenites communis, Subtriporopollis reticulate, Polycolpites cooksonii, Polypodiaceasporites tertiarus, Tricolpites crassireticulatus, Trifossapollenites constatus, Tricoloporpilites robustus*, etc., together with *dinoflagellates Ascostomocystis*, etc. It is interesting to note that Trivedi (1985 and 1990) has reported the reworked Paleozoic mioflora from the Kopili Formation of Jaintia Hills, Meghalaya. So far, no such reworked mioflora has been recorded from the study area.

The reported occurrences of shallow marine typical forams such as *Lockhartia haemai, Nummulites perforates, Assilina papillata, Pellatispira sp., Guembilina venezuala, Nummulites discorbinous, Nummulites acutus, Nummulites beaumonti, Discocyclina dispansa, Discocyclina omphalus, Assilina spira*, etc. (Dutta, 1982; Singh *et al.*, 1986; and Bhuyan, 1993 M.Tech dissertation) from the neighbouring region together with the dinoflagellates and pollen grains of Palmae family belonging to genus Neocouperipollis indicate shallow marine condition/near shore environment during the deposition of the entire Upper Paleocene-Eocene sediments. The good representations of the Pteridophytic grains suggest prevalence of humid tropical climate at the time of deposition. The complete absence of marine elements after the deposition of Kopili Formation is indicative of regression of sea at the end of Eocene.

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