Palynostratigraphical studies on subsurface Tertiary sediments in Upper Assam Basin, India

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The present paper incorporates the results of palynostratigraphical investigations of subsurface Tertiary sediments from six bore-holes in the Upper Assam Basin, India. A total of 87 palynofossil genera and 120 species belonging to pteridophytic spores, gymnospermous and angiospermous pollen, fungal spores and ascostromata and dinoflagellate cysts are recorded. The distributional pattern of palynotaxa demonstrates the reliability of palynofloral assemblages in the demarcation of different litho-units as well as for long distance correlation. The recorded palynofloral assemblages are compared with the previous reported assemblages from the north-eastern region. Qualitative and quantitative analyses of the palynoflora indicate the presence of lowland subtropical rain forest during Palaeogene times. However, in Neogene it shows distinct development of montane vegetation. Palaeoenvironmental condition of deposition of these sediments is also inferred.

Key-words—Palynology, Palynostratigraphy, Palaeoenvironment, Tertiary, North-east India.

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सारांश

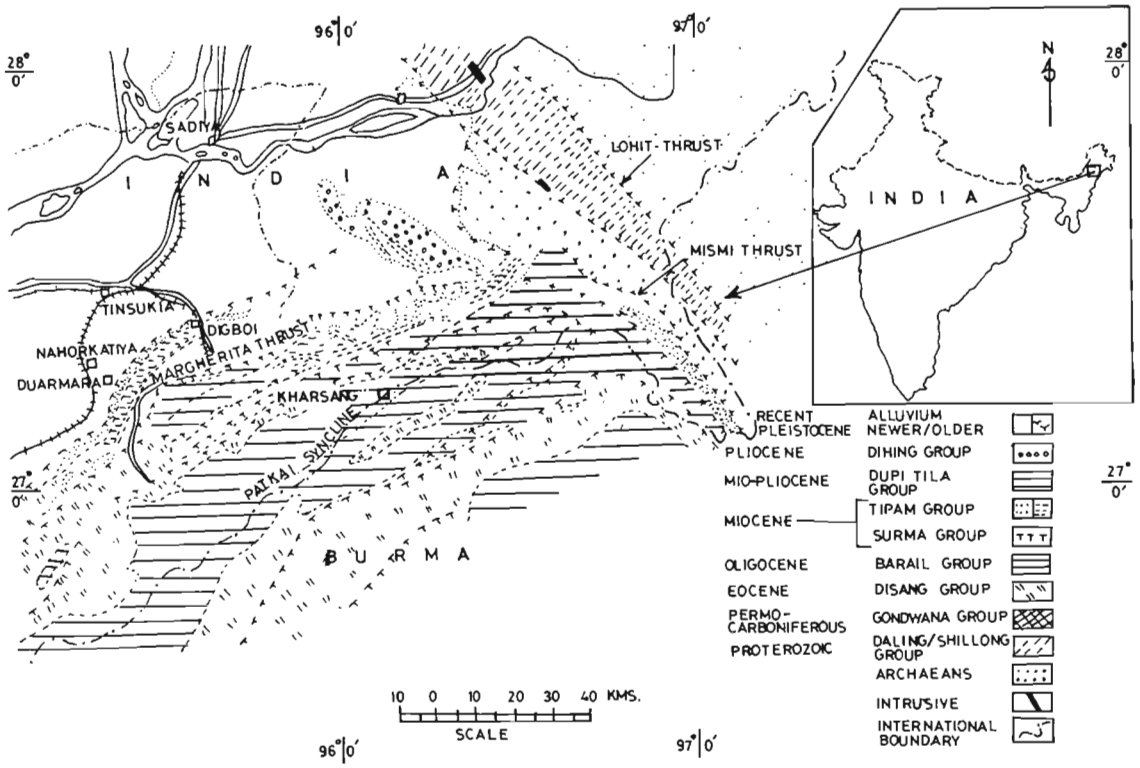
उपरि असम द्रोणी (भारत) में उपसतही तृतीयक अवसादों का परागाणुस्तरिकीय अध्ययन

रंजीत कुमार कर, जी०के० हैन्डीक, सी०के० कलिता, जगन्नाथ प्रसाद मंडल, समीर सरकार, माधव कुमार एवं आशा गुप्ता

प्रस्तुत शोध-पत्र में उपरि असम द्रोणी (भारत) में छः वेध-छिद्रों के उपसतही तृतीयक अवसादों का परागाणुस्तरिकीय अन्वेषण प्रस्तुत किया गया है। कुल मिलाकर इस समुच्चय में टेरीडोफ़ाइटी बीजाणु, अनावृतबीजी एवं आवृतबीजी परागकणों, कवकीय बीजाणु एवं कवकजाल तथा घूर्णिकाशाभपुटीयों की 87 प्रजातियाँ एवं 120 जातियाँ वर्णित की गई हैं। परागाणुवर्गकों के वितरण के स्वरूप से इंगित होता है कि परागाणुसमुच्चयों से विभिन्न शैल-इकाईयों का परिसीमन एवं दूरस्थ सहसम्बन्धन सम्भव है। प्रस्तुत परागाणविक समुच्चयों की तुलना उत्तर-पूर्वी क्षेत्र से पहले से वर्णित समुच्चयों से की गई है। परागाणुवनस्पतिजात के परिमाणात्मक एवं गुणात्मक विश्लेषणों से पूर्व-तृतीयक कल्प में निम्नभूमि उपोष्ण कटिबन्धीय वर्षा वाले वनों की उपस्थिति इंगित होती है। तथापि, पश्च-तृतीयक कल्प में यह पर्वतीय वनस्पति की उपस्थिति व्यक्त करता है। इन अवसादों के निक्षेपणीय वातावरण की भी विवेचना की गई है।

THE alluvium covered Upper Assam continental basin which is a part of the major Assam-Arakan province, forms the north-eastern corner of the Indian subcontinent. In north it is bounded by the eastern Himalayas, in south and south-east by the Naga-Patkai hill ranges, in north-east by the Mismi hills and in the south-west by Mikir hills (Text-figure 1). The Tertiary deposits in the shelf zone of this basin are very thick (average thickness about 5,000 m) and include shallow marine to brackish Palaeogene and continental fluviatile Neogene sediments. Geologists using different parameters, viz., lithological variation, heavy mineral content of the rocks, etc. attempted to classify and correlate different lithounits in this basin but due to insufficient records of animal or plant fossils several gaps still exist in our knowledge. Moreover, the lithofacies varies considerably from place to place which render difficulty in attempting correlation of strata especially in the younger Neogene sediments. This problem is further aggravated because of the disturbed natural order of superposition of strata due to strong tectonic activity in the area.

With a view to understand the distributional pattern of palynofossils in different formations in the Upper Assam Basin, Oil India Limited (OIL), Duliajan, Assam and the Birbal Sahni Institute of Palaeobotany, Lucknow worked in collaboration and carried out palynostratigraphical investigations of six bore-hole cores in the Upper Assam and Arunachal Pradesh. The major objectives of the present investigation were : (i) to record palynofossils from various stratigraphic levels



Text-figure 1—Geological map showing the location of studied bore-holes in Upper Assam Basin (after O.I.L., Duliajan).

of Upper Assam, (ii) to determine the exact correlative value of the established palynological zones, and (iii) to help in the reconstruction of palaeoclimate, palaeoenvironment and past vegetation during the deposition of Tertiary rocks in the Upper Assam Basin.

GEOLOGICAL SETTING

The generally accepted stratigraphic succession of this region is given in Table 1. Except for a few limestone beds within the Palaeogene, the area mostly consists of clastic sediments. The post Barail unconformity is the significant feature in this region which distinctly separates Neogene from Palaeogene. The area consists of more than 4 km of mainly terrigenous Cenozoic sediments above a Precambrian igneous basement ridge referred to as Brahmaputra Arch by Murty (1983). The Cenozoic succession has been subdivided on the basis of wireline log response, biostratigraphical, sedimentological and gross lithological data.

The Precambrian base rocks are exposed in the Mikir hills which may be regarded as a tectonic high with structural down wrap both towards NW-SE. This high continues towards NE under thick alluvium cover of the Upper Assam Valley as a hidden basement ridge.

Table 1

	Namsang Formation	Interbedded sands and claystones with minor lignite beds (maximum thickness—600 m)
	Girujan Formation	Massive claystone with minor argillaceous sandstones (maximum thickness—1,100 m)
NAHORKATIYA GROUP		
	Tipam Formation	Primarily sandstone dominated formation with minor to locally massive shale beds. The basal section of the formation may correspond with Surma Conglomerate Member This can be further subdivided into Early, Middle and Late Tipam sandstones separated by shale beds (maximum thickness—1,100 m)
	Tinali Formation	Massive sands with minor claystones
BARAIL GROUP		
	Moran Formation	Claystones with minor sandstones and coals (maximum thickness—1,200 m)
	Kopili Formation	Shale and fine-grained sandstones with coal bands (maximum thickness—500 m)
JAINTIA GROUP		
	Sylhet Formation	Fossiliferous limestones and shales and sandstone bands (maximum thickness—500 m)
	Unconformity	
	Precambrian granitic basement	

Recently acquired seismic data and the available drilling evidence suggest that the basement ridge which plunges NE and passes through Tengaghat-Bordubi area takes a swing towards N-N-NE beyond Bordubi area. Numerous basement faults running more or less parallel to the SW trending Naga thrust and minor transverse faults make the structure more complicated resulting in the formation of different fault blocks. These faults have played apparently an important role in the accumulation and distribution of hydrocarbons in the area (Handique & Mallick, 1989).

LOCATION OF SAMPLES AND LITHOLOGY

The palynological samples are from six bore-hole cores, viz., Nahorkatiya (NHK)-1,263,268; Kharsang-2,3 and Duarmara-2 provided by Oil India Limited, Duliajan, Assam. Nahorkatiya oil field (Lat. 27°15′: Long. 95°15′) is situated approximately between Dibrugarh and Tinsukia in the Dibrugarh District, Assam. Duarmara (Lat. 27°15′: Long. 95°40′) is on the north-eastern side of the Digboi oil field and is also in the Dibrugarh District. Kharsang oil field (Lat. 27°25′: Long. 96°02′) is in the Tirap District of Arunachal Pradesh. The location of the oil field has been shown in Text-figure 1.

The Nahorkatiya bore-hole core no. 1 (NHK-1) comprises Upper Kopili (Late Eocene) to Girujan (Miocene). Nahorkatiya 263 (NHK-263) and 268 (NHK-268) consist of Langpar (Early Palaeocene) to Dhekiajuli (Pliocene). Kharsang 2 and 3 represent Tipam (Miocene), Namsang (Mio-Pliocene) and Barails (Oligocene) above the thrust zone. Duarmara-2 penetrates through Dhekiajuli (Pliocene) to Barails (Oligocene).

METHODOLOGY

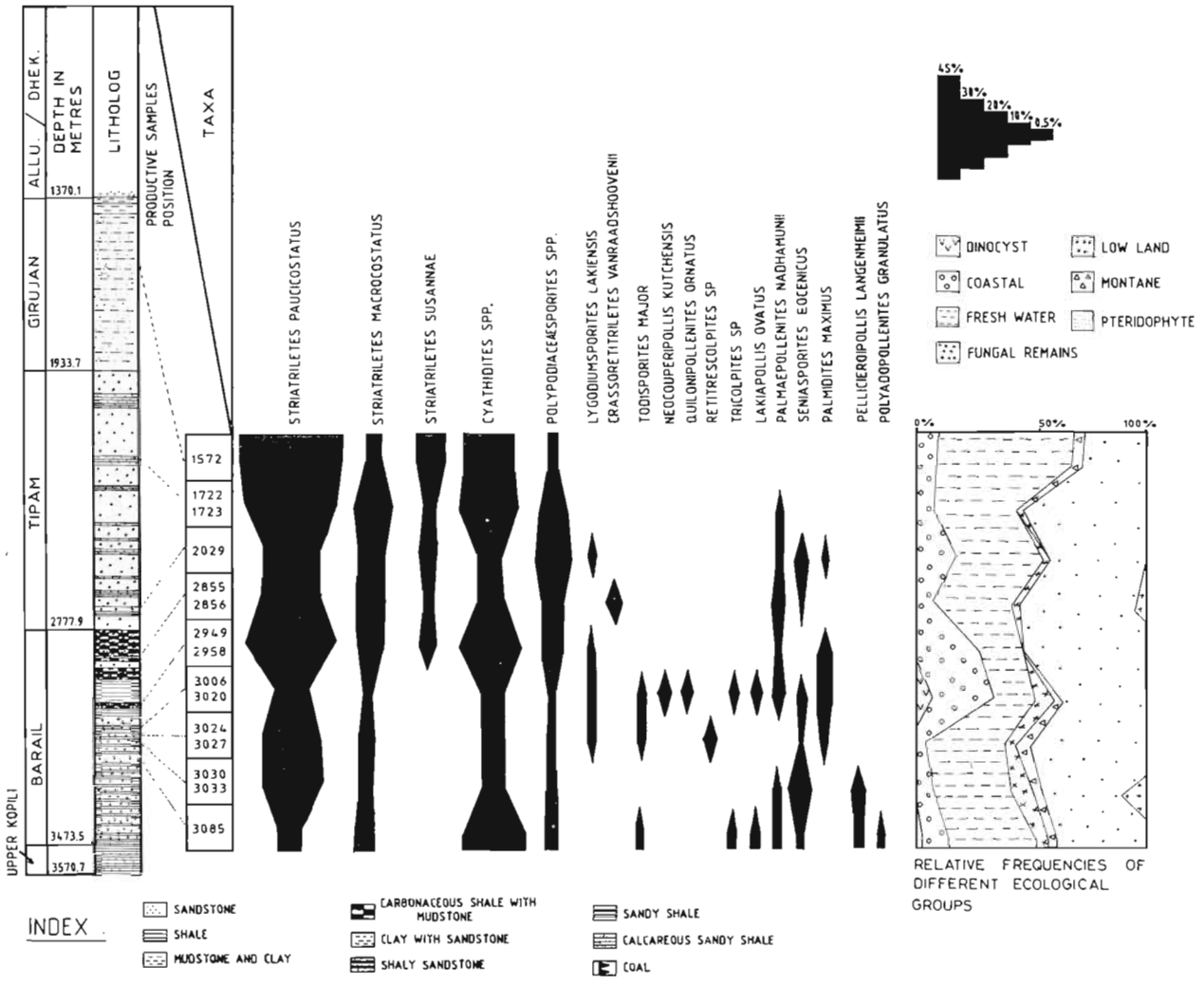
All the samples were chemically processed for the recovery of palynofossils by the usual conventional method. The slides were prepared in Polyvinyl alcohol and mounted in canada balsam. Two hundred palynofossils were counted in each sample for quantitative analysis. Negatives and slides of all the figured specimens have been kept in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

RECORDED PALYNOTAXA

The spores, pollen grains, fungal bodies and phytoplanktons recovered from the sediments of these bore-hole cores have been placed under 87 genera and 120 species. Out of these, 23 genera and 45 species represent pteridophytes, 4 genera and 5 species belong to gymnosperms, 41 genera and 53 species represent angiosperms, 9 genera and 7 species represent algae and 10 genera and 10 species represent fungi. Qualitatively, the angiosperm pollen exhibit the dominance over other plant groups but quantitatively pteridophytic spores constitute the major part of the assemblage. Gymnospermous pollen are poorly represented in most of the samples; however, at certain stratigraphical levels they form major constituents of the assemblage. Quantitative analysis of the overall assemblage reveals a comparatively poor representation of the fungal elements through the sequence. The stratigraphic distribution of significant palynotaxa in different bore-holes is given in Text-figures 2-7.

Pteridophytic spores

Alsophilidites sp.
Cyathidites minor Couper 1953
Cyathidites australis Couper 1953
Cyathidites major Couper 1953
Crassoretitriletes vanraadshoovenii Germeraad, Hopping & Muller 1968
Cheilanthoidspora monoleta Sah & Kar 1970
Dictyophyllidites dulcis Kar 1985
Dictyophyllidites kyrtomatus Kar & Kumar 1986
Dandotiaspora plicata (Sah & Kar) Sah, Kar & Singh 1971
Dandotiaspora dilata Sah, Kar & Singh 1971
Foveosporites splendus Kar & Saxena 1981
Gleicheniidites sp.
Intrapunctisporis intrapunctis Krutzsch 1959
Intrapunctisporis apunctis Krutzsch 1959
Lygodiumsporites lakiensis Sah & Kar 1969
Lygodiumsporites eocenicus Dutta & Sah 1970
Lycopodiumsporites globatus Kar 1985
Lycopodiumsporites sp.
Osmundacidites kutchensis Sah & Kar 1970
Osmundacidites wellmanii Couper 1953
Osmundacidites sp.
Pilamonoletes excellensus Kar 1990
Pilamonoletes moderatus Kar 1990
Polypodiaceaesporites tertiarus Sah & Dutta 1970
Polypodiaceaesporites levis Sah 1967
Polypodiaceaesporites chatterjii Kar 1979
Polypodiaceaesporites intrapunctatus Kar & Jain 1981
Polypodiaceaesporites major Saxena 1978
Polypodiisporites constrictus Kar 1979
Polypodiisporites repandus Takahashi 1964
Polypodiisporites impariter (Potonié & Sah) Dutta & Sah 1970
Polypodiisporites ornatus Sah 1967
Polypodiisporonites maukmaensis (Dutta & Sah) Mathur & Chopra 1982
Seniasporites minutus Sah & Kar 1969
Seniasporites eocenicus Sah & Kar 1969
Pteridacidites africanus Sah 1967
Pteridacidites vermiverrucatus Sah 1967
Pteridacidites sp.
Scantigranulites sparsus Kar 1978
Striatriletes susannae van der Hammen emend. Kar 1979
Striatriletes paucicostatus Kar 1985
Striatriletes multicostatus Kar & Saxena 1981
Striatriletes aidaensis Kar 1985
Striatriletes microverrucosus Kar & Saxena 1981
Todisporites minor Couper 1958
Todisporites major Couper 1958
Todisporites kutchensis Sah & Kar 1974
Verrucosisporites verrucus Sah & Kar 1970
Foveosporites splendus Kar & Saxena 1981



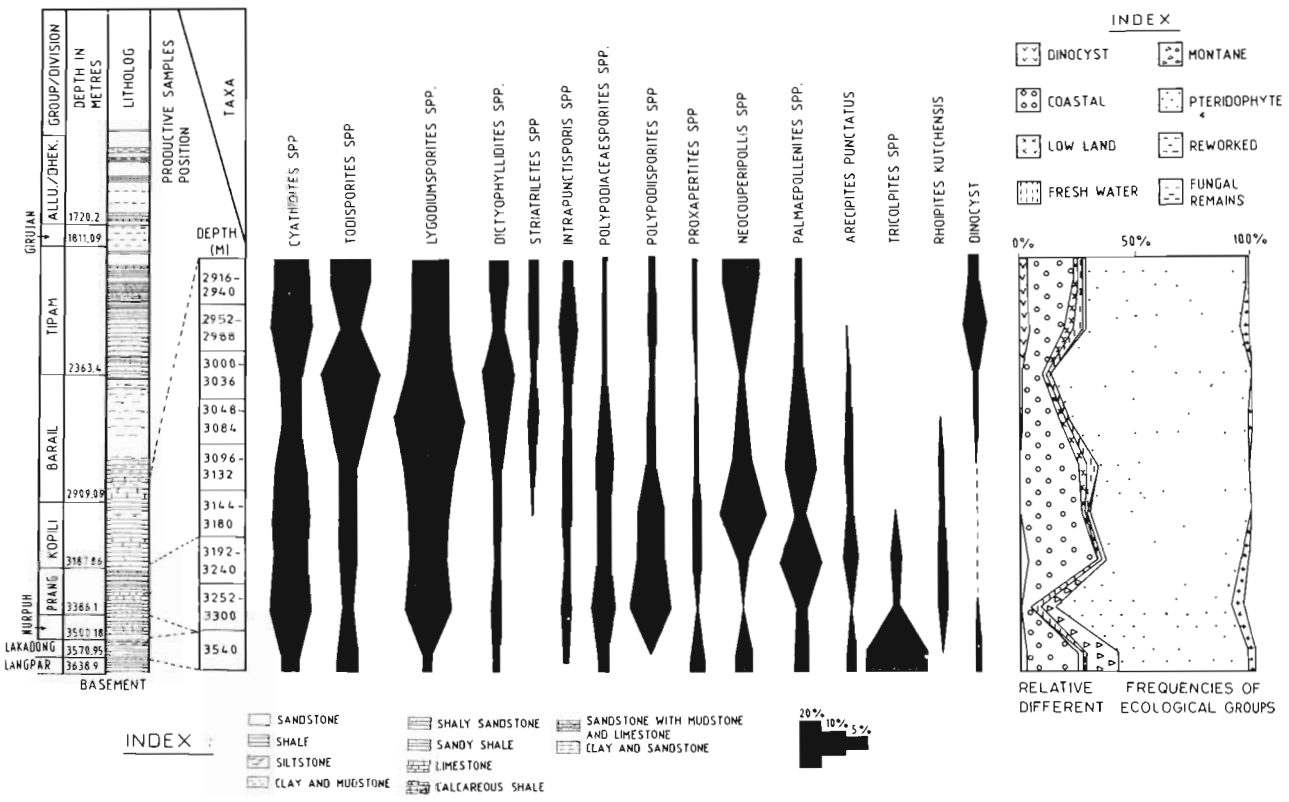
Text-figure 2—Stratigraphic distribution of significant palynofossils in Nahorkatiya Well-1, Assam alongwith summary diagram of different ecological groups.

Gymnosperm pollen

Abiespollenites cognatus Kar 1985
Pinuspollenites crestus Kar 1985
Podocarpidites khasiensis Dutta & Sah 1970
Podocarpidites densicorpus Kar 1985
Tsugaepollenites velatus Kar 1985

Angiosperm pollen

Acanthotricolpites bulbospinosus Kar 1985
Arecipites intrapunctatus Kar & Saxena 1981
Arecipites sp.
Pseudonothofagidites cerebrus Venkatachala & Kar 1969
Compositoipollenites tricolporatus Kar 1985
Compositoipollenites conicus Sah 1967
Compositoipollenites sp.
Cupuliferoipollenites pusillus Potonié 1951
Ctenolophonidites sp.
Diporopollis assamicus Dutta & Sah 1970
Graminidites media Cookson 1947
Graminidites sp.
Hibisceaepollenites splendus Kar 1985
Liguliforaedites pilatus Kar 1985
Meyeripollis naharkotensis Baksi & Venkatachala 1970
Favitricolporites ornatus Sah 1967
Retitrescolpites oblongus Sah 1967
Retitrescolpites decipiens Sah 1967
Retitrescolpites bellus Sah 1967
Echimonocolpites rarispinosus (Sah & Dutta) Mathur & Jain 1980
Echimonocolpites wodehousei (Biswas) Mathur & Jain 1980
Neocouperipollis kutchensis (Venkatachala & Kar) Kar & Kumar 1987
Neocouperipollis brevispinosus (Venkatachala & Kar) Sarkar & Singh 1988
Intrareticulites brevis (Sah & Kar) Kar 1985
Spinizonocolpites echinatus Muller 1968
Palmidites maximus Couper 1953
Quilonipollenites ornatus Rao & Ramanujam 1978
Monoporopollenites gramineoides Meyer 1956
Palmaepollenites ovatus Sah & Kar 1970
Palmaepollenites kutchensis Venkatachala & Kar 1969
Palmaepollenites nadhamunii Venkatachala & Kar 1969
Paleosantalaceaepites ellipticus Sah & Kar 1969
Palaeomalvaceaepollis mammilatus Kar 1985
Palaeomalvaceaepollis rudis Kar 1985
Pellicieroipollis langenheimii Sah & Kar 1970
Polyadopollenites miocenicus Ramanujam 1966



Text-figure 3—Stratigraphic distribution of significant palynofossils in Nahorkatiya Well-263, Assam alongwith summary diagram of different ecological groups.

Polyadopollenites granulatus Sah 1967
Polyporina multiporosa Kar 1985
Polyporina globosa Kar 1985
Paleocaesalpiniaceaepites eocenica (Biswas) Venkatachala & Rawat 1972
Tricolpites reticulatus Cookson 1947 ex Couper 1953 emend. Potonié 1960
Tricolpites crassireticulatus Dutta & Sah 1970
Tricolpites levis Sah & Dutta 1966
Tricolpites sp.
Tricolporopilites robustus (Kar & Saxena) Kar 1985
Tricolporopilites pseudoreticulatus Kar 1985
Verrucolporites verrucus Sah & Kar 1969
Myricipites sp.
Palaeocoprosmadites arcotense Ramanujam 1966
Polybrevicolporites cephalus Venkatachala & Kar 1969
Rhoipites kutchensis Venkatachala & Kar 1966
Meliapollis ramanujamii Sah & Kar 1970
Lakiapollis ovatus Venkatachala & Kar 1969
Retistephanocolpites kutchensis Saxena 1979
Proxapertites microreticulatus Jain, Kar & Sah 1973
Bombacacidites triangulatus Kar 1985
Pilatrisyncolpites triangulatus Kar, Mandal, Sarkar & Kumar 1994
Triporate pollen
Striacolporites cephalus Sah & Kar 1970

Fungal and other remains

Inapertisporites kedvesii Elsik 1968
Phragmothyrites eocaenica Edwards emend. Kar & Saxena 1976
Notothyrites setiferous Cookson 1947
Pluricellaesporites ellipticus Mathur & Mathur emend. Kar 1985
Kutchiathyrites eccentricus Kar 1977
Fusiformisporites pseudoradbii Elsik 1969
Dicellaesporites sp.
Dyadosporonites constrictus Mathur & Mathur 1969
Heliospermopsis sp.
Operculosculptites globatus Kar 1990

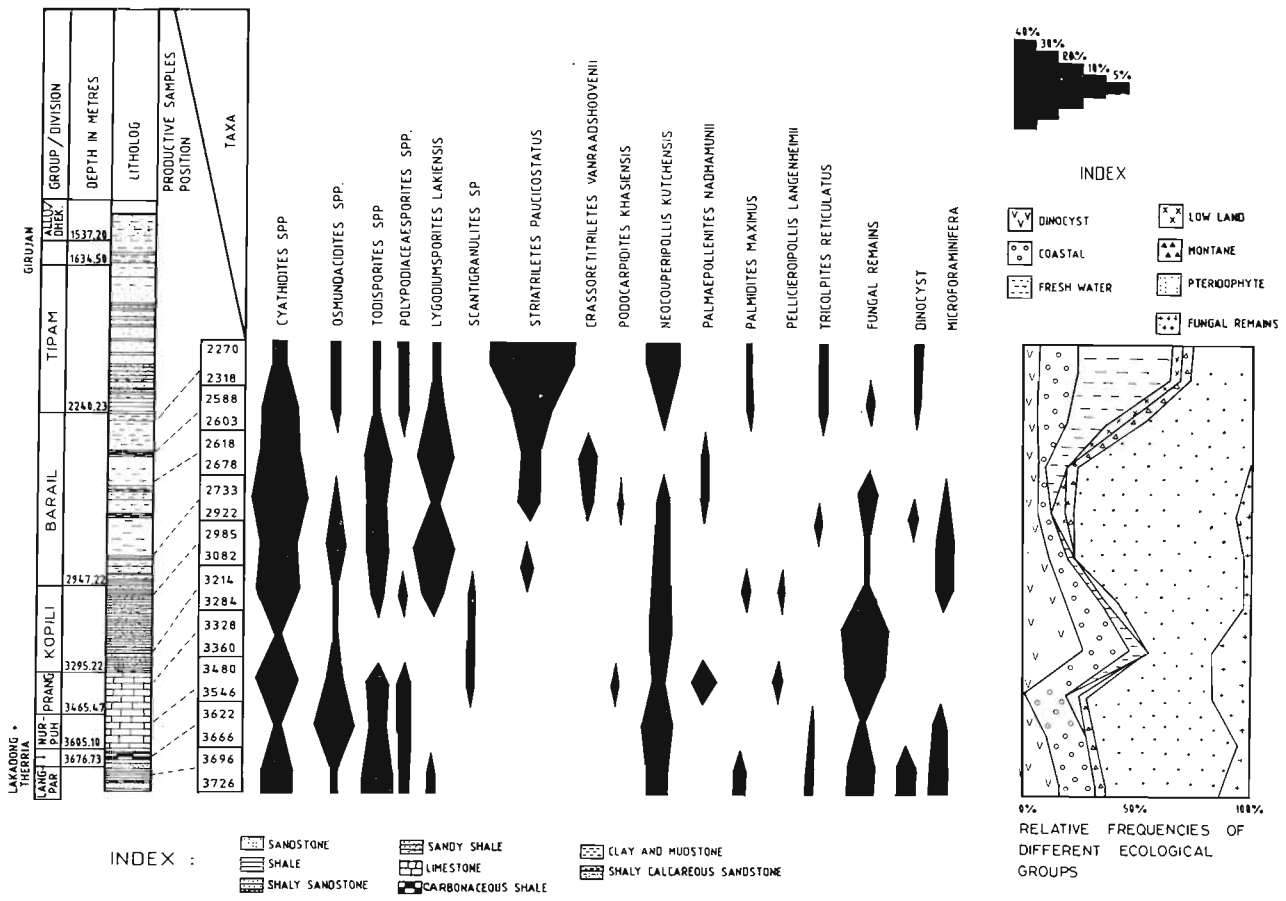
Algae

Pediastrum boryanum var *longicorne* Reinsch.
Psiloschizosporis psilata Jain & Kar 1981
Azolla aglochidia Kar 1985
Cordosphaeridium exilimurum Davey & Williams 1966
Cleistosphaeridium cephalum Kar 1985
Cleistosphaeridium diversispinosum Davey, Downie, Sarjeant & Williams 1966
Glaphyrocysta exuberans (Deflandre & Cookson) Stover & Evitt 1978
Glaphyrocysta sp.
Operculodinium centrocarpum (Deflandre & Cookson) Wall 1967
Oligosphaeridium complex (White) Davey & Williams 1966
Homotryblium plectilum Drugg & Loeblich 1967

LITHO- AND BIO-STRATIGRAPHY

Nahorkatiya well-1

The lowermost part of this bore-core (3570.7-3473.5 m) is represented by the upper part of the Kopili Formation. Lithologically, it is characterised by alternation of sandstone and shale. The older horizons are highly

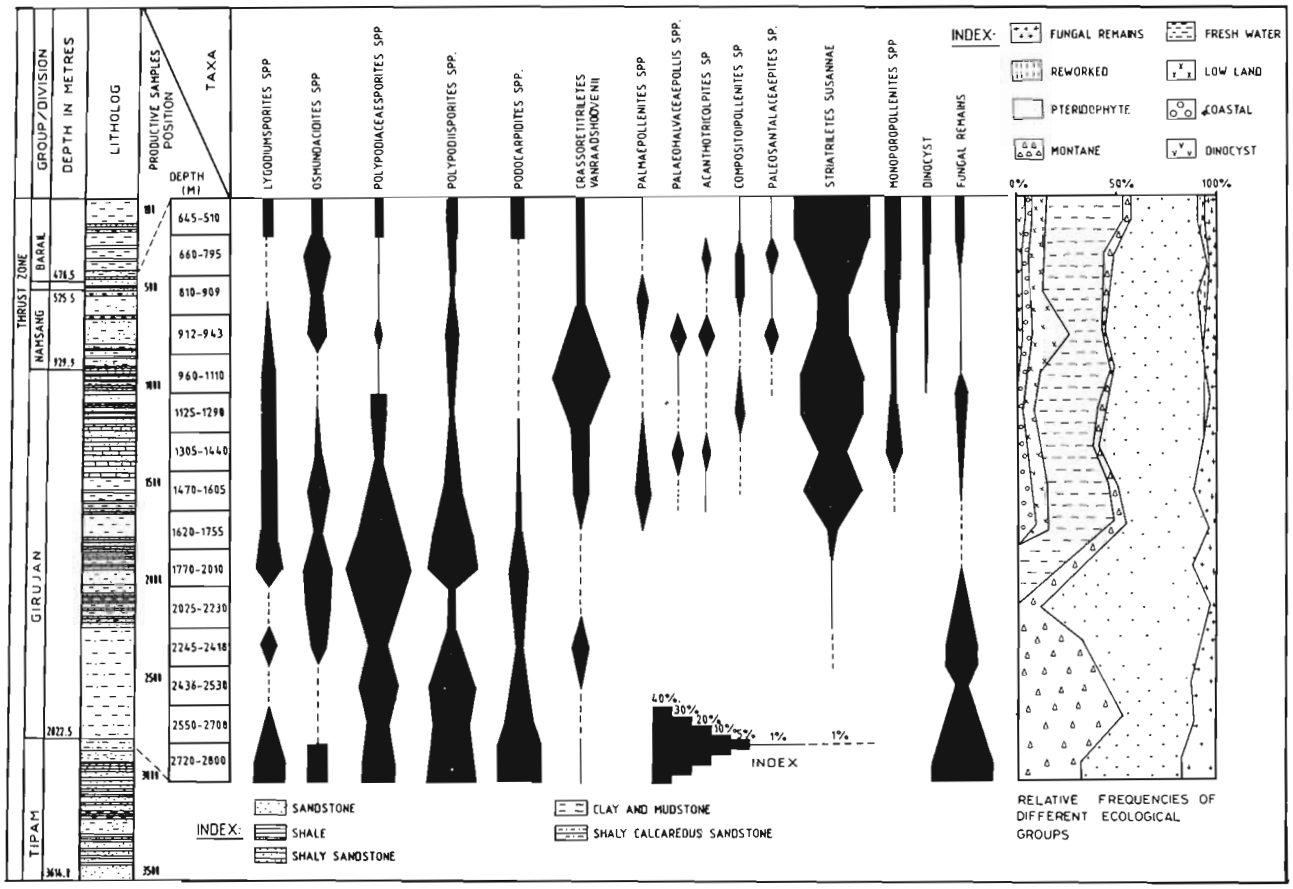


Text-figure 4—Stratigraphic distribution of significant palynofossils in Nahorkatiya Well-268, Assam alongwith summary diagram of different ecological groups.

arenaceous in nature. All the samples examined between this interval were barren of palynofossils.

The overlying Barail Group of rocks are well developed at 3473.5 to 2777.9 m interval comprising mainly sandstone with few bands of shale in between at lower and carbonaceous shales and mudstones at the upper part. Pteridophytic spores are predominant. Some of the important constituents are *Striatriletes paucicostatus, S. multicostatus, S. microverrucosus, S. susannae, Cyathidites australis, Polypodiaceaesporites chatterjii, Polypodiaceaesporites levis, Polypodiisporites repandus, Crassoretitriletes vanraadshoovenii* and *Seniasporites minutus*. The overwhelming dominance of *Striatriletes paucicostatus* and *Cyathidites* spp. in the younger horizons is a noteworthy feature of this assemblage. *Crassoretitriletes vanraadshooveni* is restricted in its occurrence at the top of Barails (2856-2855 m). Bisaccate gymnosperm pollen, viz., *Podocarpidites khasiensis* begin to appear from 3085 m. Angiosperm pollen, viz., *Palmaepollenites nadhamunii, Palmidites maximus, Polyadopollenites granulatus, Neocouperipollis kutchensis, Quilonipollenites ornatus, Pellicieroipollis langenheimii, Tricolpites crassireticulatus* and *Retitrescolpites decipiens* are predominant in the older-horizons. *Favitricolporites ornatus, Spinizonocolpites echinatus, Tricolpites levis, Rhoipites kutchensis, Palaeocoprosmadites arcotense* and *Polyporina multiporosa* are sporadically present.

The Tipam Formation runs from 2777.9-1933.6 m. It is represented by sandstone with some thin shale bands. The palynological assemblage includes angiosperm taxa, viz., *Palmaepollenites nadhamunii, Palmidites maximus* along with pteridophytic spore genera, viz., *Striatriletes paucicostatus, Seniasporites eocenicus* and *Polypodiisporites impariter*. Girujan Formation (1933.7-1370.1 m) consists mostly of claystones, but minor sandstones are present at many levels. Overwhelming dominance of pteridophytic spores has been noticed in all the samples. Significant taxa recorded in this assemblage are *Striatriletes paucicostatus, S. macrocostatus, S. susannae, Cyathidites australis, C. minor, Polypodiaceaesporites chatterjii* and *Polypodiisporites repandus*. Angiosperm pollen grains are poorly represented in this assemblage. Fungal spores and conidia have also been recorded throughout the sequence.



Text-figure 5—Stratigraphic distribution of significant palynofossils in Kharsang Well-2, Arunachal Pradesh alongwith summary diagram of different ecological groups.

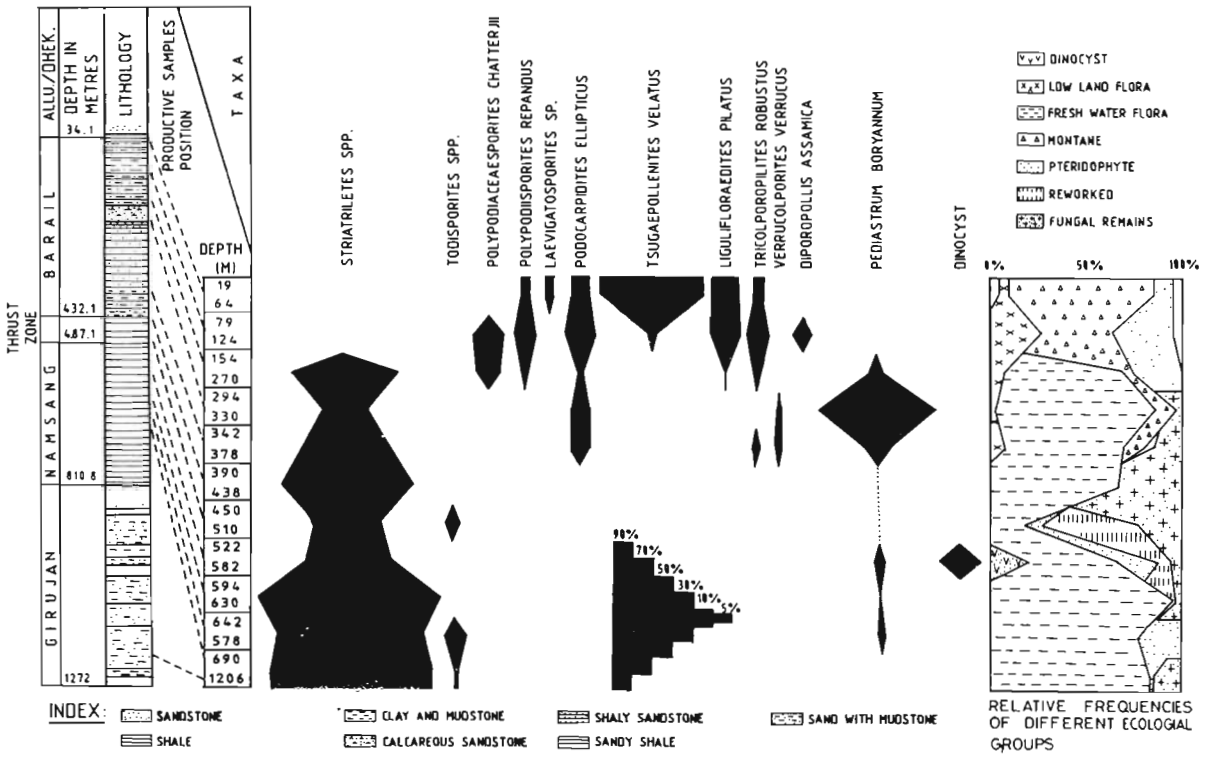
Nahorkatiya Well-263

It represents a continuous sequence from the Langpar Formation to Recent. The Langpar Formation is confined to 3638.96-3570.94 m interval. The lithology of this formation is characterised by limestone, sandstone and mudstone. All available samples have proved palynologically unproductive.

The overlying Sylhet Formation is well-developed in this bore-hole. Sample from the lower part of this formation (3570.94-3500.18 m), i.e., Lakadong Member yielded a rich palynological assemblage dominated by pteridophytic spores, viz., *Cyathidites australis, Todisporites minor, Lygodiumsporites lakiensis, Dictyophyllidites dulcis, Intrapunctisporis intrapunctis* and *Polypodiaceaesporites levis.* Angiosperm pollen taxa recorded from this assemblage are *Tricolpites reticulatus, T. crassireticulatus, Tricolporopilites pseudoreticulatus, Neocouperipollis kutchensis, Neocouperipollis brevispinosus, Proxapertites microreticulatus, Palmaepollenites nadhamunii* and *Arecipites* sp. Dinoflagellate cysts have been recorded in high percentage in some samples from 2952 to 2988 m. The significant dinocyst taxa are *Cordosphaeridium exilimurum, Cleistosphaeridium cephalum, C. diversispinosum* and *Operculodinium centrocarpum.* Lithologically, Lakadong members are characterised by having limestone bands, shale, clay and mudstone. The base of the Lakadong is marked by the presence of a thick sandstone band.

The Nurpuh Member is confined to 3500.18-3386.11 m. The basal part of this member consists of sandstone, whereas in the uppermost mudstone and limestones are the predominant lithofacies. Palynofossils recorded from this horizon include mostly pteridophytic spores alongwith many angiosperm pollen taxa. This part of the bore-core is dominated by the presence of *Lygodiumsporites eocenicus, Dictyophyllidites dulcis, Polypodiaceaesporites levis, Proxapertites microreticulatus* and *Neocouperipollis brevispinosus. Rhoipites kutchensis* makes its first appearance at 3500.18 m.

Prang Member is encountered at 3386.11 to 3187.86 m and contains mostly calcareous shale and limestone at the basal part and sandstones at the upper part. Samples from this horizon have yielded abundant palynofossils. The significant palynotaxa are : *Polypodiisporites impariter, P. repandus, P.*



Text-figure 6—Stratigraphic distribution of significant palynofossils in Kharsang Well-3, alongwith summary diagram of different ecological groups.

mawkmaensis, Lygodiumsporites lakiensis, Arecipites intrapunctatus and *Palmaepollenites kutchensis.*

Rocks of Kopili Formation is recovered at 3187.86 to 2909.09 m. It is characterised mostly by sandy shale and sandstone. The lower part of this formation yielded a rich palynological assemblage. The assemblage is dominated by *Lygodiumsporites eocenicus, Osmundacidites kutchensis, Striatriletes susannae, Pteridacidites vermiverrucatus* and *Neocouperipollis kutchensis.* Palynotaxa, viz., *Polybrevicolporites cephalus, Retistephanocolpites kutchensis, Meliapollis ramanujamii* and *Arecipites intrapunctatus* are quite common in the samples. *Proxapertites* spp. are poorly represented in this assemblage. Dinoflagellate cysts, viz., *Operculodinium centrocarpum, Cleistosphaeridium diversispinosum, Glaphyrocysta* spp. are predominant in the samples of upper part, i.e. 2988-2952 m. The remaining part of the bore-hole is represented by the rocks of the following litho-units in ascending order of stratigraphy, viz., Barail Group (2209.09-2368.48 m),

PLATE 1 →

(All photographs are enlarged ca. × 500, unless otherwise stated. England finder's readings given after slide numbers)

1. *Alsophilidites* sp., Slide no. BSIP 10924 (O 52/3).
2. *Polypodiaceaesporites intrapunctatus*, Slide no. BSIP 10916 (C 36/4).
3. *Polypodiisporites ornatus*, Slide no. BSIP 10917 (R 43/3).
4. *Seniasporites eocenicus*, Slide no. BSIP 10917 (O 53).
5. *Tricolpites* sp., Slide no. BSIP 10941 (R 31/2).
6. *Favitricolporites ornatus*, Slide no. BSIP 10921 (Y 35/3).
7. *Pilatrisyncolpites triangulatus*, Slide no. BSIP 10922 (E 33/3).
8. *Compositoipollenites* sp., Slide no. BSIP 10920 (H 35).
9. *Pteridacidites africanus*, Slide no. BSIP 10955 (T 54).
10. *Tricolpites reticulatus*, Slide no. BSIP 10926 (P 37).
11. *Tricolpites crassireticulatus*, Slide no. BSIP 10925 (S 40).
12. *Polyporina multiporosa*, Slide no. BSIP 10930 (P 14/1).
13. *Tricolporopilites pseudoreticulatus*, Slide no. BSIP 10936 (N 56/2).
14. *Acanthotricolpites bulbospinosus*, Slide no. BSIP 10927 (C 39).
15,24. *Retitrescolpites decipiens*, Slide no. BSIP 10929 (O 28), 10931 (V 24).
16. *Echimonocolpites rarispinosus*, Slide no. BSIP 10951 (X 35).
17. *Pteridacidites* sp., Slide no. BSIP 10943 (R 73/4).
18. *Operculosculptites globatus*, Slide no. BSIP 10934 (N 3).
19. *Intrapunctisporis intrapunctis*, Slide no. BSIP 10932 (L 49/2).
20. *Striacolporites cephalus*, Slide no. BSIP 10928 (L 50).
21 *Paleosantalaceaepites eocenica*, Slide no. BSIP 10918 (R 3).
22. *Crassoretitriletes vanraadshoovenii*, Slide no. BSIP 10952 (R 19/3).
23. *Monoporopollenites gramineoides*, Slide no. BSIP 10946 (G 22/4).
25. *Striatriletes susannae*, Slide no. BSIP 10925 (N 21).
26. *Operculodinium centrocarpum*, Slide no. BSIP 10956 (J 14/3).
27. *Homotriblium plectilum*, Slide no. BSIP 10958 (C 45/4).
28. *Dandotiaspora dilata*, Slide no. BSIP 10927 (Q 20/1).

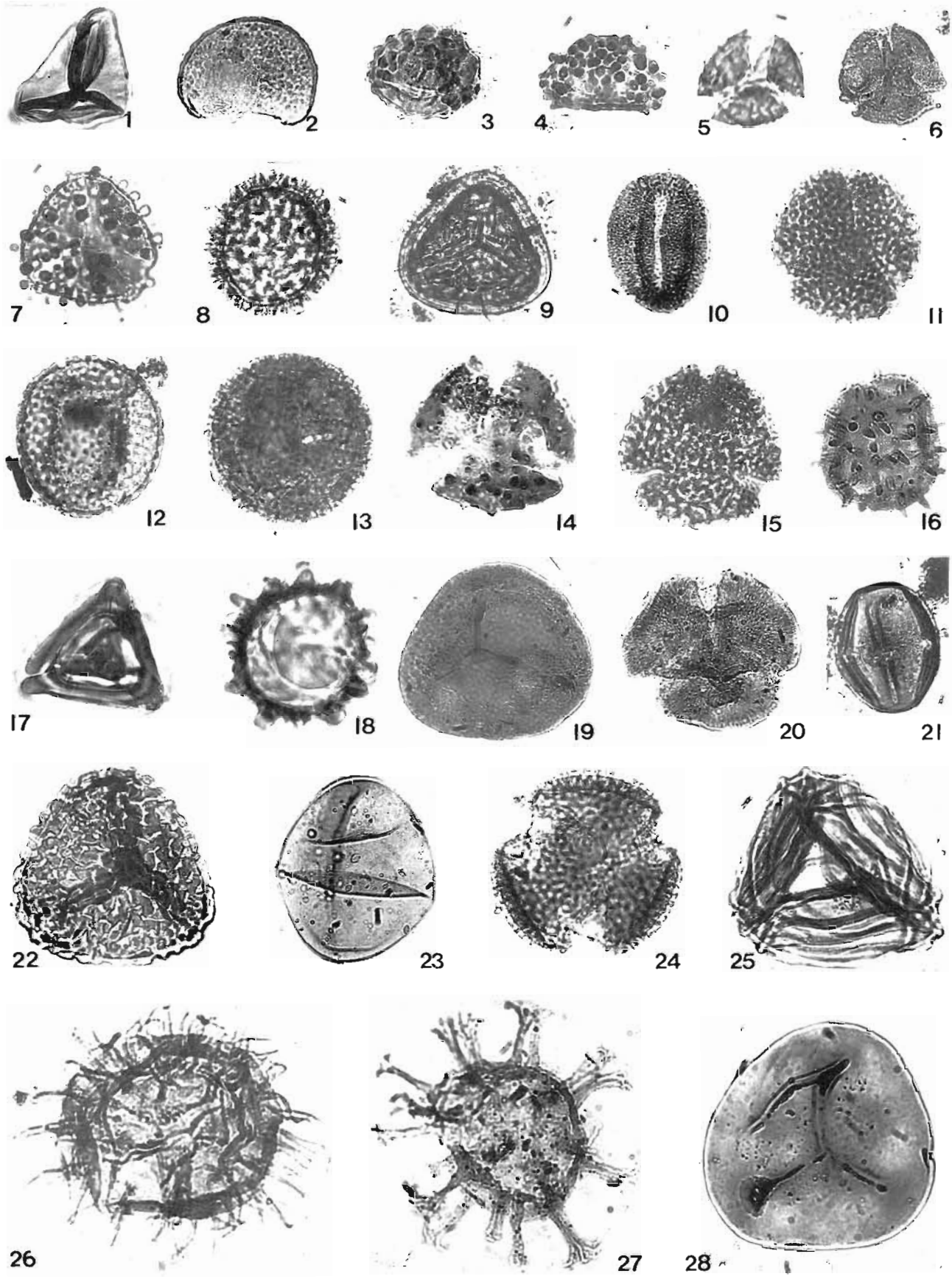
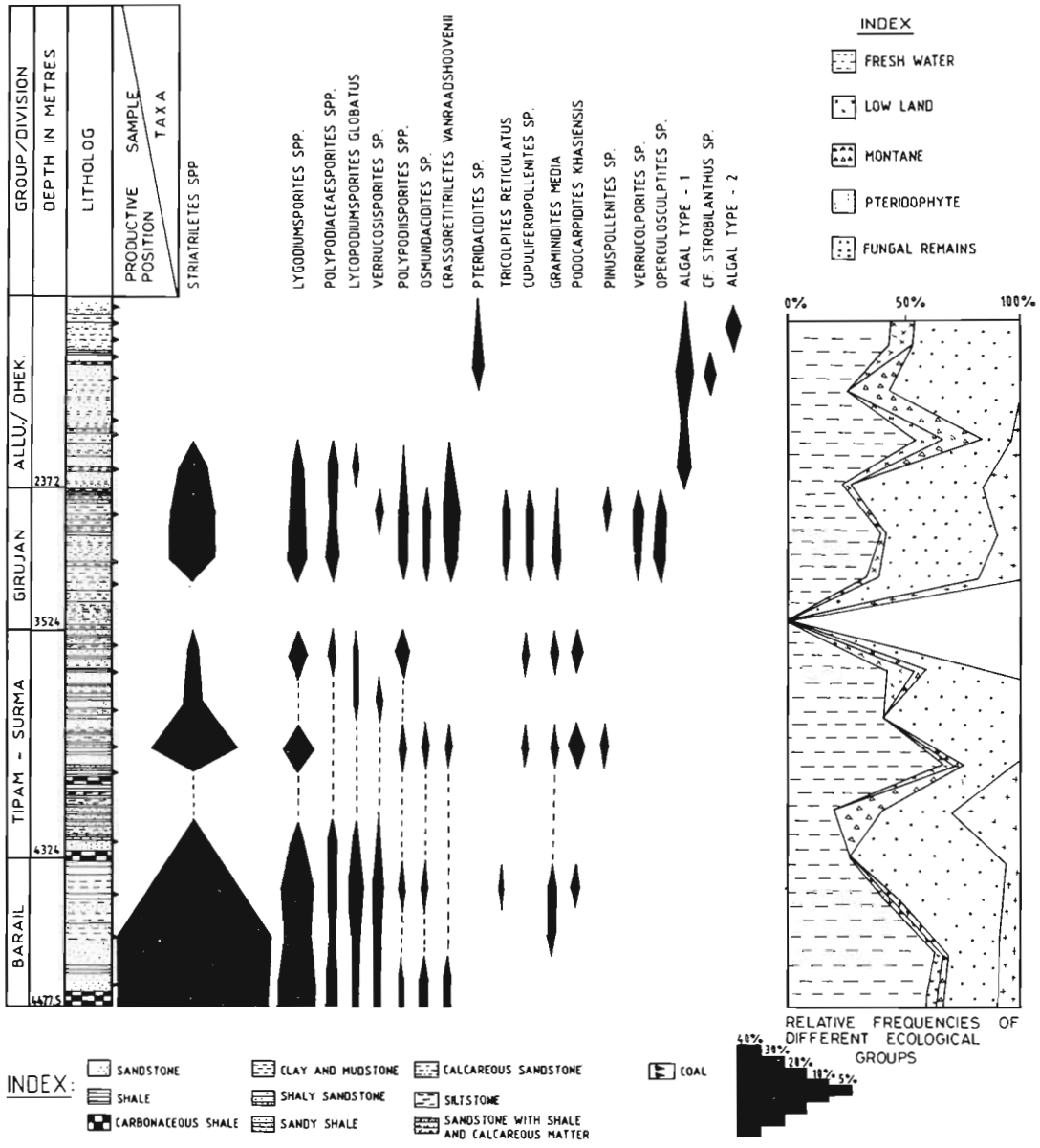


PLATE 1



Text-figure 7—Stratigraphic distribution of significant palynofossils in Duarmara Well-2 alongwith summary diagram of different ecological groups.

Tipam Group (2368.48-1811.09 m), Girujan Formation (1811.09-1720.2 m) and Dhekiajuli Formation (1720.2-1311.5 m). Palynological informations from this litho-unit could not be recorded due to the nonavailability of samples.

Nahorkatiya Well-268

The Langpar Formation is found at 3726-3696 m level. Lithologically, it comprises sandstones at the basal part and carbonaceous shale at the upper. Langpar palynological assemblage comprises pteridophytic spores, angiospermic pollen, fungal spores and conidia and dinoflagellate cysts. The most dominant elements are *Cyathidites major*, *Todisporites kutchensis*, *Neocouperipollis kutchensis* and *Palmidites maximus*. Few other angiosperm pollen taxa are also sporadically present, viz., *Tricolpites reticulatus*, *Palmidites maximus* and *Intrareticulites brevis*.

The overlying Sylhet Formation is well developed at 3696 to 3328 m. The basal most Lakadong Member is characterised by the presence of carbonaceous shale. *Polypodiisporites constrictus* and *Polypodiaceaesporites chatterjii* are quite common in all the samples. Fungal elements are quite common in samples at 3676 m.

Nurpuh Member (3546-3480) contains shaly sandstone in between limestone layers. The palynological assemblage records substantial increase of pteridophytic

spores, viz., *Cyathidites australis* and *C. minor*. Angiosperm taxa—*Neocouperipollis kutchensis* and *Tricolpites reticulatus* are abundantly present in the samples. *Pellicieroipollis langenheimii* and *Podocarpidites khasiensis* have the first appearance at 3480 m and 3546 m respectively.

The Prang Limestone Member at 3360 to 3328 m is very poor in palynofossils. Fungal spores, conidia and ascostromata are dominant in all the samples. *Lygodiumsporites eocenicus*, *Todisporites kutchensis*, *Verrucolporites verrucus*, *Neocouperipollis brevispinosus* and *Osmundacidites* sp. are common.

The Kopili Formation at 3284-2986 m comprises mostly alternating shale and sandy shale. The palynological assemblage is dominated by pteridophytic spores, viz., *Lygodiumsporites eocenicus* and *Striatriletes susannae*. Angiosperm are poorly represented in this assemblage. *Pellicieroipollis langenheimii* and *Palmidites maximus* are commonly present. Fungal spores are very poorly represented in all the samples.

Barail Group of rocks are observed at 2941.22-2240 m level. It is characterised by the occurrence of arenaceous shales. Thin band of clays are noticed at the basal part. Pteridophytic spores, viz., *Lygodiumsporites lakiensis*, *Striatriletes susannae* and *Polypodiaceaesporites constrictus* are abundantly present. *Crassoretitriletes vanraadshooveni* shows overwhelming dominance at 2922 to 2618 m. *Podocarpidites khasiensis* is present in high percentage at 2922 to 2733 m. Among the angiosperms, *Palmidites maximus*, *Tricolpites reticulatus* and *Palmaepollenites nadhamunii* are very common. *Neocouperipollis kutchensis* is sporadically present at the basal part up to 2733 m. Fungal elements are very common in the assemblage. Some significant forms are *Pluricellaesporites eocenicus*, *Notothyrites setiferus* and *Phragmothyrites eocenicus*. Samples at 2603 m level are rich in dinoflagellates. Some common forms are *Glaphyrocysta exuberans*, *Oligosphaeridium complex* and *Cleistosphaeridium diversispinosum*, etc.

The remaining part of the bore-hole is represented by the Tipam Group (2240.22-1634.50 m) and Girujan (1537.20-1400 m) Formation in ascending order. Palynological informations from these litho-units could not be generated due to nonavailability of samples for palynological investigations.

Kharsang-2

Due to Naga thrust, the Barails are placed at the top of the sequence. The thickness of this group here is roughly 500 m and constitutes mostly sandstones with thin bands of shales. The Tipam and Surma groups of rocks are found at the base (3614-2922.5 m) containing mostly sandstone and shale. The Girujan Formation is present at 2922.5-929.9 m interval. It is characterised by well-developed sandstones at the basal part and shaly sandstone at the upper part. In this bore-hole, the topmost litho-unit is represented by the Namsang bed (929.9-525.5 m). It is characterised by mostly clay and mudstones. Palynological investigation is carried out on the available samples from Girujan Formation and Namsang bed only. The Girujan palynoflora is dominated by pteridophytic spores specially up to 1750 m; the angiosperm pollen are absent in basal part. *Paleosantalaceaepites ellipticus* and *Palmaepollenites ovatus* begin to appear at 1620 m. Some significant palynotaxa of this assemblage are *Lygodiumsporites eocenicus*. *Osmundacidites kutchensis*, *Polypodiaceaesporites chatterjii*, *Polypodiaceaesporites levis*, *Polypodiisporites ornatus*, *Cheilanthoidspora monoleta*, etc. *Crassoretitriletes vanraadshooveni* and *Bombacacidites triangulatus* occur at 2530-2230 m in less quantity but at 1120-960 m they attain overwhelming dominance. *Striatriletes susannae* first appears at 2245 m and maintains low profile up to 1770 m, but becomes dominant at 1629 to 510 m.

Quantitatively, angiosperm pollen are poorly represented in this assemblage. Some of the significant taxa recorded in this assemblage are : *Compositoipollenites conicus*, *Acanthotricolpites bulbospinosus*, *Paleosantalaceaepites ellipticus*, *Polyporina globosa*, *Tricolpites reticulatus*, *Ctenolophonidites* sp. and *Monoporopollenites gramineoides*. *Monoporopollenites gramineoides* first appears at 1605 m and later attains dominance in the overlying Namsang bed. Gymnosperm pollen, viz., *Podocarpidites densicorpus* and *Tsugaepollenites velatus* occur abundantly at 2800-2708 m, *Podocarpidites* disappears at 1290 m. However, its recurrence in Namsang bed at 660-510 m is noticeable. Fungal elements are quite common at 2800-2720 m. Some of the major elements are *Phragmothyrites eocenicus*, *Fusiformisporites* spp., *Dicellaesporites* spp., etc. Dinocysts are poorly represented in Girujan Formation; *Cleistosphaeridium* spp. and *Operculodinium* spp. are the major elements. In Namsang bed many angiosperm taxa are recorded, viz., *Polyadopollenites miocenicus*, *Retitrescolpites decipiens*, *Hibisceaepollenites splendus*, etc.

Kharsang-3

The Barails (438-64 m) are thrust over on Namsang beds (810.8-487.1 m) in this bore-hole. Sandstone facies are dominant but carbonaceous shaly layers are noticed at the basal part. The Barail palynological assemblage includes *Todisporites major*, *Dictyophillidites kyrtomatus*, *Polypodiaceaesporites chatterjii*, *Polypodiisporites repandus*, *Podocarpidites densicorpus*, *Liguliforaedites pilatus*, *Pseudonothofagidites cerebrus*, *Tricolporopilites robustus*, *Verrucolporites verrucus* and *Diporopollis assamicus*. *Striatriletes susannae* is found in abundance

in the lower horizons. Fresh water alga *Pediastrum* is very common in the samples at 390 to 330 m interval. Samples from the thrust zone at 510 m show sudden decrease in palynofossil contents. Namsang palynoflora is dominated by *Striatriletes susannae* and *Todisporites major*. At 690 to 582 m, *Pediastrum* occurs abundantly Dinoflagellate cysts have been found quite common in the samples at 588 to 522 m. Only a few samples from Girujan Formation are available for palynological analysis. The important constituents of this assemblage are *Striatriletes susannae* and *Todisporites* spp.

Duarmara-2

The Barails are represented from 4477.5-4324 m and contain carbonaceous shale at the basal part and sandstone in the upper part. The palynofloral assemblage consists mostly of pteridophytic spores alongwith some angiospermic pollen. Significant taxa include *Striatriletes susannae*, *Lygodiumsporites* spp., *Lycopodiumsporites* sp., *Verrucosisporites verrucus*, *Pteridacidites* sp., *Crassoretitriletes vanraadshooveni*, *Tricolpites reticulatus* and *Graminidites* sp.

The Tipam and Surma groups of rocks are encountered at 4324-3524 m. It has dominant sandstone facies with intercalation of carbonaceous shale bands. At 3600 m several layers of thin coal bands are found. Most of the recorded palynofossils from Barails are continuing in this group of rocks. *Podocarpidites khasiensis* and *Pinuspollenites crestus* first appear in this group at 4000 m level.

Girujan Formation is well developed at 3524-2372 m. Major lithofacies of this unit are shaly sandstone, clay and mudstone. Many coaly streaks are observed at the basal part. Samples are very rich in palynofossil contents. Important palynotaxa present in this part are *Striatriletes susannae*, *Osmundacidites kutchensis*, *Crassoretitriletes vanraadshooveni*, *Cupuliferoipollenites pusillus*, *Graminidites media* and *Pinuspollenites crestus*. The top most Dhekiajuli Formation at 2372-1720 m exhibits coaly streaks at many levels. Sandstones form major lithofacies. Samples are very poor in palynofossil contents. Most of the angiosperm taxa recorded in the underlying Girujan Formation are absent in this assemblage. Important taxa recorded in this assemblage are *Operculosculptites globatus*, *Pteridacidites africanus*, *Lycopodiumsporites globatus*, etc. Algal elements, viz., *Psiloschizosporis psilatus* and unidentifiable cysts are overwhelmingly dominant in the younger horizon.

DISCUSSION

Qualitative analysis of the recorded palynofossils from different bore-holes reveals that the angiosperm taxa are predominant. It has also been noticed that the distribution of palynofossils in different formations of different bore-holes varies considerably. Quantitatively pteridophytic spores are found to be over represented in all the formations. This may be due to high production rate and effective dispersal mechanism of spores in a localised area. In addition to the recorded palynofossils in the checklist, a large number of reworked palynofossils have also been recorded from different lithounits. They are particularly very common in the Barails and Tipam-Surma units. Among the reworked palynofossils Palaeozoic forms are very common in the assemblage, viz., *Psilaplicates subcircularis* Bose & Kar 1976, *Microbaculispora gondwanensis* Bharadwaj 1962, *Indotriradites korbaensis* Tiwari 1964, *Parasaccites korbaensis* Bharadwaj & Tiwari 1964, *Divarisaccus lelei* Venkatachala & Kar 1966, *Scheuringipollenites tentulus* Tiwari 1968, *Rhizomaspora costa* Venkatachala & Kar

PLATE 2 →

1 *Palaeocoprosmadites arcotense*, Slide no. BSIP 10919 (M 36).
2. Triporate pollen, Slide no. BSIP 10941 (Q 44/4).
3. *Polyporina globosa*, Slide no. BSIP 10941 (G 47/1).
4-6. *Rhoipites kutchensis*, Slide no. BSIP 10919 (R 43/0), 10951 (M 40/3), 10944 (D 11/3).
7. *Tricolpites levis*, Slide no. BSIP 10945 (K 19).
8. *Pteridacidites vermiculatus*, Slide no. BSIP 10955 (J 24/3).
9. *Retitrescolpites bellus*, Slide no. BSIP 10947 (Q 9).
10. *Spinizonocolpites echinatus*, Slide no. BSIP 10949 (O 39).
11. *Palmaepollenites nadhamunii*, Slide no. BSIP 10916 (O 47/2).
12,13. *Quilonipollenites ornatus*, Slide no. BSIP 10951 (O 27/2), 10953 (H 41).
14. *Osmundacidites wellmanii*, Slide no. BSIP 10948 (K 28/3).
15,28. *Compositoipollenites conicus*, Slide no. BSIP 10956 (Q 42), 10953 (X 23/2).
16. *Arecipites intrapunctatus*, Slide no. BSIP 10955 (D 20/2).
17. *Heliospermopsis* sp., Slide no. BSIP 10954 (R 53).
18. *Pseudonothofagidites cerebrus*, Slide no. BSIP 10934 (Y 18/1).
19. *Meliapollis ramanujamii*, Slide no. BSIP 10957 (L 10/2).
20. *Lakiapollis ovatus*, Slide no. BSIP 10957 (L 10/4).
21. *Foveosporites splendus*, Slide no. BSIP 10941 (J 15/2).
22. *Cupuliferoipollenites pusillus*, Slide no. BSIP 10942 (G 46/1).
23. *Crassoretitriletes vanraadshooveni*, Slide no. BSIP 10938 (G 27/3).
24. *Neocouperipollis brevispinosus*, Slide no. BSIP 10915 (F 35).
25. *Myricipites* sp., Slide no. BSIP 10937 (W 5/1).
26. *Bombacacidites triangulatus*, Slide no. BSIP 10937 (N 6/3).
27. *Acanthotricolpites bulbospinosus*, Slide no. BSIP 10935 (E 20).
29. *Proxapertites microreticulatus*, Slide no. BSIP 10924 (O 41).
30. *Dyadosporonites constrictus*, Slide no. BSIP 10939 (V 40/4).
31. *Pinuspollenites crestus*, Slide no. BSIP 10950 (W 23/1).
32. *Retitrescolpites oblongus*, Slide no. BSIP 10938 (F 31/10).
33,34. *Pellicieroipollenites langenheimii*, Slide no. BSIP 10940 (O 35/1), 10940 (Q 47/3).
35. *Striatriletes susannae*, Slide no. BSIP 10923 (F 31).
36. *Polyadopollenites miocenicus*, Slide no. BSIP 10933 (H 50/4).
37. *Tricolporopilites robustus*, Slide no. BSIP 10956 (J 51/4).
38. *Hibisceaepollenites splendus*, Slide no. BSIP 10930 (W 26/3).

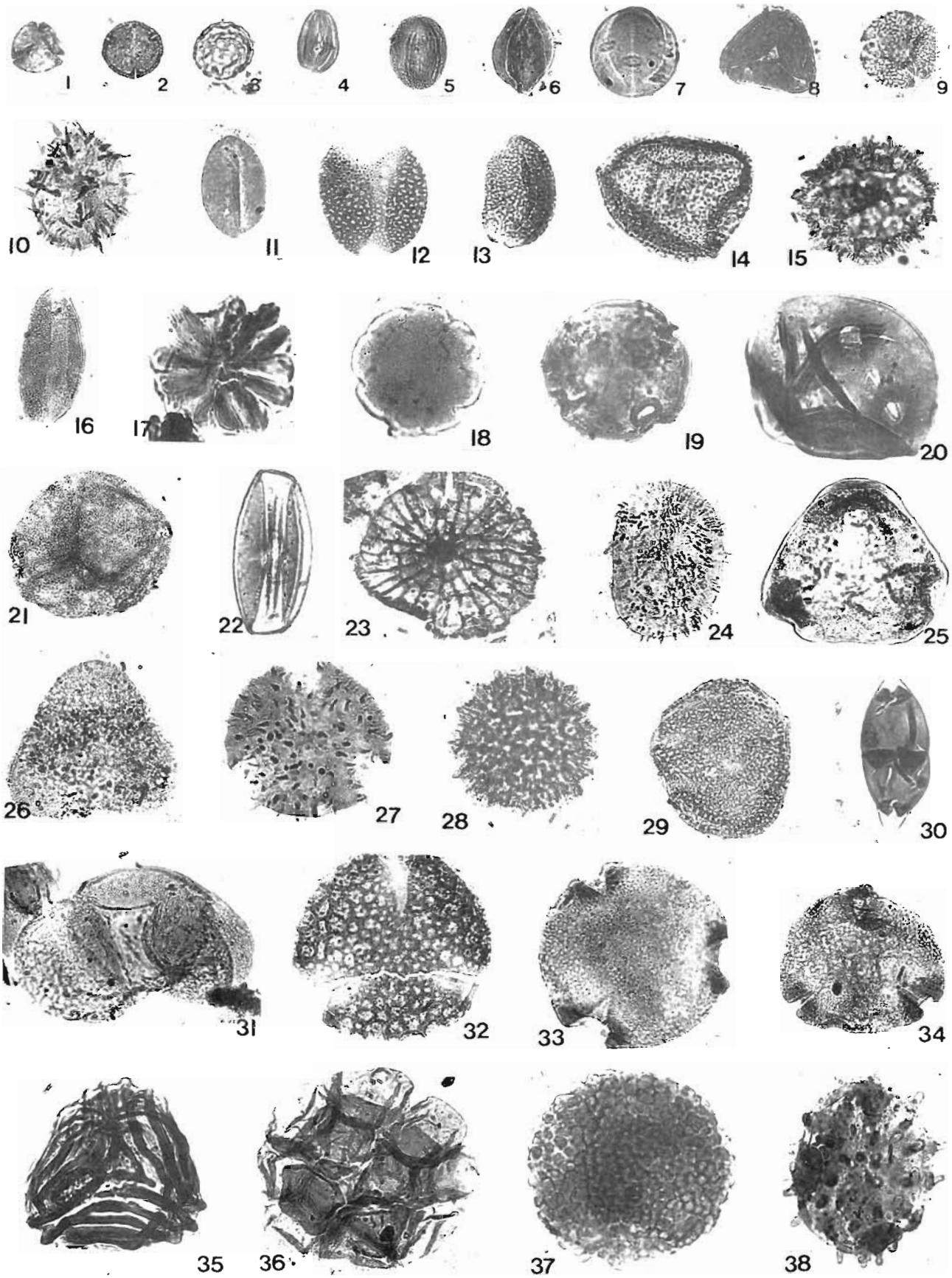

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PLATE 2

1960, *Striatopodocarpites diffusus* (Bharadwaj & Salujha) Bose & Maheshwari 1964, etc.

The recorded Mesozoic forms are *Aequitriradites spinulosus* (Cookson & Dettmann) Cookson & Dettman 1961, *Densoisporites velatus* Wayland & Krieger 1953, *Klukisporites pseudoreticulatus* Couper 1958, *Callialasporites trilobatus* (Balme) Dev 1961 and *Katrolaites kutchensis* Venkatachala & Kar 1976. These forms are very common in the Barail sediments.

REGIONAL COMPARISON

The recorded palynofloral assemblages have been compared with other known Tertiary palynofloral assemblages recorded from Upper Assam Basin and other parts of north-east region (Banerjee *et al.*, 1973; Sah & Kar, 1972; Singh & Tiwari, 1979; Sah *et al.*, 1980; Singh & Saxena, 1984; Srivastava *et al.*, 1974 etc.).

The lowermost Langpar Formation has been studied from two bore-holes, i.e., NHK-263 and Duarmara Well-2. The recorded palynofloral assemblages are very similar to the palynofloral assemblage recorded by Sah and Singh (1977) from Upper Assam in having most of the significant palynofossils, viz., *Proxapertites assamicus, Dandotiaspora dilata, Lycopodiumsporites speciosus, Neocouperipollis brevispinosus.* Jain *et al.* (1975) recorded a rich dinoflagellate cysts assemblage from Langpar Formation at Dawki and Cherrapunji area of Meghalaya. However, in the present investigation we could not find any dinocyst taxa. The palynoflora recorded from Therriaghat on the Um-Shoryngkew River, Meghalaya by Kar (1992) also shows similarity in the occurrence of many palynotaxa, viz., *Cyathidites minor, Lygodiumsporites lakiensis, Schizaeoisporites* sp., *Matanomadhiasulcites* sp., *Proxapertites cursus*, etc.

The overlying Sylhet Formation has been studied palynologically from NHK-263 and NHK-268 bore-holes. Present palynofloras are closely comparable with the earlier recorded palynofloras by Sah and Dutta (1966), Dutta and Sah (1970) and Kar and Kumar (1986). Many palynotaxa are found to be common in the Lakadong assemblages, viz., *Lycopodiumsporites speciosus, L. parvireticulatus, Dandotiaspora dilata, D. telonata, Proxapertites crassimurus, Neocouperipollis kutchensis, Echimonocolpites wodehousei, Lygodiumsporites lakiensis, Polypodiisporites umstewensis. Polycolpites-Monosulcites* assemblage zone for Lakadong and Nurpuh sandstone at Cherrapunji area, Meghalaya (Baksi, 1965) shows close resemblances in the dominance of *Neocouperipollis* spp., *Palmaepollenites* spp., *Polycolpites* spp., etc.

Palynological assemblage from Nahorkatiya Well-263 corresponds to the Lakadong palynological zone of the Shillong Plateau (Sah & Dutta, 1974; Singh & Tiwari, 1979). Palynofloral assemblage recorded by Meyer (1958) from Nahorkatiya Well-12 shows similarity in having dominance of *Striatriletes, Polypodiaceaesporites, Todisporites, Cyathidites, Tricolpites*, etc.

Kopili Formation in this area shows sudden decline of the taxa *Polycolpites* and *Paleocaesalpinaceaepites.* Present palynoflora corresponds with the other assemblages recorded from Jaintia hills (Sah & Singh, 1974) and Meghalaya (Baksi, 1972; Trivedi, 1985; Singh & Tripathi, 1987).

Barail sediments have been investigated from bore-holes, viz., NHK-1,268; Kharsang-3 and Duarmara-2. Palynofloral assemblage shows similarity with the uppermost part of the Barail sequence in Meghalaya (Sah & Singh, 1977; Sein & Sah, 1974) in having abundance of *Striatriletes* spores alongwith *Polypodiisporites* spp. *Polypodiaceaesporites* assemblage zone established in the Barail sequence of Upper Assam has also been traced out in the investigated bore-holes—NHK-1,268, Kharsang-3 and Duarmara-2. Palynological assemblage recorded from the Bengal Basin (Deb, 1970; Baksi, 1972) closely resembles the present assemblage by the dominance of polypodiaceous spores alongwith grass pollen.

The present palynological assemblages have also been compared with known palynofloral assemblage of Tipam/Surma sediments from Nahorkatiya-1 (Sah *et al.*, 1980); Rokhia bore-hole-1 and Baramura bore-hole-2, Tripura (Kar, 1990). Many palynofossils have been found to be common in between the two assemblages, viz., *Podocarpidites, Striatriletes, Bombacacidites*, etc. Gymnospermous pollen grains are found in abundance in the Tipam/Surma sediments of Kharsang-2 of Arunachal Pradesh, however, they are poorly represented in the Duarmara-2 and Nahorkatiya bore-hole nos. 263 and 268.

The Girujan palynofloral assemblage recorded from Kharsang-2 and 3 bore-holes has a close similarity with Lakwa-27 (Kar, 1990) in having the dominance of gymnospermous pollen grains, viz., *Pinuspollenites* spp. Girujan palynofloral record from Duarmara-2, however, contains mostly pteridophytic spores and angiosperm pollen grains. Some of the common genera recorded in this assemblage are *Pinuspollenites, Lycopodiumsporites, Psiloschizosporis*, etc. Kharsang palynofloral assemblage exhibits the abundance of *Crassoretitriletes vanraadshooveni, Striatriletes susannae, Palaeomalvaceaepollis rudis, Compositoipollenites conicus*, etc. The dominance of pteridophytic spores—*Seniasporites, Polypodiaceaesporites, Striatriletes, Lygodiumsporites*, etc. in Girujan Formation recorded by earlier workers (Sah *et al.*, 1972; Singh & Saxena, 1984) have also been noticed in the present investigation.

Palynological records from the Namsang and Dhekiajuli beds are poorly known. However, occurrence of reworked palynotaxa—*Proxapertites, Dandotiaspora,*

Palmidites, etc. have also been noticed in the bore-holes Kharsang-2 and Duarmara-2 as in the Moran Well nos. 2 and 9 and subsurface samples from Dihing River section (Singh & Tewari, 1979). For palynological demarcation of different formations relative abundance of the different species, their appearance and disappearance have been taken into consideration. In NHK-1, Barail-Tipam boundary is not clearly demarcated because most of the dominant species are common to both and exhibit equal prominence. The number of productive samples are also less. In NHK-263 and 268 the samples from Tipam sandstone were unfossiliferous. However, in Duarmara-2, Barail-Tipam/Surma transition is clearly distinguished by the abundance of various species of *Striatriletes*, viz., *Striatriletes susannae, S. paucicostatus, S. microverrucosus* and *S. macrocostatus* in Barails. The presence of *Lygodiumsporites globatus, Polypodiisporites repandus* and *Verrucosisporites* spp. also helps to demarcate Barails from Tipam/Surma.

Some of the species of *Lygodiumsporites, Osmundacidites, Polypodiaceaesporites, Polypodiisporites, Crassoretitriletes, Podocarpidites* are common to both the formations in Kharsang-2. Girujans are, however, differentiated from Namsang by the frequent occurrence of *Palaeomalvaceaepollis mammilatus, P. rudis, Acanthotricolpites* sp., *Compositoipollenites conicus, C. tricolporatus, Paleosantalaceaepites primitiva, Striatriletes susannae* and *Monoporopollenites* sp.

In Dhekiajuli *Striatriletes, Lygodiumsporites, Polypodiaceaesporites, Lycopodiumsporites, Osmundacidites, Crassoretitriletes* and *Podocarpidites* are absent. This formation is distinguished by the presence of some algal types like *Pteridacidites* sp. and cf. *Strobilanthus* sp.

REMARKS ON PALAEOENVIRONMENT

Considering the modern affinities of the recorded palynotaxa and their distributional pattern in different stratigraphic horizons of the bore-holes, it is evident that the older horizons, viz., Langpar and Sylhet Limestone formations have been deposited under brackish water to shallow marine environment. The sediments of Langpar and Sylhet Limestone formations are characterized by the dominance of pteridophytic spores, viz., *Polypodiaceaesporites tertiarus, P. levis, Lygodiumsporites lakiensis, Osmundacidites kutchensis, O. wellmanii* and angiospermic pollen, viz., *Tricolpites reticulatus, Palmidites maximus, Palmaepollenites nadhamunii*. The dinoflagellate cysts are represented by *Cordosphaeridium exilimurum, Glaphyrocysta exuberans* and *Cleistosphaeridium diversispinosum* in the assemblage. The percentage of dinocysts in the assemblage gradually declines towards the top horizons in upper part of Sylhet Limestone Formation. The palynofloral assemblage recorded from Kopili Formation indicates that the sediments of upper part of the formation were deposited under shallow marine conditions, whereas the brackish water environment was prevalent during the sedimentation of older horizons. Recorded palynofloral data strongly support the presence of coastal influence during Palaeocene-Eocene times in the Upper Assam Basin. It has been observed that a large number of palynotaxa extend in the Barail sediments with practically no change in their population. The Barail sediments were deposited in a deltaic flood plain as evidenced by the abundance of various species of *Striatriletes*. The extant genus *Ceratopteris* of the family Parkeriaceae which produces this type of spores is restricted to tropical fresh water flood plains throughout the world. The onset of Tipam/Surma diminishes the abundance of *Striatriletes* indicating thereby that the deposition took place above the deltaic flood plain. The same type of deposition also took place during Girujans. Poor representation of gymnospermous pollen in Tipam/Surma and Girujan reflects the paucity of montane plants nearby. It also indicates that the taxa were growing mostly along the depositional sites. Montane flora mostly represented by gymnosperm taxa exhibit its maximum abundance in the upper horizons of the Girujan Formation. It depicts the occurrence of higher lands around the depositional sites in the latter stage. The absence of gymnosperm pollen in the Tipam/Surma and Girujans in Duarmara Well is very significant. These two basins were separated as is evidenced by the distinct palynofloral assemblages. A comparative study of the present day distribution of nearest living relatives of the recovered palynofossils helps us to understand the palaeoclimatic conditions which prevailed during the deposition of Tertiary rocks in Upper Assam Basin. The Palaeogene palynofloral assemblage is very rich in pteridophytic spores and angiospermic pollen belonging to the families, viz., Cyatheaceae, Polypodiaceae, Osmundaceae, Parkeriaceae, Schizeaceae, Arecaceae, Bombacaceae, Alangiaceae. Their high percentage in the Langpar, Sylhet Limestone and Kopili formations tends to support the occurrence of lowland subtropical rain forest during the Palaeogene times in this area. Neogene palynoflora mostly dominated by coniferous pollen grains show palaeoclimatic change in the upper horizons of Girujan Clay and other younger formations. Overwhelming dominance of montane plants, viz., *Pinuspollenites crestus, Abiespollenites cognatus, Tsugaepollenites velatus* towards the top may be caused by the elevation of the rocks at the close of Oligocene in the Upper Assam Basin. The presence of fungal spores, conidia and ascostromata throughout the stratigraphic sequence of the bore-holes depicts a warm, humid climate during Tertiary Period in the basin. Our findings are in total agreement with those published by earlier

workers in Assam and Meghalaya (Dutta & Sah 1970; Sah & Singh, 1974; Singh, 1977a, 1977b; Singh & Tripathi, 1987; Singh *et al.*, 1986).

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