Palynofossils from the Tertiary (Barail Group) of Nagaland : Palaeoecological interpretation and age

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The palynofloral assemblage from the sediments of Barail Group exposed on the Moriani-Mokokchung Road, Nagaland contains 43 genera and 52 species. Spores of Parkeriaceae and Polypodiaceae dominate the assemblage, whereas *Tricolporopilites, Lanagiopollis, Lakiapollis* and palm pollen are the major angiospermic elements. The assemblage compares well with that of the Kopili Formation of Assam and Bengal Basin and Harudi Formation of Kutch Basin. The palynoassemblage indicates an Upper Eocene age. The presence of *Barringtonia* and Parkeriaceae indicates swampy environment of deposition.

Key-words—Palynology, Barail Group, Upper Eocene, Nagaland.

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सारांश

नागालैंड में तृतीयक अवसादों (बैरेल समूह) से अश्मित परागाणुः पुरापारिस्थितिकीय व्याख्या एवं आयु

जगन्नाथ प्रसाद मंडल

नागालैंड में मौरियानी-मोकोकचंग रोड के साथ अनावरित बैरेल समूह के अवसादों से परागाणु वनस्पतिजातीय समुच्चय में 43 प्रजातियाँ एवं 52 जातियाँ हैं। इनमें पार्केरियेसी एवं पोलिपोडिएसी कुलों की बाहुल्यता है जबकि *ट्राइकॉल्पोरोपाइलाइटिस, लानाजिओपॉलिस, लकियापॉलिस* एवं ताड़ के परागकण आवृतबीजी अवयवों के हैं। यह समुच्चय असम और बंगाल द्रोणी तथा कच्छ द्रोणी के हरुड़ी शैल-समूह से तुलनीय है। उपलब्ध परागाणविक समुच्चय से इसकी उपरि आदिनूतन आयु इंगित होती है। *बैरिंग्टोनिआ* एवं पार्केरिएसी की उपस्थिति से निक्षेपण के समय दलदली वातावरण का होना इंगित होता है।

NAGALAND is located in the north-eastern part of India broadly within 25° 30'- 27° 20' N and 93° 40'-95° 30'E . The area consists of a linear strip of hilly country running northeast to southwest. In the entire area within the state, barring recent deposits of the alluvial plain and narrow 'ophiolite belt' with associated rocks near Myanmar border, the Tertiary sediments are exposed which broadly match with the Upper Assam, in their geological setting, structure and stratigraphy. Survey work was initiated in Assam and its adjoining areas in Nagaland for coal exploration by Mallet (1876), Oldham (1883), Pascoe (1912), Evans (1932) and others but has extensively been taken up in mid sixties by the Geological Survey of India and Oil and Natural Gas Commission and other agencies for coal, oil and limestone prospecting.

A generalised geological succession in the western part of Nagaland on south of 27° latitude published by Saxena and Yedekar (1984) is given below:

Group	Formation	Lithology	Age
Dihing	-	Conglomerate and pebble beds with ferruginous sandstone and sandrock	Pliocene
	Namsang	Coarse-grained sandstone / pebbly sandstone /grit and clay	Mio-Pliocene
Tipam	Girujan clay	Clay with bands of coarse, gritty sandstone/sandrock and shale	Miocene
	Tipam sandstone	Fairly coarse-grained gritty sandstone or alternating bands of coarse-grained gritty sandstone and clay/shale with coal, conglomerate	Miocene

Surma	-	Bands of grey to khaki-grey, thinly bedded, fine to medium- grained sandstone, shaly sandstone and shale	-
Barail	-	Alternating units of sandstone and shale with occasional pockets and lenses of carbona- ceous shale / sandstone and dominantly shale with sandstone at places	Oligocene
Disang	-	Shale with bands of siltstone/ splintary nodular shale, hard and compact shale	Eocene

STRATIGRAPHY

Post-Oligocene rocks along Moriani-Mokokchung Road (i.e., Surma, Tipam and Dihing groups) lie bordering the Assam plain in a NE-SW tending, 30-40 km wide belt. The rest of the area is occupied by Barail and Disang groups of rocks in alternating fashion. These two groups of sequences—Disang and Barails, were deposited in geosynclinal facies. The Disang sediments are predominantly argillaceous and comprise mainly compact or splintary shales and thin-bedded sandstone in a rhythmic pattern. The Barail Group is molassic, represented by alternating units of shale and sandstone of varying thicknesses. Occasionally, thin bands of carbonaceous shale and coal occur in pockets within the shale as well as the sandstone units (Saxena and Yedekar, 1984).

The present paper deals with the age and depositional environment of Barail sediment exposed along Moriani-Mokokchung Road as deciphered by the palynofossils.

MATERIAL AND METHOD

The results are based on the investigation of thirty-four samples collected from three sections at 35, 35.2, and 37 kilometer posts on Moriani-Mokokchung Road, Nagaland (Map 1). Fourteen samples were collected from about 1.00 m thick first section, at 35 km post bearing about half meter thick coaly layer between the carbonaceous shales, and sixteen samples from about four meter thick section characterized by carbonaceous shale with lenses of coal exposed by landslide at 37 km post. Base of this section is covered by debris and top is covered by vegetation. Four samples were collected at 35.2 km point by cleaning and exposing the surface. The slides are housed in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

PALYNOASSEMBLAGE

A checklist of 52 different species of pteridophytic spores and angiospermous pollen recovered is given below indicating their distribution in different sections. Several fungal remains, algal spores and reworked spores/pollen have also been found but they are not listed.

Taxa	Sections at Kilometers posts 35 km	35.2 km	37 km
Pteridophytic spores			
Cyathidites australis Couper 1953	+	+	+
C. minor Couper 1953	+	+	+
Lygodiumsporites lakiensis Sah & Kar 1969	+	+	+
Striatriletes susannae van der Hammen emend. Kar 1970	+	+	+
S. paucicostatus Kar 1985	+	+	+
Polypodiaceaesporites levis Sah 1967	+	+	+
Polypodiisporites repandus Takahashi 1964	+	+	+
P. terbinatus Sah 1967	+	-	+
Polypodiaceaesporites major Saxena 1978	+	-	+
P. strictus Kar & Saxena 1981	+	-	+
Polypodiisporites impariter (Potonié & Sah) Dutta & Sah 1970	+	-	+
Leptolepidites verrucatus Couper 1958	+	+	+
Seniasporites minutus Sah & Kar 1969	+	-	-
Polypodiaceaesporites tertiarus Dutta & Sah 1970	+	-	-
Scantigranulites sparsus Kar 1978	+	-	-
Pilamonoletes excellensus Kar 1991	+	-	-
Deltoidospora sp.	+	-	-
Malayaeaspora sp.	+	-	-
Foveomonoletes sp.	+	-	-
Schizaeoisporites phaseolus Delcourt & Sprumont 1955	+	-	-
Osmundacidites cephalus Saxena 1978	-	+	-
Todisporites major Couper 1958	-	+	-
Angiospermous pollen			-
Lakiapollis ovatus Venkatachala & Kar 1969	+	+	+
Tricolporocolumellites pilatus Kar 1985	+	+	+
Tricolporopilites robustus (Kar & Saxena) Kar 1985	+	+	+
Rhoipites kutchensis Venkatachala & Kar 1969	+	+	+
Cupuliferoipollenites ovatus Venkatachala & Kar 1969	+	+	-
Proxapertites cursus van Hoeken-Klinkenberg 1964	+	-	+
Pellicieroipollis langenheimii Sah & Kar 1970	+	-	+
Lanagiopollis regularis Morley 1982	+	-	+
Tricolporopilites pseudoreticulatus Kar 1985	+	-	+
Retitetrabrevicolporites globatus (Venkatachala & Kar) Kar 1985	+	-	+
Palmaepollenites kutchensis Venkatachala & Kar 1969	+	+	+
Echidiporites indicus gen. et sp. nov.	+	-	-

Spinizonocolpites baculatus Muller 1968	+	-	-
Dracaenoipollis circularis Sah & Kar 1970	+	-	-
Platoniapollenites iratus Sah & Kar 1970	+	-	-
Tricolporopilites differentiales Singh & Misra 1991	+	-	-
Retitribrevicolporites matanomadhensis (Venkatachala & Kar) Kar 1985	+	-	-
Densiverrupollenites eocenicus Tripathi & Singh 1984	+	-	-
Tribrevicolporites eocenicus Kar 1985	+	-	-
Angulocolporites microreticulatus Kar 1985	+	-	-
Marginipollis kutchensis (Venkatachala & Kar) Kar 1978	+	-	-
Polyadopollenites miocenicus Ramanujam 1966	+	-	-
Echitricolpites communis Regali ,Uesgui & Santos 1974	+	-	-
Palaeoaraliaceaepites indica Biswas 1962	+	-	-
Striacolporites striatus Sah & Kar 1970	+	-	-
Ctenolophonidites sp.	+		-
Racemonocolpites sp.	+	-	-
Retistephanocolpites granulatus - (Sah & Kar) Kar 1985	-	-	+
Palmidites maximus Couper 1953 -	-	-	+
Neocouperipollis kutchensis (Venkatachala & Kar) Kar & Kumar 1987	-	-	+

(+ = present; -, = absent)

OBSERVATIONS

The difference in species diversity is observed in the assemblages from three sections but the important taxa are, however, the same. The section at 35 km post yielded maximum number of spores/pollen taxa, while at 35.2 km post section their yield is poor both in quantity and quality. Though the assemblage of 37 km post is not as rich as that of the 35 km post section, the palynofossil representation is good. In the 35 km post section the coal bands are full of fungal remains and leaf cuticles, apart from few pteridophytic spores. Major palynofossils in this section have been recorded from the associated shaly layers. Gymnospermous pollen and dinocysts are absent in these assemblages.

The palynofloral assemblages of the three sections are represented by 52 species belonging to 43 genera. Of these, 22 species of 15 genera belong to pteridophytes, 7 species of 7 genera to palms and 23 species of 21 genera to dicots. In quantity, the pteridophytic spores, particularly *Striatriletes* and polypodiaceous spores, are dominant (up to 60 %) in Moriani-Mokokchung Road section. The angiospermic pollen are rich in variety (30 species) in the assemblage but they contribute only 31 per cent, the dominating forms are *Tricolporopilites, Lanagiopollis* and *Lakiapollis*. Some genera like *Tricolporocolumellites, Retitribrevicolporites* and *Ctenolophonidites* are recorded for the first time from this region.

The distributional pattern of the dominant taxa at 35 km post and 37 km post sections are shown in Text-figures 1 and 2, respectively. Stratigraphically important taxa are common at both the places. However, in the first section trilete spores, particularly *Striatriletes*, are abundant and monolete spores do not encounter more than 30 per cent (Text-figure 3) but this pattern is reversed at the 37 km post section (Text-figure 4). Colpate and colporate pollen from 37

PLATE 1

(All figures unless otherwise stated are X 500; the numbers indicated after slide number are England-finder reading and within bracket are circle numbers).

1. *Striatriletes susannae*, Slide no. BSIP 10694; P 63/3 (1)
2. *S. paucicostatus*, Slide no. BSIP 10696; U 48/3 (7)
3. *Pilamonoletes excellensus*, Slide no. BSIP 10690; X 43/4 (2)
4. *Polypodiisporites terbinatus*, Slide no. BSIP 10707; G 47 (1)
5. *Malayaspora* sp., Slide no. BSIP 10703; X23/4 (7)
6. *Leptolepidites verrucatus*, Slide no. BSIP 10686; V 46 (2)
7. *Polypodiaceaesporites levis*, Slide no. BSIP 10676; S 60 (1)
8. *P. strictus*, Slide no. BSIP 10679; R 64 (1)
9. *Polypodiisporites tertiarus*, Slide no. BSIP 10694; U 30/3 (3)
10. *Neocouperipollis kutchensis*, Slide no. BSIP 10693; Q 47 (3)
11. *Ctenolophonidites* sp., Slide no. BSIP 10705; G 56 (5)
12. *Rhoipites kutchensis*, Slide no. BSIP 10704; J 28 (6)
13. *Polypodiisporites* sp., Slide no. BSIP 10691; U 29 (3)
14. *Retistephanocolpites granulatus*, Slide no. BSIP 10699; H 56/2 (3)
15. *Dracenoipollis circularis*, Slide no. BSIP 10688; L 56/3 (4)
16. *Retitetrabrevicolporites globatus*, Slide no. BSIP 10691; Q 52/2 (2)
17. *Striacolporites striatus*, Slide no. BSIP 10682; H 43 (3)
18. *Lanagiopollis regularis*, Slide no. BSIP 10696; Q 66 (12)
19. *Cupuliferoipollenites ovatus*, Slide no. BSIP 10701; H 40/2 (7)
20. *Tribrevicolporites eocenicus*, Slide no. BSIP 10687; J 57/2-J 58/1 (2)
21. *Spinizonocolpites baculatus*, Slide no. BSIP 10705; P29/3 (9)
22. *Echitricolpites communis*, Slide no. BSIP 10676; X 34/3 (4)
23. *Retistephanocolpites granulatus*, Slide no. BSIP 10702; P31(3)

24-26. *Pellicieroipollis langenheimii*, fig.24. Slide no. BSIP 10700; T 46/4 (2); fig.25. Slide no. BSIP 10684; D41/3 (4); fig. 26. Slide no. BSIP 10701; K35/3 (1)

27. *Pellicieroipollis* sp., Slide no. BSIP 10699; J23/2 (4)
28. *Osmundacidites cephalus*, Slide no. BSIP 10679; O12/3 (2)
29. *Polypodiisporites repandus*, Slide no. BSIP 10683; C34 (4)

30, 34. Palaeozoic reworked pollen, fig. 30.Slide no. BSIP 10676; R 54/3 (2)fig. 34. Slide no. BSIP 10692; J31/4 (3)

31. Mesozoic reworked pollen, Slide no. BSIP 10698; T 56 (2)
32. Fungal remains, Slide no. BSIP 10694; N 63/3 (1)
33. *Platoniapollenites iratus*, Slide no. BSIP 10685; G43/4 (2)

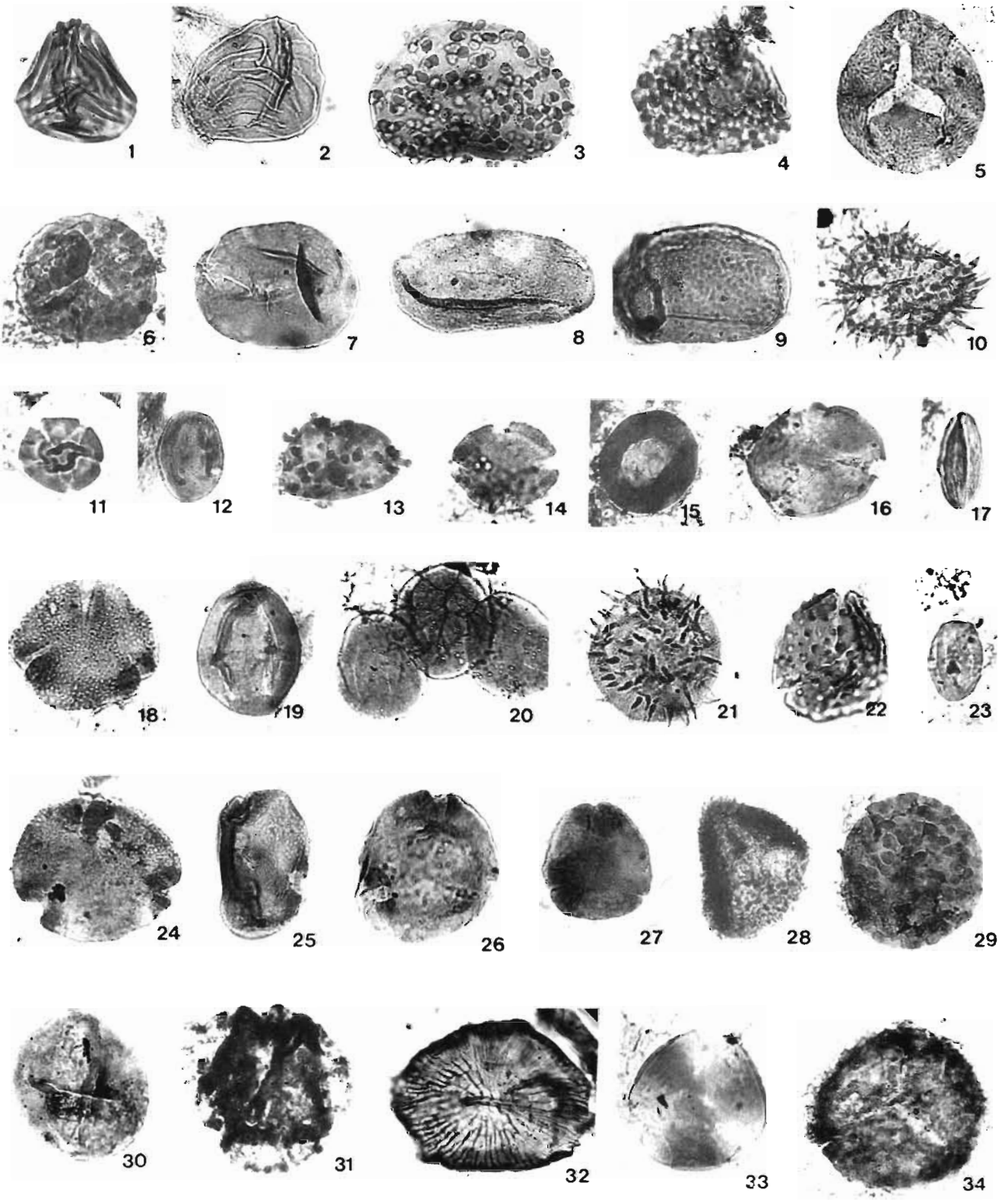
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PLATE 1

km post section occur dominantly at the begining but the preponderance of palm pollen is observed at the top. Fungal bodies are common in all sections. At the 37 km post section, their representation is maximum towards top (Text-figure 5) and reversely richer at the coaly layers of the 35 km post section (Text-figure 6).

Recycled Gondwana palynofossils like *Calamospora, Hoegiasaccites, Baculatisporites, Callialasporites trilobatus, Cicatricosisporites, Klukisporites,* etc., were also recorded (2-5%) in all the assemblages. The presence of reworked palynofossils in the Tertiary sediments of north-east India is well- known (Dutta, 1978; Singh *et al.*, 1990; Trivedi, 1990). The source of these recycled grains has been a matter of discussion. Gondwana sequence in the foot-hills of Himalaya in Bhutan and Arunachal Pradesh, as advocated by Dutta (1978), most likely could be the source rock in the Upper Assam and Nagaland for these microfossils.

SYSTEMATIC DESCRIPTION

Descriptions of only new and important taxa have been given.

Echidiporites gen. nov.

Type species—*Echidiporites indicus* sp. nov.

Diagnosis—Pollen grains drum-shaped, biporate, pores big, simple, placed at either side of pole; exine thin, tectate, dominantly spinose, mixed with few bacula and coni, interspinal areas finely granular; sexine thicker than nexine, uniformly thick.

Comparison—*Spinizonocolpites* Muller 1968 and *Neocouperipollis* Kar & Kumar 1987 have similar exomorphic features but both possess sulcus instead of pores. *Acanthotricolpites* Kar 1985 and *Echimonoporopollis* Saxena, Khare & Misra 1991 are closely comparable in being porate and spinose but *Echidiporites* has only two pores. *Echidiporites* differs from all the known genera in being diporate and echinate.

Echidiporites indicus sp. nov.

Pl. 2, figs 12,13

Holotype—Slide no. BSIP 10680; Y 46/1(3)

Locality & age—Carbonaceous shale bed at the 35 km post section (sample no 14); Late Eocene, Barail Group.

Description—Pollen drum-shaped, 50-60 X 65-78 m, diporate, pores on either end of pole, big 15-17 µm in diameter, without any thickening, pore margin granular, free of spines; exine thin, 1.5 µm, tectate, nexine thinner (0.5 µm) than sexine, surface sculpture dominantly spinose mixed with bacula and coni, closely and irregularly placed. Spine tips blunt, rarely branched and varying in size, 1.5-5 µm long. Interspinal spaces finely granular.

Remarks—This species is closely comparable to *Acanthotricolpites bulbospinosus* Kar 1985 and *Echimonoporopollis grandiporus* Saxena, Khare & Misra 1991. However, *A. bulbospinosus* is characterised by three pores and *E. grandiporus* by one pore only. *Echidiporites indicus* sp.nov. is characterised by having two pores. The genus is based on the observation of four specimens.

Echitricolpites Regali *et al.* 1974

Type species— *Echitricolpites communis* Regali *et al.* 1974

Echitricolpites communis Regali *et al.* 1974

Pl. 1, fig. 22

Description—Pollen oblate, subtriangular in polar view, amb rounded, 52 x 63 µm, angulaper-

PLATE 2

(All figures unless otherwise stated are X 500; the numbers indicated after slide number are England-finder reading and within bracket are circle numbers).

1. *Densiverrupollenites eocenicus*, Slide no. BSIP 10689; O 41/2 (3)
2. *Angulocolporites microreticulatus*, Slide no. BSIP 10681; N 27 (3)
3. *Tricolporocolumellites pilatus*, Slide no. BSIP 10684; Y65/1 (1)
4. *Lakiapollis ovatus*, Slide no. BSIP 10697; M 53 (3)
5. *Proxapertites cursus*, Slide no. BSIP 10687; P37/2 (4)
6. *Tricolporopilites robustus*, Slide no. BSIP 10695; J 54/4-K 54/2 (1)
7. *Marginipollis kutchensis*, Slide no. BSIP 10689; V 57/4 (2)
8. *Retitribrevicolporites matanomadhensis*, Slide no. BSIP 10692; L67 (1)
9. *Polyadopollenites miocenicus*, Slide no. BSIP 10676; T 59/4 (1)
10. *Tricolporopilites differentiales*, Slide no. BSIP 10702; D 54/2 (4)
11. *T. pseudoreticulatus*, Slide no. BSIP 10706; E 30/3 (8)
12-13. *Echidiporites indicus*, gen. et sp. nov. X 1000, fig. 12, Slide no. BSIP 10679; J20 (3); fig.13, Slide no. BSIP 10680; Y 46/1 (3), Holotype
14. *Palaeoaraliaceaepites indica* showing polar view, X 1000, Slide no. BSIP 10677; O 48 (2)
15. *P. indica* another specimen showing equatorial thick band, X1000, Slide no. BSIP 10678; X 44/1 (3)
16. *P. indica* different specimen in equatorial view, X 1000, Slide no. BSIP 10708; J 37/4 (4)

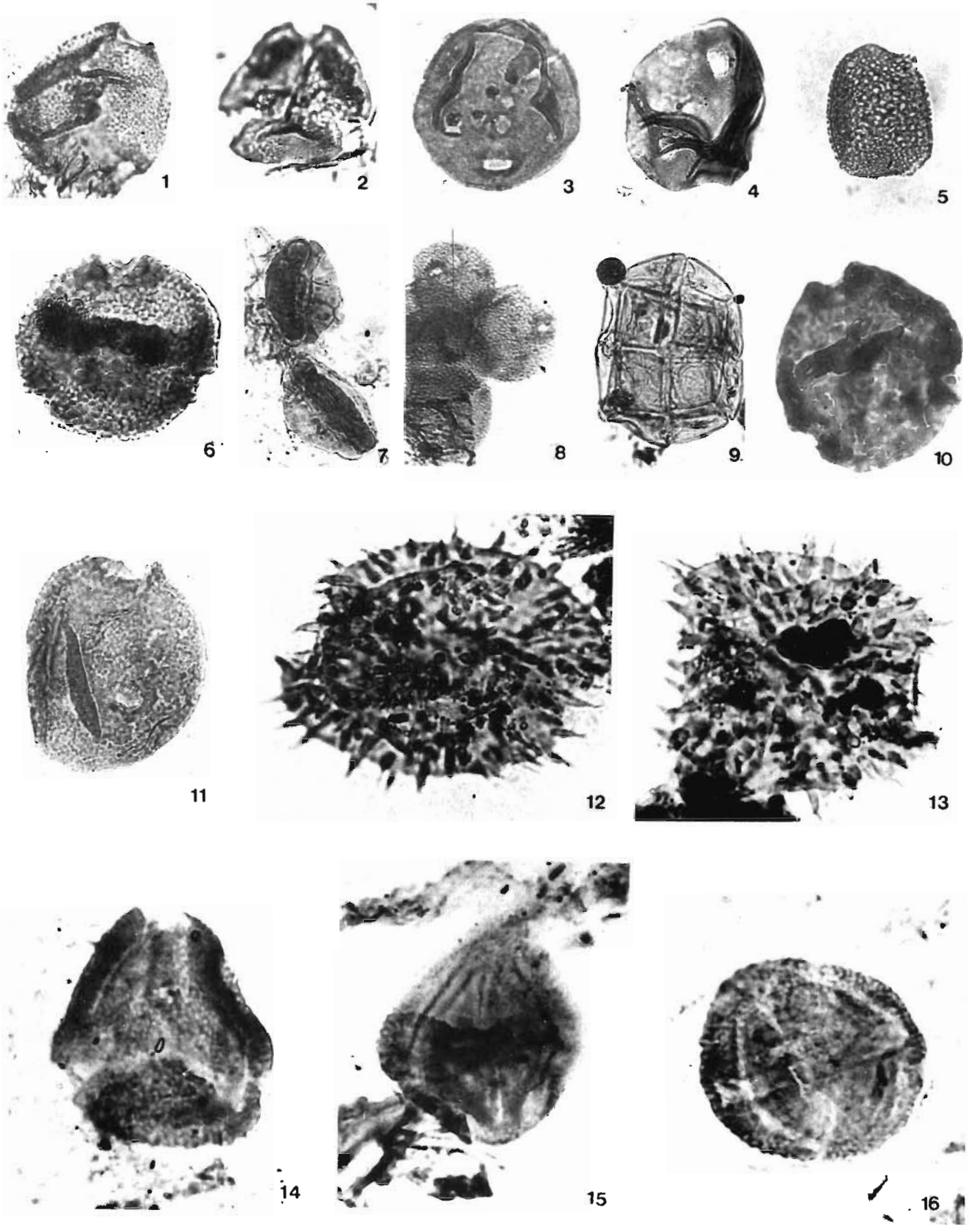
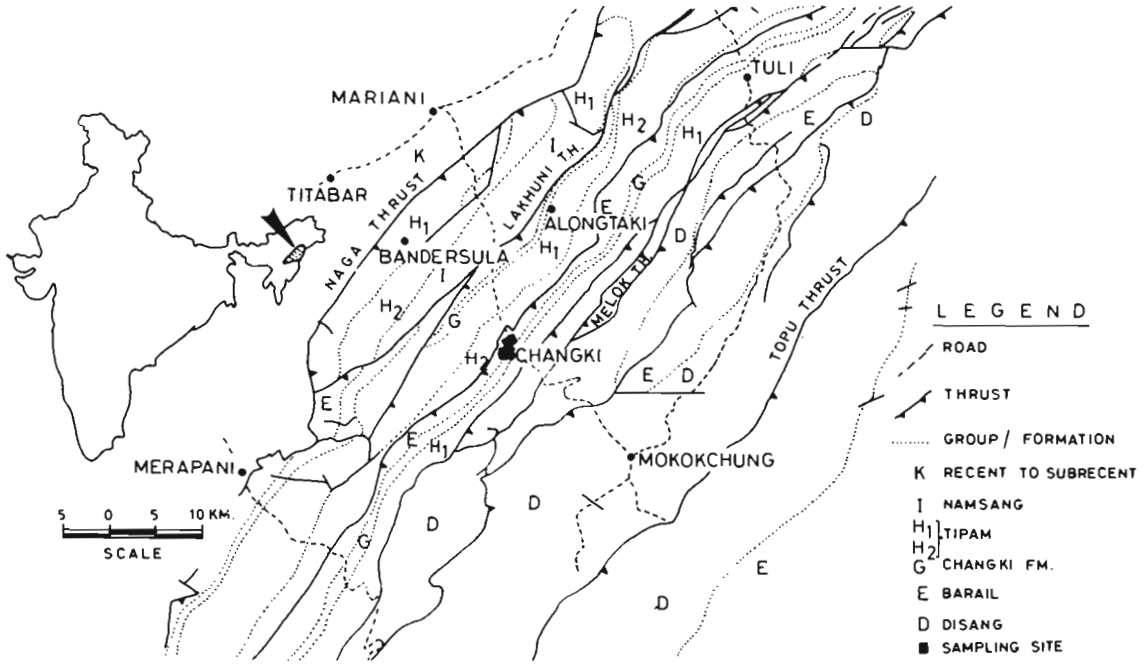
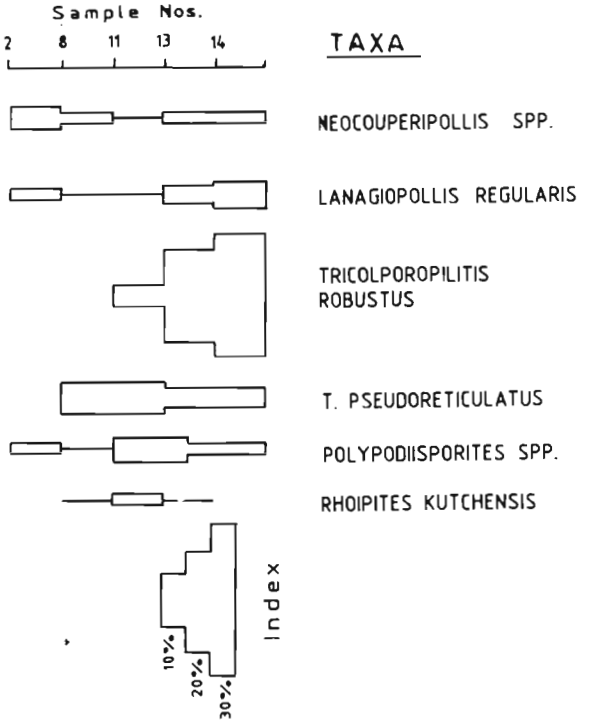


PLATE 2



Map 1—Map of Moriani-Mokokchung Road showing the sampling locality.

turate, tricolpate, colpi 12 µm long, narrow, pointed towards pole but 1.5 µm wide at equator, Exine 2 µm thick, tectate, sexine much thicker than nexine (0.5 µm), thins out towards aperture. Sexine spinose, spines conical with acuminate tips, 2-2.5 µm long, sparsely placed, space between spines smooth, nexine uniformly thick.



Text-figure 1—Frequency of selected palynotaxa at 35 km post section.

Remarks—*Echitricolpites* is reported from the Palaeocene of Cambay Basin (age not specifically mentioned; Koshal & Unial, 1986). In the present assemblage single specimen is recovered from 37km post section. The taxon has identical characters to that of Brazilian specimen but is bigger in size.

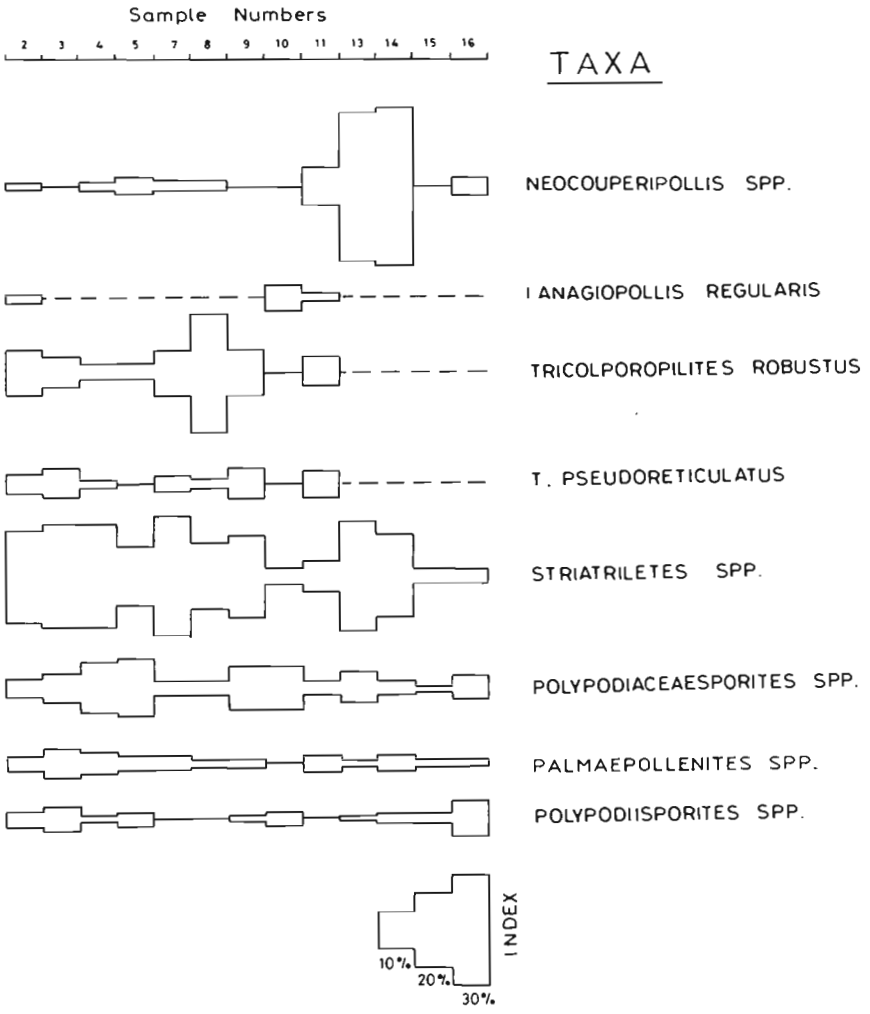
***Palaeoaraliaceaepites* Biswas 1962**

Palaeoaraliaceaepites indica Biswas 1962

Pl. 2, figs 14-16

Remarks—Biswas (1962) recorded this genus from Middle-Upper Eocene Tura Formation of Garo Hills. The account given by Biswas (1962) is very brief. However, the present specimens appear to be similar as those from Garo Hills (Biswas,1962; pl. 6, fig. 25). Based on the study of additional specimens, an elaborated generic and specific descriptions are given here.

Generic description—Pollen isopolar in polar view, oblate to subspheroidal in equatorial view, tricolporate, angulo-aperturate, longicolpate, pore circular, costate; costae form an equatorial band;



Text-figure 2—Behaviour of different spore and pollen groups from 37 km post section.

sexine thicker than nexine; exine microreticulate, muri simplibaculate.

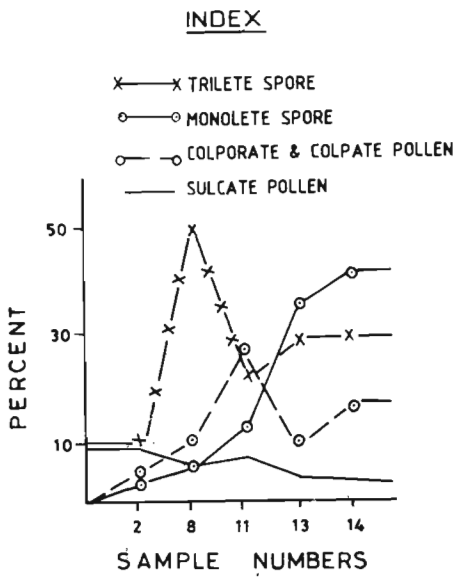
Specific description—Pollen radially symmetrical, 43-56 µm, subtriangular in polar view and oblate to subspheroidal equatorially; tricolporate, colpi 15-19 µm long, nearly reaching up to the pole, narrow, rounded both in equatorial and polar views, width at equator 3 µm, pore circular 2-5 µm, generally indistinct, costate; costae forming a band along equator. Exine about 5 µm thick, minutely plicated at the polar region; sexine thicker than nexine, uniformly thick, gently narrowed at aperture margin, columellae 2 µm thick, tectum perforate, surface microreticulate, lumina 1 µm, irregular in shape, muri thin, simplibaculate, nexine 1.5 µm thick in the mesocolpial region.

Affinity—Fine and shallow reticulate exine, long colpi, projecting transverse furrows and equatorial thick band provide a characteristic appearance to pollen in both polar and equatorial views. These characters reflect its affinity with *Calophyllum* L. rather than Araliaceae as suggested by Biswas (1962).

Ctenolophonidites sp.

Pl. 1, fig. 11

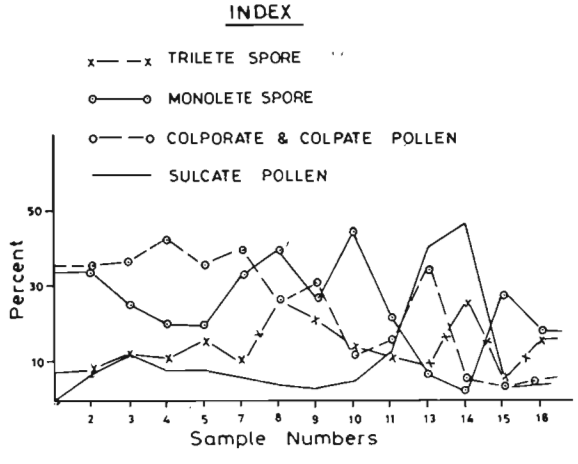
Description—Pollen circular in polar view, 36.5 x 39 µm; pentacolporate, colpi 10-12 µm long, slit-like, end tapering, 3 µm wide at equator, pore distinct,



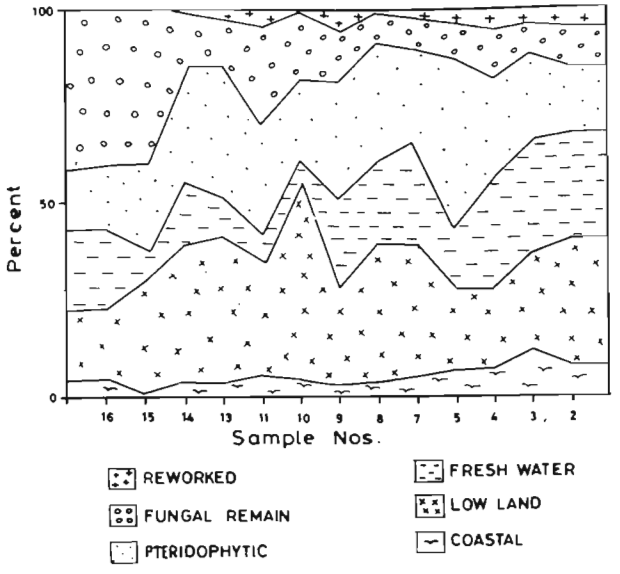
Text-figure 3— Frequency of selected palynotaxa at 37 km post section.

round, diameter 3 µm, exine tectate, 2 µm thick, psilate, stratification not distinct, ring-like thickening at pole.

Remarks—Polycolporate condition with polar thickening are the main characters of *Ctenolophonidites*. However, the smaller size, nature of exine, number of aperture and anastomosing nexinal thickening at the poles in the present specimens do not match with the known species of the genus. The genus *Ctenolophonidites* was so far not recorded from northeast India.



Text-figure 4—Behaviour of different spore and pollen groups from 35 km post section.

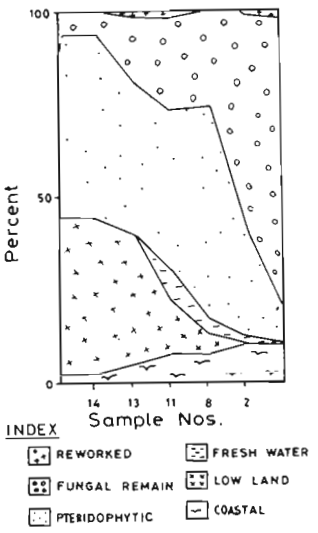


Text-figure 5—Expression of different ecological groups at 37 km post section.

AGE AND CORRELATION

Lithostratigraphically the sediments of Barail Group of Assam and neighbouring areas of Nagaland are dated as Oligocene (Pascoe,1964; Dutta, 1982). Using remote sensing data and image analytical keys Ganju *et al.* (1986) opined Oligocene age for the rocks in the areas south of 27° latitude. However, Eocene age for the lower part and Oligocene for the upper part was suspected by Mathur and Evans (1964, p.13) and Anonymous (1974) for part of Barail sediments of Nagaland. Acharyya *et al.* (1986) recorded foraminifera of Late Eocene and Middle Eocene affinity from Kishore-Tuensang Road and Kohima foot-hill section, respectively.

No data on plant mega- or microfossils of Barail is available from Nagaland. However, fragmentary leaf-impressions are generally found but they are unidentifiable. The Barail Group and its equivalent rock sequences from adjoining Assam, Meghalaya, Bengal Basin and Tripura have been investigated for palynofossils (Baksi, 1972; Sein & Sah, 1974; Salujha *et al.*, 1972, 1974; Singh *et al.*, 1986; Kar, 1990; Mandaokar, 1993). All the studies have assigned an Oligocene age to the rock sequence of Barail Group, based on the presence of marker taxa like *Crassoretitriletes, Meyeripollis, Trisyncolpites, Polyadopolle-nites, Bombacacidites* in association with other taxa.



Text-figure 6—Expression of different ecological groups at 35 km post section.

The present palynofloral assemblage is dominated by spores of Parkeriaceae and Polypodiaceae (up to 60 %). The stratigraphically significant angiospermic taxa occurring in the assemblage are—*Pellicieroipollis, Lakiapollis, Tribrevicolporites, Marginipollis, Tricolporopilites, Densiverrupollenites, Palaeoaraliaceaepites, Spinizonocolpites, Neocouperipollis* and *Retitribrevicolporites*. These are known to have extended up to Eocene and majority of them represent Middle to Late Eocene (Biswas, 1962; Dutta, 1982; Kar, 1985; Thanikaimoni *et al.*, 1984; Tripathi & Singh, 1984; Venkatachala *et al.*, 1988). The palynoassemblage of Moriani-Mokokchung Road resembles Late Eocene assemblage of Assam (Tripathi & Singh, 1984; Trivedi, 1985), palynozone III of Bengal Basin (Baksi, 1972), and Harudi Formation of Kutch Basin (Kar, 1985). Thus, the presence of Eocene marker taxa in the assemblage, a close similarity with the Middle to Late Eocene assemblages and the appearance of *Polyadopollenites* indicate Late Eocene age of the sediments of Barail Group exposed along Moriani-Mokokchung Road.

PALAEOCLIMATE AND ENVIRONMENT OF DEPOSITION

Palaeobotanical evidences (Lakhanpal,1970; Thanikaimoni *et al.*, 1984; Bande,1991; Guleria, 1991) have established that Palaeogene and Neogene floras of India were predominantly tropical. The tropical forest is flourishing even today in the north-east India.

Geological and palaeontological data indicate that the lower arenaceous and upper argillaceous units of Barail Group containing fauna of shallow marine habitat were deposited near the shore in marine/deltaic and estuarine conditions (Murthy, 1983). Uninterrupted sedimentation during the Eocene-Oligocene Period caused shallowness of the basin and the shallow marine condition gave place to a delta system on which mangrove, coastal and terrestrial plants flourished to form coal-facies locally (Acharyya & Roy, 1986). Sarmah (1989) studied clay minerals (kaolinite) in the Barail sediments near Kohima and concluded that fresh water environment of deposition was prevailing in the area with moist climate and a good drainage system.

A few palynomorphs which can be tagged with extant forms are listed below with their habitat (after Willis, 1973; Muller, 1981; Thanikaimoni *et al.*,1984; Venkatachala *et al.*, 1988):

Fossil taxa	Botanical affinity	Habitat
Lakiapollis	(*Durio* type) Bombacaceae	Tropical, lowland to evergreen forest
Tricolporopilites	(*A. vilosum* type) Alangiaceae	Tropical lowland to evergreen forest
Tricolporocolumellites	Bombacaceae	Tropical lowland to evergreen forest
Marginipollis	*Planchonia, Barringtonia, Carya,* Lecythidaceae	Coastal swamp to lowland swamp
Pellicieroipollis	Alangiaceae	Humid deciduous forest
Lanagiopollis	Alangiaceae	Humid deciduous forest
Spinizonocolpites	(*Nypa*) Arecaceae	Mangrove shrub
Proxapertites	*Rhaphidophora, Monstera,* Arecaceae (*Nypa*)	Climbers in evergreen forest, mangrove shrubs
Palaeoaraliaceaepites	Clusiaceae, *Calophyllum*	Littoral coastal tree
Striacolporites	Caesalpiniaceae *Bauhinia, Cradia*	Cosmopolitan
Striatriletes	Parkeriaceae	Swamp and lowland areas

The extant plant groups identified above still thrive in the tropical climate. The abundance of fern spores and high representation of microthyriaceous fungi, e.g., *Notothyrites, Phragmothyrites,* etc. suggest the existence of warm and humid climate.

Striatriletes, one of the major element of the assemblage, in association with *Marginipollis*, suggests swampy environment of deposition. The presence of coal-band also supports for the same. *Spinizonocolpites* indicates the existence of a nearby mangrove community.

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