Palynology of the Middle Bhuban Formation near Kolasib, northern Mizoram, India*

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Banerjee, S. & Nandi, B. 1993. Palynology of the Middle Bhuban Formation near Kolasib, northern Mizoram, India. *Geophytology* **23**(2):215-220.

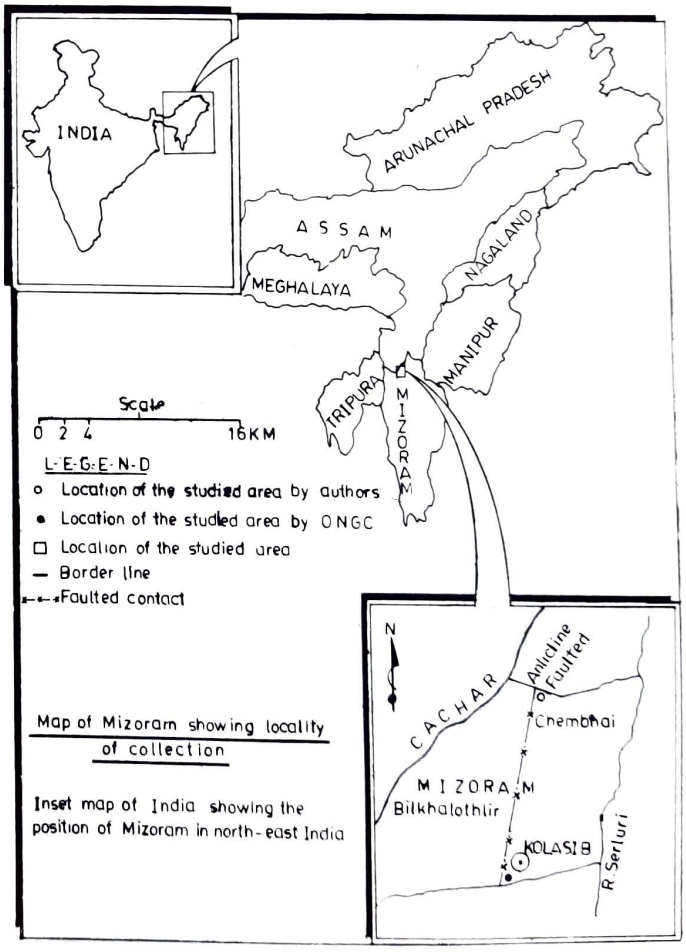
Palynoflora of the Bhuban Formation exposed near Kolasib, Mizoram is described. Qualitatively, fungal sporomorphs are dominant whereas the pteridophytic spores, angiospermous and gymnospermous pollen are less dominant. The inadequacy of microplankton is a notable feature. A tropical, subtropical, warm and humid climate during the deposition of Bhuban Formation is suggested. The study of different vegetational communities in the basinal area indicates a fluvio-estuarine conditions with occasional tidal influx nearer to the tectonically uplifted high altitude areas.

Key-words—Palynology, Tertiary, Bhuban Formation, Mizoram, India.

INTRODUCTION

THE hills of Mizoram constitute a part of the Assam-Arakan geosynclinal belt and represent Surma and Tipam groups ranging in age from early to late Miocene. Detailed geological work in Mizoram has been carried out by Ganju (1975) and Ganguly (1983). The palynological work on the sedimentary formations in Mizoram is not well documented. Ganguly (1975) reported some palynomorphs and interpreted the climatic history of the area. Banerjee and Nandi (1992) reported fungal assemblage from the Bhuban Formation.

The studied area is situated in the northern portion of Mizoram (See Map). A few samples were obtained through the kind courtesy of the Member (Exploration), Oil & Natural Gas Commission, Dehra Dun and others were collected by the authors from the Rengte anticline near Kolasib at a regular interval of 15 cm. These include various litho-types, such as, shales, siltstones, mudstones, sandstones and sand-shale alternations. About 25 samples from the Middle Bhuban Formation were macerated using the conventional technique. The slides are stored in the repository of the Palaeobotany and Palynology Laboratory, Department of Botany, University of Kalyani.



* Paper presented at the Birbal Sahni Birth Centenary Palaeobotanical Conference, Lucknow, November 20-22, 1991.

PALYNOFLORA

The Middle Bhuban Formation of Rengte anticline in Mizoram yielded a diverse palynoflora. The floral assemblage has striking similarities with that of the Middle Miocene of Upper Assam (Baksi, 1962; Banerjee, 1964; Sah & Dutta, 1968; Nandi, 1981; Salujha *et al.*, 1973; Saxena & Rao, 1984; Singh *et al.*, 1986; Rao, 1986; Rao *et al.*, 1985; Saxena *et al.*, 1987; Singh *et al.*, 1987).

The palynoassemblage also includes abundant algal and fungal remains (Plate 1). Algal representatives are: *Botryococcus* sp., *Pediastrum* sp., *Concentricystis rubina*, *Lingulodinium* sp., *Operculodinium* sp., *Veryhachium* sp. and *Baltisphaeridium* sp. The fungal assemblage is dominated by *Exesisporites* sp., *Hypoxylonites* sp., *Spirotremesporites* sp., *Fusiformisporites* sp., and *Paleoamphisphaerella* sp. Other fungal remains are *Microthyriacites* sp. and *Hyphopodia*.

The palynoflora is dominated by the pteridophytic spores and angiospermous pollen (Pl. 1). The pteridophytic spores are represented by *Cyathidites australis, Lygodiumsporites adriennis, Leptolepidites couperi, Dictyophyllidites trilobiformis, Cyathidites minor, Foraminisporis medius, Cicatricosisporites multicostatus, Pteridacidites triangulatus, Laevigatosporites ovatus, Polypodiaceaesporites haardtii, Polypodiisporites ornatus* and *P. mawkamaensis*.

The gymnospermous assemblage is represented by a few *Pinuspollenites* sp., *Podocarpidites clarus, Piceaepollenites* sp. and *Tsugaepollenites velatus* (Plate 1).

The dominant angiospermous pollen are: *Araliaceoipollenites reticulatus, Rhoipites communis,*

Plate 1

(All photomicrographs are in differential interference contrast and X 200, Stage coordinates refer to Carlzeiss Jenaval microscope).

1. *Cyathidites minor* Couper, Slide no. BKLR-CHMP-8B. Coordinates: 129.9 x 19.10.
2. *Dictyophyllidites trilobiformis* Sah, Slide no. BKLR-CHMP 14B. Coordinates: 120.8 x 10.2.
3. *Pteridacidites triangulatus* Sah, Slide no. BL-HLM-23. Coordinates: 172.8 x 10.5.
4. *Cyathidites australis* Couper, Slide no. BKLR-CHMP 14B. Coordinates : 140.0 X 15.3.
5. *Polypodiaceoisporites pseudoreticulatus* Nandi,. Slide no. RKSL-25. Coordinates: 174.5 X 18.5.
6. *Cicatricosisporites macrocostatus*, Slide no. RKSL -33. Coordinates: 160 X 19.2.
7. *Polypodiaceoisporites* sp., Slide no. RKSL-33. Coordinates: 142-X30.5.
8. *Cicatricosisporites multicostatus* Kar & Saxena, Slide no. BKLR-CHMP 8B. Coordinates: 155.1 X 12.6.
9. *Foraminisporis medius* Dutta & Sah, Slide no. BL-HLM-23 Coordinates: 110.7 X 6.2
10. *Leptolepidites couperi* Nandi, Slide no. BL-HLM-21. Coordinates: 189.7 X 8.2.
11. *Palmaepollenites communis* Sah & Dutta, Slide no. BL-HLM-17. Coordinates: 165. X 17.10.
12. *Deltoidospora delicata* Sah & Dutta, Slide no. BL-HLM-29. Coordinates: 175.7 X 5.2.
13. *Araliaceoipollenites reticulatus* Dutta & Sah, Slide no. BKLR-CHMP-14B. Coordinates: 140.8 X 17.1.
14. *Alnipollenites verus* Potonié, Slide no. BKLR-CHMP-8B. Coordinates: 149.3 X 16.6.
15. *Baltisphaeridium* sp., Slide no. RKSL-50. Coordinates: 136.2 X 15.2.
16. *Proxapertites cursus* Van Hoeken-Klinkenberg, Slide no. RKSL- 33. Coordinates: 180.10 X 27.3.
17. *Polypodiisporites ornatus* Sah, Slide no. BL-HLM-17. Coordinates: 176.5 X 19.5.
18. *Tsugaepollenites velatus* Kar, Slide no. BL-HLM-17. Coordinates: 150.7 X 16.0.
19. *Piceapollenites* sp., Slide no. BL-HLM-17. Coordinates: 142.8 X 21.5.
20. *Marginipollis kutchensis* Venkatachala & Kar, Slide no. BKLR-CHMP-8B. Coordinates : 136.7.X 17.10.
21. *Microthyriacites* sp., Slide no. BK-PBK-37. Coordinates: 160.7 X 20.2.
22. *Spinizonocolpites baculatus* Muller, Slide no. BL-HLM-23. Coordinates : 159.1 X 11.2.
23. *Pinuspollenites* sp., Slide no. BL-HLM-23. Coordinates : 137.3 X 19.2.
24. *Meyeripollis laudabilis* Salujha, Kindra & Rehman, Slide no. BL-HLM 29. Coordinates : 158.3 X 22.8.
25. *Veryhachium* sp. Deunff & Downie, Slide no. RKSL-50. Coordinates : 100.4 X 24.10.
26. *Rhoipites communis* Sah, Slide no. RKSL-25. Coordinates : 158.4 X 22.2.
27. *Paleoamphisphaerella* sp., Slide no. BL-HLM-23. Coordinates : 145.5 X 24.4.
28. *Polyporina globosa* Sah, Slide no. BKLR-CHMP-8B. Coordinates : 152.5 X 30.9.
29. *Pediastrum* sp., Slide no. RKSL-50. Coordinates : 180.8 X 11.4.
30. *Spirotremesporites* sp., Slide no. RKSL-50. Coordinates : 135.2 X 19.0
31. *Hypoxylonites* sp., Slide no. RKSL-50. Coordinates : 132.2 X 10.0.
32. *Fusiformisporites* sp., Slide no. RKSL-50. Coordinates : 153.2 X 18.2.
33. *Pleospora* sp., Slide no. RKSL-50. Coordinates : 144.5 X 9.3.
34. *Exesisporites* sp., Slide no. RKSL-50. Coordinates: 143.5 X 26.2.
35. *Botryococcus* sp., Slide no. RKSL-33. Coordinates: 174.9 X 19.5.

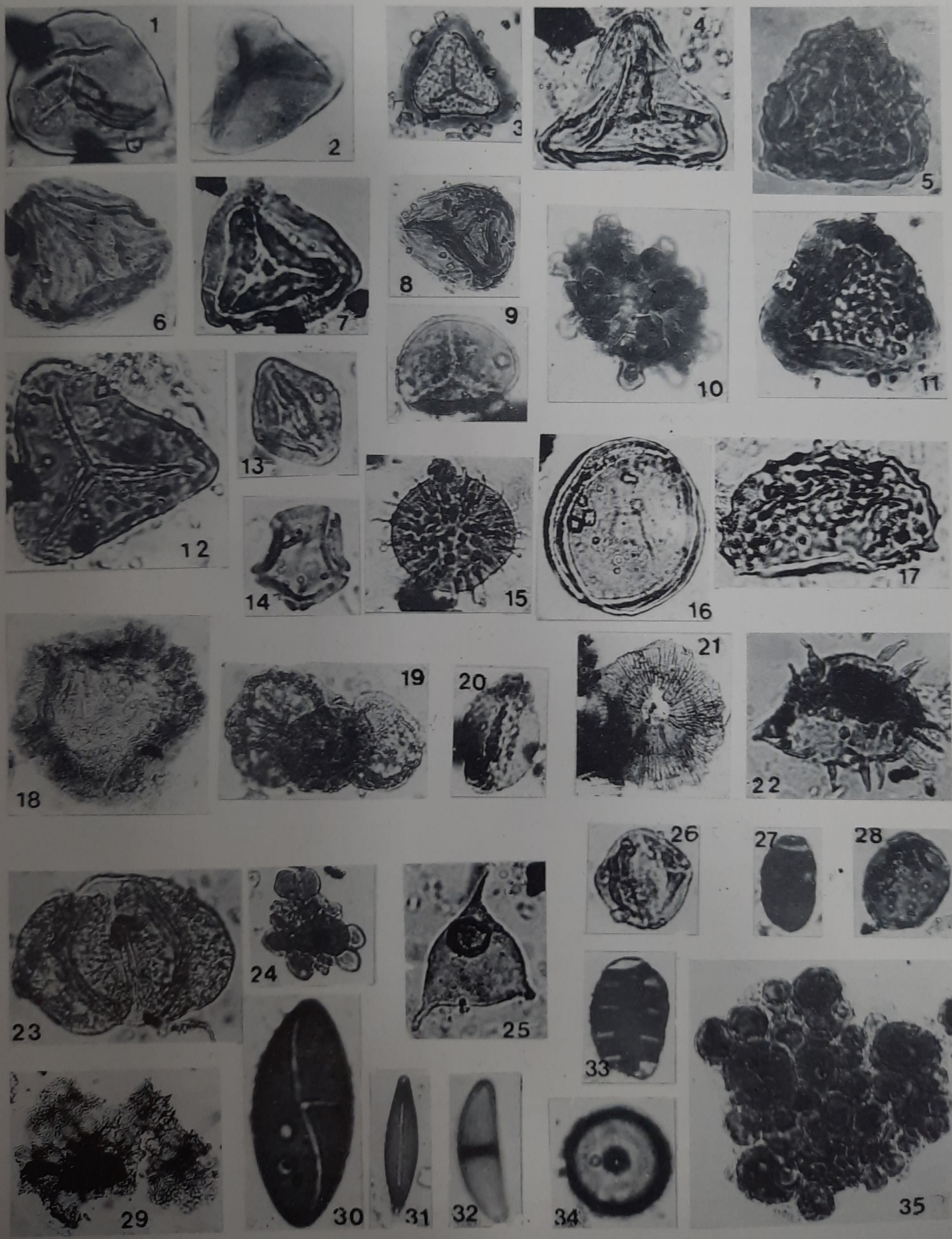

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Plate 1

Palmaepollenites communis, *Alnipollenites verus*, *Polyporina globosa*, *Meyeripollis laudabilis* and *M. naharkotensis*. The other significant taxa are: *Spinizonocolpites baculatus*, *Proxapertites cursus*, *Dicolpopollis psilatus*, *Zonocostites ramonae*, *Polyadopollenites* sp., *Marginipollis kutchensis* and *Heliospermopsis* sp. (Plate 1).

PALAEOECOLOGY AND PALAEOCLIMATE

The Middle Bhuban miofloral assemblage is represented by different plant associations. The composite assemblage contains algae, fungi, pteridophyte, gymnosperm, angiosperm taxa, most of which are comparable to the present day taxa. These are indicators of different climatic conditions (Table 1). The following palaeovegetational associations have been recognised.

1. *Mangrove association*— It is represented by the pollen of mangrove and back mangrove taxa, viz., *Zonocostites ramonae* (Rhizophoraceae), *Rhoipites communis* (Anacardiaceae), *Spinizonocolpites baculatus* (Arecaceae), *Proxapertites cursus* (Arecaceae), *Araliaceoipollenites reticulatus* (Araliaceae), *Meyeripollis laudabilis, M. naharkotensis*. The other mangrove representatives are *Heliospermopsis (Oudhkusmites)*, the salt glands of some mangrove plants. *Microthyriacites*, the fruiting body of microthyriaceous fungi which usually grow on mangrove plant.

2. *Coastal to freshwater low land association*— This association includes the plant which grow beyond the shoreline but may tolerate the salt water influence. The pollen taxa recorded are : *Marginipollis kutchensis* (Lecythidaceae), *Dicolpopollis psilatus* (Arecaceae), *Sapotaceoidaepollenites* sp. (Sapotaceae), *Engelhardtioidites parvus* (Dipterocarpaceae), *Talisiipites* sp., *Quercoidites* sp., *Cupuliferoipollenites* sp. (Fagaceae), *Cupuliferoidaepollenites* sp., *Bombacacidites* sp. (Bombacaceae), *Ctenolophonidites* sp., *Myricaceoipollenites* sp. (Myricaceae), *Margocolporites* sp. (Caesalpineaceae).

3. *Low wet land association*— Ferns are indicator of a marshy and bottom land environment. Some may also grow in the area of periodic tidal inundation. The pollen taxa indicating such an association are: *Lygodiumsporites adriennis* (Schizaeaceae), *Dictyophyllidites trilobiformis* (Dicksoniaceae), *Pteridacidites triangulatus* (Adiantaceae), *Polypodiaeceoisporites* sp. (Polypodiaceae), *Cicatricosisporites* sp. (Schizaeaceae), *Magnastriatites* sp. (Parkeriaceae), *Laevigatosporites)* sp. (Polypodiaceae), *Polypodiaceaesporites* sp. (Polypodiaceae) and *Polypodiisporites* sp. (Polypodiaceae).

4. *Sand dune and salt marsh association*— This association includes the taxa which are indicator or salt marsh condition. Some of the common types are *Pamaepollenites communis* (Arecaceae), *Longapertites* sp. (Arecaceae), *Polyporina globosa* (Chenopodiaceae-Amaranthaceae).

5. *Algal association*— It includes freshwater as well as salt tolerant algae. The common forms are *Botryococcus* (Chlorophyta), *Pediastrum* (Chlorophyta) and *Concentricystis rubina* (Prasinophyta).

This association also includes the dinoflagellate cysts and acritarchs of which some are indicator of marine influence, viz., *Lingulodinium*, *Operculodinium*, *Spiniferites*, *Veryhachium* and *Baltisphaeridium*.

6. *Fungal association*— The fungal assemblage are the indicator of humid, tropical climate. A variety of fungal spores, hyphae, fruiting bodies, hyphopodia are recorded that are mostly restricted to fresh water environment. Some of the fungal representatives are, however, brackish water indicator which are restricted within the mangrove association, e.g., *Microthyriacites* sp., (Microthyriaceae), *Fusiformisporites (Cookeina, Porodiella), Hypoxylonites* sp. *(Hypoxylon), Paleoamphisphaerella (Amphisphaerella).*

7. *Montane association*— The high altitude plants taxa recorded are *Tsugaepollenites* sp. *Pinuspollenites* sp. *Piceaepollenites* sp. *Abietineaepollenites* sp. (Pinaceae); *Betulaepollenites* sp. *Alnipollenites* sp. and *Engelhardtioidites* sp. (Dipterocarpaceae).

Table 1. Botanical affinity and climate of the palynotaxa recorded from the Middle Bhuban Formation of Mizoram

Name of taxa	Affinity	Climate/ environment
Algae		
Botryococcus sp.	Chlorophyta	Freshwater, can also grow on salt water
Pediastrum sp.	Chlorophyta	Fresh water, Cosmopolitan
Concentricystis rubina	Prasinophyta	Tropical, brackish water
Lingulodinium	Lingulodiniaceae	Shallow marine
Baltisphaeridium	Acritarch	Shallow marine
Veryhachium	Acritarch	Shallow marine
Fungi		
Hypoxylonites sp.	*Hypoxylon*	Cosmopolitan
Exesisporites sp.	Uncertain	Warm
Fusiformisporites sp.	*Cookeina* *Porodiella*	Tropical
Microthyriacites sp.	Microthyriaceae	Tropical humid
Paleoamphisphaerella	Amphisphaerella	Tropical humid
Hyphopodium	Uncertain but can associate with *Meliola*	Terrestrial, palustrine and coastal

Table 1 contd.

Pteridophytes		
Pteridacidites triangulatus	Adiantaceae	Tropical to subtropical
Polypodiaceoisporites simplex	Polypodiaceae	Tropical to subtropical
Dictyophyllidites trilobiformis	Dicksoniaceae	Tropical to subtropical
Leptolepidites couperii	Denstaedtiaceae	Tropical to subtropical
Foraminisporis medius	Lycopodiaceae	Cosmopolitan, prefering swampy and marshy habitats
Laevigatosporites ovatus	Polypodiaceae	Tropical to subtropical
Polypodiaceaesporites haardti	Polypodiaceae	Tropical to subtropical
Polypodiisporites ornatus	Polypodiaceae	Tropical to subtropical
Cyathidites australis *C. minor*	Cyatheaceae	Tropical and subtropical
Cicatricosisporites multicostatus	Schizaeaceae	Tropical and subtropical aquatic
Lygodiumsporites adriensis	Schizaeaceae	Tropical
Gymnosperms		
Podocarpidites clarus	Podocarpaceae	Subtropical
Piceaepollenites sp.	Pinaceae	Subtropical to temperate
Pinuspollenites sp.	Pinaceae	Subtropical to temperate
Tsugaepollenites velatus	Pinaceae	Temperate
Angiosperms		
Sparganiaceaepollenites sp.	Sparganiaceae	Aquatic and cosmopolitan
Polygalacidites sp.	Polygalaceae	Tropical to Subtropical
Polyporina globosa	Chenopodiaceae Amaranthaceae	Tropical
Palmaepollenites communis	Arecaceae	Tropical and subtropical
Proxapertites cursus	Arecaceae	Tropical and subtropical
Longapertites sp.	Arecaceae	Tropical and subtropical
Spinizonocolpites beculatus	Arecaceae	Tropical and subtropical
Dicolpopollis psilatus	Arecaceae	Tropical and subtropical
Polyadopollenites sp.	Mimosaceae	Tropical and subtropical
Rhoipites communis	Anacardiaceae	Tropical
Araliaceoipollenites reticulatus	Araliaceae	Tropical
Marginipollis kutchensis	Lecythidaceae	Tropical
Engelhardtioidites parvus	Dipterocarpaceae	Tropical to lower hill ranges
Zonocostites ramonae	Rhizophoraceae	Tropical and mangrove
Betulaepollenites sp.	Betulaceae	Temperate
Alnipollenites verus	Betulaceae	Temperate
Cupuliferoideaepollenites liblarensis	Fagaceae	Temperate
Incertae Sedis		
Salt gland (trichome)		
Heliospermopsis sp.	? *Aegiceros*	Tropical mangrove halophyte

OBSERVATIONS

The differential distribution pattern of the miofloral assemblage from the Middle Bhuban Formation (Table 1) suggests a tropical to subtropical, warm humid climatic condition during the Lower to Middle Miocene in this area.

The mixed floral assemblage comprising mangrove elements, inland fresh water angiosperms, rich pteridophytes and gymnosperms indicates that the basinal area was nearer to the coast and an elevated land was situated in proximity to the basin.

The association of dominant fresh water and lower frequency of brackish water vegetation along with rich *Botryococcus, Pediastrum* and *Concentricystis rubina* indicate a fluvio-estuarine conditions in which the pteridophyte dominating fresh water marshes, swamp and stream were common. Lower percentage of dinoflagellate cysts and acritarchs suggests the influence of shallow marine environment. Occasional presence of *Zonocostites, Rhoipites, Spinizonocolpites* indicates the presence of a localized mangrove vegetation and frequent inundation of the basinal area by the tidal influx. The intermixed montane-pollen association indicates the presence of tectonically uplifted high altitude areas where a subtropical mixed deciduous forest was present.

ACKNOWLEDGEMENTS

The authors are grateful to the authorities of the Oil and Natural Gas Commission, Calcutta for kindly supplying the samples. Grateful thanks are due to Dr D. Banerjee, Ex-Chief Palynologist, ONGC for his helpful suggestions. The first author is thankful to the University of Kalyani for financial support through University Research Scholarship.

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