

Early Holocene pollen data from Mikir Hills, Assam, India

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ABSTRACT

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The pollen analytical studies of a 1.5 m deep soil profile (12210±110 years BP at 80 cm level) from Kaki Forest Division in Mikir Hills of Assam have been carried out. The pollen investigation of surface samples was made to understand the pollen/vegetation relationship in the forest. However, the study of surface samples does not fully cohere with the present day set up of vegetation. Palynological studies of the sediment profile indicate that since the last 15,000 years there have been three stages of vegetational developments followed by a reducing environment at the beginning (150-120 cm) reflecting directly on brief phases of climate such as arid, semi arid and warm and humid. The abundance of grasses both cultivated as well as wild throughout the pollen diagram has revealed the existence of an open savanna forest for a long period. The arboreal vegetation is represented by mixed tropical and subtropical trees and shrubs. Both monolete and trilete ferns are well documented in the assemblage. Occurrence of some degraded pollen and spores indicate the biodegradation of microbiota as evidenced by the presence of fungal spores and hyphae in almost all the sediments.

The low occurrence of extra regional plant taxa like *Pinus*, *Picea*, *Abies*, *Larix*, *Betula* and *Alnus* in the sediments is indicative of long distance transportation of pollen from high elevation.

Key-words—Early Holocene, Pollen, Mikir Hills, Assam.

भारत के असम प्रांत की मिकिर पर्वत श्रेणियों से प्राप्त प्रारंभिक होलोसीन युगीन परागाणविक आंकड़े

समीर कुमार बेरा

सारांश

असम की मिकिर पर्वत श्रेणियों के काकी वन प्रभाग से प्राप्त एक 1.5 मीटर गहरी मृत्तिका परिच्छेदिका (80 सेमी स्तर पर 12210 ± 110 वर्ष पूर्व का) परागाणविक विश्लेषण किया गया। वन में परागकणों/वनस्पतियों के संबंध को समझने हेतु पृष्ठीय नमूनों का परागाणविक विश्लेषण किया गया। पृष्ठीय नमूनों का अध्ययन वनस्पतियों के वर्तमान परिदृश्य से पूर्णतः संगत नहीं है। अवसादी परिच्छेदिका का परागाणविक अध्ययन इंगित करता है कि विगत अन्तिम 15,000 वर्षों में वनस्पतियों के विकास की तीन प्रावस्थाएँ रही हैं, जिनके पश्चात क्रमशः प्रारंभ में (150-120 सेमी) एक न्यूनीकृत पर्यावरण आया, जिसका प्रत्यक्ष प्रभाव जलवायु की विभिन्न प्रावस्थाओं, जैसे—शुष्कता, अर्द्ध शुष्कता तथा आर्द्रता एवं उष्णता पर पड़ा। कृषि से प्राप्त घासों तथा जंगली घासों की संपूर्ण परागकण आरेख में प्रचुरता से एक दीर्घ अवधि हेतु विवृत सवाना वनों की उपस्थिति प्रदर्शित हुई है। वृक्षीय वनस्पतियाँ सम्मिश्र उष्णकटिबन्धीय एवं उपोष्ण कटिबन्धीय वृक्षों तथा गुल्मों द्वारा

निरूपित हैं। एक अरीय तथा त्रिअरीय दोनों ही पर्णांग (फ़र्न) समुच्चय में सुस्पष्टतः अभिलेखित हैं। कुछ निम्नीकृत परागकणों तथा बीजाणुओं की प्राप्ति सूक्ष्मजीवजातों का जैवनिम्नीकरण इंगित करती है, जो प्रायः सभी अवसादों में कवकीय बीजाणुओं तथा कवक तन्तुओं (हाइफी) की उपस्थिति से अभिपुष्ट है।

क्षेत्र से बाहर के क्षेत्रीय पादप वर्गकों, जैसे—पाइनस, पाइसिया, एबीज़, लैरिक्स, वीटुला तथा एलनस की अवसादों में कम प्राप्ति परागकणों के उच्च उन्नयन से दूरस्थ परिवहन का परिचायक है।

संकेत शब्द—प्रारंभिक होलोसीन, परागकण, मिकिर पर्वत श्रेणी, असम.

INTRODUCTION

POLLEN bearing sediments found in lakes provide a record of past vegetation presumably arranged in a stratigraphic column. Thus, description of the deposits depends greatly upon a quantitative determination of the relative proportion of pollen type at various levels. Interpretation of pollen deposit assumes that frequencies of pollen types deposited reflect changes in proportions of species or genera in the surrounding vegetation. These changes are often interpreted as the result of climatic change one of the major factors affecting species composition of vegetation. Therefore, with the acquired knowledge of the extant vegetation one may reconstruct the vegetational history and palaeoenvironment of the Quaternary period in terms of the ecological status of the dispersed pollen grains and spores.

Hitherto, no information is available on recent pollen spectra and Quaternary vegetational history on North eastern Hill region especially from Mikir Hills of Assam. Although preliminary works have been carried out at Cinnamara (Gupta, 1971), Upper Assam (Bhattacharya & Goswami, 1981; Bhattacharya & Chanda, 1982, 1988; Bhattacharya, 1985; Bhattacharya *et al.*, 1986) and Mikir Hill (Bera, 2000).

It is therefore, supposed that pollen analysis would be valuable for tracing the Quaternary vegetational history of the Mikir Hills and for revealing changes in palaeoclimate and ecology.

The typical subtropical monsoon climate prevalent in the area is characterised by the excessive moisture content of the air throughout the year. Two distinct climates i.e., Winter and summer can be recognised. The altitudinal range varies from 78 m asl to 1282 m asl. The soil within the Kaki Forest varies from sandy loam to fine silt and clayey loam. It is generally deep except on some hill slopes where rock occurs near the surface. In the hilly region the soil is derived by the decomposition and weathering of mostly gneiss or sandstone. The characteristic red loam is readily apparent. Clayey soil and fine silt are found in the depression and hollows in water logged location and exposure of the soil on the ridges and slopes losses its fertility very quickly due to washing away of

the fine material with organic and mineral matter. The texture of the soil is governed to a large extent on the vegetational cover and on past history of biotic activities. Soil under semi evergreen formation are comparatively richer in organic contents. The soil along the ridges and steeper slopes of the hills are usually sandy and gritty having shallow depth.

The forest types are of moist semi evergreen and moist mixed deciduous in the region. The moist semi evergreen formation occurred in Dhansiri, Disama, Daldaliya and partly in Kaki Forest areas and along nallahs and depressions where sufficient moisture and sunlight are available. The forest is dominated by principal arboreal taxa like *Tetrameles nudiflora*, *Stereospermum personatum*, *Amoora wallichii*, *Artocarpus chaplasi*, *Mesua ferrea*, *Phoebe goalparenses*, *Canarium resiniferum*, *Terminalia chebula*, *Gmelina arborea*, *Cinnamomum glanduliferum*, etc.

Moist mixed deciduous formation is predominant in Kaki reserve forests. The major arboreal taxa found growing luxuriantly in the region are *Terminalia bellerica*, *Bombax ceiba*, *Schima wallichii*, *Adina cordifolia*, *Lagerstroemia*

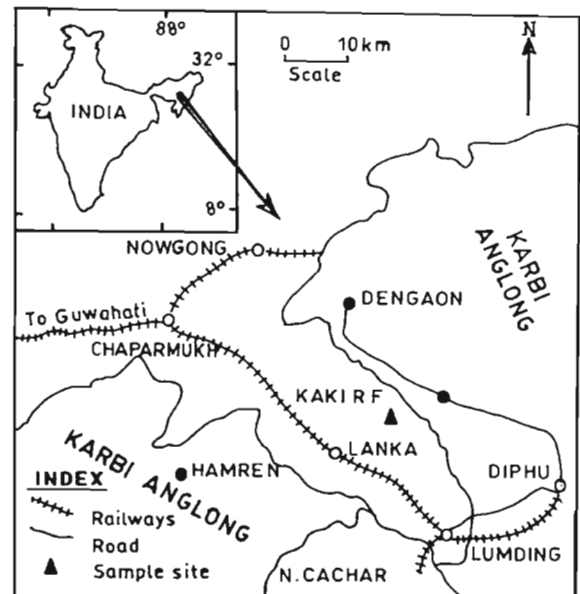


Fig. 1—Showing the site of sampling.

perviflora, *Sterculia villosa*, *Dillenia pentagyna*, *Albizia odoratissima*, *Anthocephalus cadamba*, *Bauhinia variegata*, *Holarrhena antidyenterica*, *Eugenia jambolana*, *Embllica officinales*, *Kydia calysina*, *Eupatorium odoratum*, *Zizyphus* sp., *Murraya koenghii*, *Laportea crenulata*, *Clerodendron viscosum*, etc. Among climbers *Mikania* spp. is predominant. Due to extensive felling of important plant taxa, the condition of the major crops of the formation have deteriorated and natural regeneration is almost absent caused by repeated grazing by the cattle of the neighbouring villages.

The main object involves undertaking of moss, soil and mud as surface samples collected in a transect at 100 m interval from within the forest into the open land with a view to understand the pollen/vegetation relationship in Mikir Hill forests which could help in ascertaining various climatic cycles to a great extent involving various controlling factors in the past through the palynostratigraphical study of sediment profile (Fig. 1).

MATERIAL AND METHODS

The modern surface samples were collected from within and outskirts of the forests. Moss cushion 1-4 were collected in a transect from within the forest to the edge. Sample numbers 5 and 6 were collected from near a swamp in open land whereas, mud samples 7 and 8 were collected from cultivated areas. The samples were collected in air tight double polythene bags. After several trials one 1.5 m soil sediment profile was collected by trenching in a dry cracked swampy areas within the forest. Due to hard stratum it was not possible to dig deeper sediments more than 1 to 1.5 m depth. Lithologically entire profile is divisible into three distinct lithozones viz., the upper clayey, middle organic mud and lower comparatively much thicker zone of sandy clay. The samples were chemically processed by conventional acetolysis method (Erdtman, 1943). The pollen counts vary from 150-250 depending upon the productivity of sample. The frequency percentages have been calculated in terms of total plants pollen counts. The plant taxa are grouped as arboreals, nonarboreals, ferns and drifted, etc. and arranged accordingly in the pollen spectra and diagram.

POLLEN/VEGETATION RELATIONSHIP

Pollen study of eight surface samples i.e., moss cushions, soil and mud procured from forested as well as open land in and around Kaki Forest Division in Mikir Hills of Assam has revealed that pollen spectra does not fully cohere with the modern vegetation set up both qualitatively and quantitatively. However, among arboreals *Ardisia*, *Artocarpus*, *Dillenia*, *Terminalia*, Oleaceae, Malvaceae, Anacardiaceae and Meliaceae are the only elements recorded within the values of 4-22 per cent out of which the extra regional taxa such as *Pinus*, *Alnus* and *Larix* are represented at the 6-10 per cent.

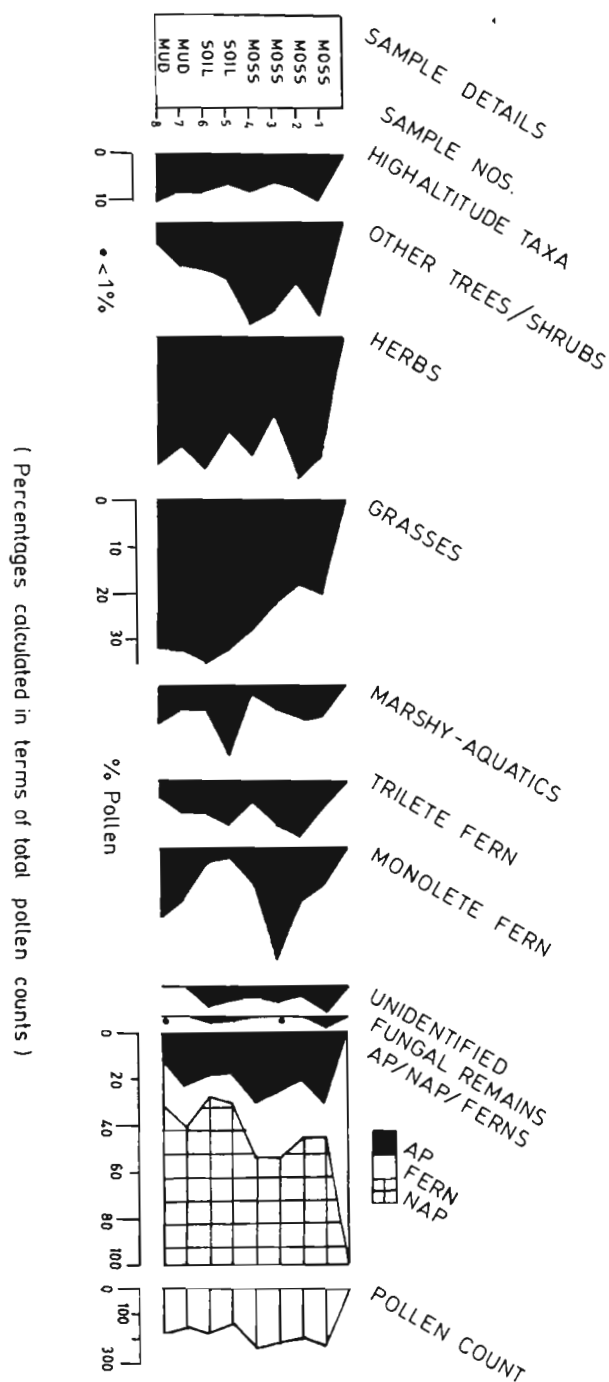


Fig. 2—Pollen spectra from Kaki Forest, Mikir Hills, Assam.

Ground vegetation is largely dominated by grasses under 18-35 per cent followed by other herbaceous elements like Asteraceae (4-15%), Chenopodiaceae/Amaranthaceae (2-4%), Lamiaceae, Apiaceae, Rubiaceae, Ranunculaceae and

Impatiens within the value of 1-3 per cent. Whereas, *Brassica nigra* (4.5-6.5 %) is recorded only in the samples collected from near the cultivated land. Cyperaceae, *Polygonum serrulatum* and *P. plebejum* are the main marshy elements whereas, *Potamogeton*, *Typha* and Liliaceae represent the aquatic vegetation. Monolete as well as trilete fern spores are mainly derived from the species of *Polypodium*, *Davallia*, *Pteris*, *Pteridium*, *Polytrichum*, etc. A large number of saprophytic fungi have been encountered in all the samples (Fig. 2).

DESCRIPTION OF POLLEN DIAGRAM

The constructed pollen diagram has been divided into three distinct vegetational phases followed by a barren zone at the beginning (150-120 cm) at the base of the profile on the basis of changing pollen sequences. The pollen assemblages are designated as M I, M II and M III whereas, the barren zone as BZ. The vegetational phases are separately described as follows (Fig. 3).

Phase M I (120-90 cm) : Grass-Brassicaceae-Tubuliflorae-Caryophyllaceae-Chenopodiaceae/Amaranthaceae-Fern assemblage

This phase is characterised by the high values of grasses along with moderate value of Tubuliflorae, Caryophyllaceae and Chenopodiaceae/Amaranthaceae. Among others like Euphorbiaceae, Cyperaceae and *Justicia* are encountered in sporadic to low values. Cerealia and Brassicaceae are also reported in the scenario. Monolete fern spores are reported in relatively high values than that of trilete fern spores. The overall assemblage indicates the existence of open grassland with luxuriant growth of ferns. The occurrence of fungal remains along with a few degraded pollen and spores are indicative of microbial activity in the sediments.

Phase M II (90-50 cm) : Grass-Tubuliflorae-Lamiaceae-Chenopodiaceae/Amaranthaceae-Oleaceae-Terminalia-Syzygium assemblage

Among nonarboreals grasses maintain slightly low values than the preceding one. Whereas, Tubuliflorae, Lamiaceae, Ranunculaceae, *Impatiens*, etc. are recorded in low to moderate values. The invasion of arboreal taxa like *Terminalia*, *Syzygium*, *Artocarpus*, *Zizyphus*, Oleaceae, etc. have occurred for the first time in this phase. Among others *Adina*, Anacardiaceae, Fabaceae, Malvaceae and Liguliflorae are recorded sporadically. Fern spores both monolete and

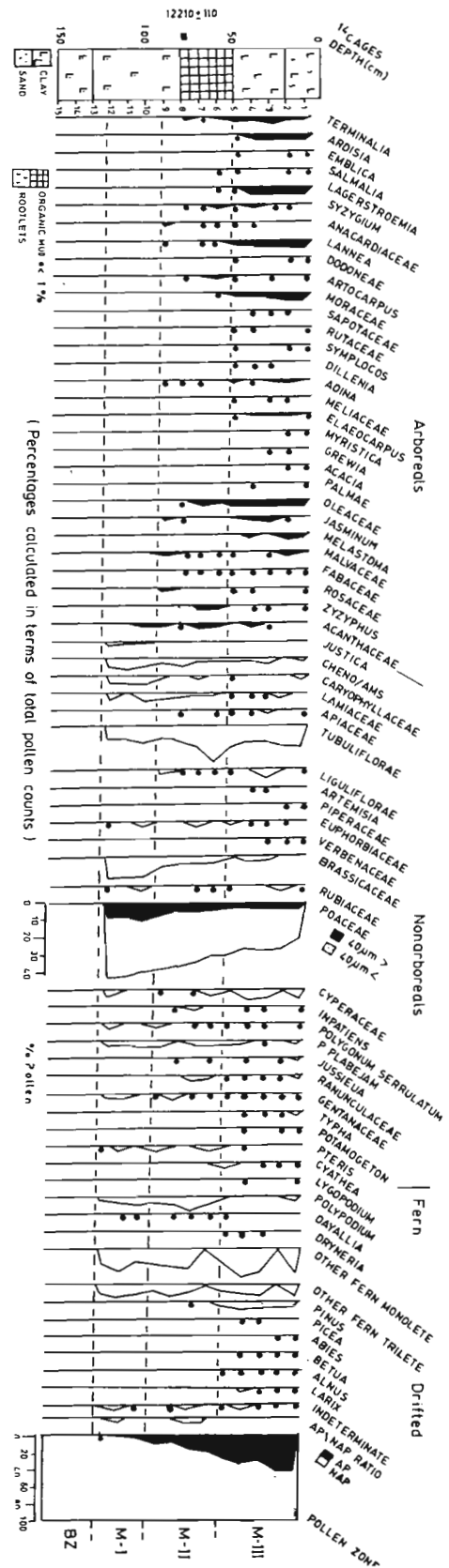


Fig. 3—Pollen diagram from Kaki Forest, Mikir Hills, Assam.

trilete maintained the same value as in the preceding one. The overall pollen assemblage indicates the savanna type of vegetation. The occurrence of fungal spores associated with degraded palynomorphs are supportive of the indication of biological degradation of microbiota.

Phase M III (50-0 cm) : Grasses–Cyperaceae–Tubuliflorae–Terminalia–Ardisia–Lagerstroemia–Elaeocarpus–Moraceae–Oleaceae–Fern assemblage

Grasses along with Tubuliflorae and Cyperaceae show relatively low values than the preceding phase. *Polygonum*, *Impatiens*, Ranunculaceae and Euphorbiaceae are reported sporadically. The values as well as numbers of the arboreal taxa are reported relatively high in the pollen assemblage and the important taxa are *Terminalia*, *Ardisia*, *Lagerstroemia*, *Lansea*, Moraceae, etc. Whereas, *Elaeocarpus*, *Melastoma*, *Adina* and Oleaceae are some of the taxa reported in low value. *Emblica*, *Syzygium*, *Dillenia*, Sapotaceae and Fabaceae are reported sporadically. Fern spores both monolete and trilete maintain the same value as in the preceding phase. *Larix*, *Picea*, *Abies*, *Betula* and *Alnus* are first time appeared in the assemblage which are not growing in the region. The fungal remains and some biodegraded pollen spores are encountered in low values in the assemblage. The overall assemblage indicates the establishment of arboreal vegetation during the phase.

HISTORY OF VEGETATION AND CLIMATE

North-eastern India which today possesses a diversified and luxuriant vegetation has not received much attention regarding its palaeovegetational succession and palaeoclimatic oscillation excepting the study of one brick kiln quarry dated back to about 18,000 years BP from Lakhimpur District of Upper Assam (Bhattacharya & Chanda, 1988). Hitherto, no work has been done from Mikir Hills region and adjoining areas. This is the first comprehensive attempt in this direction.

One 1.5 m deep sediment profile collected from Kaki Forest Division of Mikir Hills, has solitary date of 12210±110 years BP at 80 cm level but on extrapolation of date based on the rate of sedimentation reveals palaeovegetational scenario covering last 15,000 years BP.

The vegetation scenario in Mikir Hills began with a vast stretches of grassland during 13,000 years BP before which no biota was observed at the lower part of the profile (150-120 cm), indicative of reducing environment which precludes the pollen deposition. The grass is the dominant constituent in which the cerealia (10-12 %) along with other culture pollen viz., Asteraceae, Caryophyllaceae, Chenopodiaceae-

Amaranthaceae, etc. indicate the clue for land clearance for agricultural practice. The other major elements associated with grassland such as *Polygonum* spp., Lamiaceae, *Justicia* and Gentianaceae are encountered in low to moderate value. Ferns are represented by tropical/subtropical genera.

The overall vegetation scenario is suggestive of arid climatic regime. A few biodegraded fern spores especially, *Pteris* sp. along with the occurrence of a number of fungal remains indicate the biodegradation of spores in the sediments. During the period 13,000-6000 years BP the invasion of a number of arboreal taxa in the scenario along with the predominance of non-arboreals reflects the open savanna type of vegetation. The grass curve although tends to slightly decrease, Cerealia and other cultural pollen like Caryophyllaceae, Tubuliflorae, *Artemisia*, Chenopodiaceae-Amaranthaceae, etc. are indicative of continuous agricultural practice during the phase. Among the arboreal taxa like *Terminalia*, Anacardiaceae, *Syzygium*, Oleaceae, *Zizyphus* and Acanthaceae, etc. are encountered in low to moderate values whereas, *Salmalia*, *Lagerstroemia*, Oleaceae and Malvaceae are recorded in sporadic to low values. Ferns are constantly maintaining their stable values in the whole column. The appearance of degraded *Pinus* pollen along with a few monolete fern spores are suggestive of biodegradation in sediments during the phase.

The overall vegetation scenario indicates semi arid climatic condition during this phase. In the last phase during 6,000 years BP till date the establishment of tropical forest occurred as evidenced by the appearance of a number of arboreals in the vegetation scenario could perhaps be the result of the impact of enhanced precipitation inducing amelioration of climate in the region. The major arboreal taxa recorded in good values are, *Terminalia*, *Ardisia*, *Lagerstroemia*, *Lansea*, Moraceae, *Adina*, *Elaeocarpus*, *Melastoma*, etc. whereas, others like *Emblica*, *Syzygium*, Sapotaceae, Meliaceae, *Dillenia*, *Artocarpus*, Fabaceae and *Zizyphus* are encountered in sporadic to low values.

Non-arboreal vegetation is dominated by grasses along with low value of Cerealia, Asteraceae, Chenopodiaceae-Amaranthaceae, etc. whereas, other herbaceous taxa like Cyperaceae, Piperaceae, Verbenaceae, Apiaceae, *Typha* and *Potamogeton* are recorded for the first time either sporadically or in low values. The presence of Palm pollen in one sample still needs further investigation. Among ferns both monolete and trilete spores played an insignificant role in the vegetational association because of their local origin. The appearance of *Pinus*, *Picea*, *Abies*, *Larix*, *Betula* and *Alnus* may have been transported from higher elevation. Low occurrence of fungal spores and absence of degraded pollen in the assemblage are indicative of less chance for biodegradation during sedimentation.

The overall vegetation scenario indicates the warm and humid climatic conditions where the establishment of tropical

and sub tropical forests occurred and probably last till date. In question the interpretation of pollen diagram depends on the following factors : (a) the relative frequency of pollen-spores production by different taxa in different years, (b) the extent of pollen dispersal, (c) various mode of pollination viz., anemophilous, entomophilous or amphiphilous, (d) long distance pollen transport, (e) differential depositional environments during sedimentation, etc. The above said factors may not apply to the study as the sedimentation did not take place in a typical peat-bog environment but possibly occurred in a vast flood plain as evidenced by the nature of the soil profile (silty clay) and the presence of pollen-spores in low frequency in the sediments. The recorded pollen-spores show good state of preservation although in low amount. In some cases the pollen spectra were masked with exotic pollen taxa growing in upper reaches. The overall pollen analytical results reflect a mixed assemblage of ferns, conifers and Angiosperms. Ferns are represented by tropical/subtropical genera which included *Pteris*, *Cyathea*, *Lycopodium*, *Polypodium*, *Davallia*, *Dryneria*, *Athyrium*, *Microlepia*, *Pteridium*, *Osmunda*, etc. The conifers are found to be psychophilic and possibly transported through river as well as upthermic winds from higher reaches and incorporated in sediments. The Angiosperms are described as mostly mixed tropical deciduous elements excepting a few subtropicals.

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REFERENCES

- Bera SK 2000. Modern pollen deposition in Mikir hills. Assam. *Palaeobotanist* 49 : 325-328.
- Bhattacharya K 1985. Pollen analysis of a few Quaternary deposits of Upper Assam with reference to dating, vegetation history and biostratigraphy. Ph.D. Thesis. Calcutta University.
- Bhattacharya K & Chanda S 1982. A brief report on partial late Quaternary vegetational history and biostratigraphy of Digboi. Assam. *Transactions of Bose Research Institute* 45 : 72-76.
- Bhattacharya K, Chanda S & Barui NC 1986. Vegetational History and biostratigraphy of late Quaternary sequence of Tinsukia. Upper Assam, India. *Bulletin of Geological Mining & Metallurgical Society of India* 54 : 202-209.
- Bhattacharya K & Chanda S 1988. Late-Quaternary vegetational history, Palaeoecology and Biostratigraphy of some deposits of Brahmaputra Basin, Upper Assam, India. *Journal of Palynology* 23-24 : 225-237
- Bhattacharya K & Goswami AB 1981. Pollen analysis of a Quaternary deposit of Ledo-Matikhad, Upper Assam. *Proceedings of 68th Session, Indian Science Congress* : 59-60 (Abstract).
- Erdtman G 1943. An introduction to pollen analysis. Waltham, Mass. USA.
- Gupta HP 1971. Pollen analytical investigations of some upper Pleistocene samples from Tocklai, Cinnamara, Assam. *Palaeobotanist* 18 : 234-236.