PALYNOLOGY OF THE TERTIARY SUBCROPS OF UPPER ASSAM[1,2]

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ABSTRACT

A brief account of the palynological studies carried out on the subcrops of Upper Assam during the last decade and more, mostly by one of us (D.B.), is presented. One representative well, each from Borholla, Naginijan, Teok, Amguri, Disangmukh, Rudrasagar, Geleki, Naz-ira and Lakwa structures, in Sibsagar district of Upper Assam, have been incorporated in the present report. On the basis of the palynofossils recorded, the subsurface sequence has been divided into three or four broad palynological zones, depending on the formations penetrated. The lowest zone, Paly. Zone IV, has been dated as Eocene (Mid. to Upp.) on the basis of the common occurrence of *Retialetes* spp., *Monolites mawkmaensis, Palmaeplloenites eocenicus, Palaeorubiaceaepites* sp., *Palaeocaesalpiniaceaepites eocenica, Polycolpites* spp., *Nothofagidites* spp., *Schizosporis* spp., *Hystrichospheridium* spp. etc. In Geleki, Nazira and Lakwa structures, wells have not been drilled deep enough to encounter this zone. Sylhet and Kopili Formations are included in this zone. The next higher zone, Paly. Zone III, has been dated as Oligocene and includes the Barail Formation. The palynomorphs of common occurrence are *Meyeripollis* sp., *Foldexina inaperturata, Cicatricosisporites* sp., *Disulcites* sp., *Palaeocaesalpiniaceaepites* sp., *Polycolpites* spp. (not more than 5-6 colpi), *Simsangia trispinosa* etc. Paly. Zone II has been dated as Miocene (Mid. to Upp.) and is characterised by the occurrence of *Dicksoniaceaesporites* sp., *Cicatricosisporites* spp., *Pinuspollenites* spp., *Podocarpidites* sp., *Castaneapollenites* sp., *Alnipollenites* sp., *Ericipites* sp., *Stephanocolpites* sp., etc. Tipam Formation is included in this zone. The Surma Group, if present, has not been confirmed so far; Bhuban Formation is not represented in the sequence studied so far. The topmost zone, Paly. Zone I, includes Girujan, Namsang and younger formations. This zone has been dated as Plio-Pleistocene to Recent and the taxa occurring commonly are *Pteridacidites, Scabratriletes, Sporites circulus, Cyathidites, Graminidites, Juglanspollenites, Compositoipollenites, Umbelliferaepites, Impatiensidites* etc.

The distribution of the taxa in different zones is more or less the same in all the wells under report, which suggests the prevalence of largely similar ecological conditions during deposition of successive zones. Some of the important phenomena noted are:

1. the frequent occurrence of typical Barail microflora in the Namsang,
2. the consistant occurrence of typical Lr. Gondwana (Permo-Carb.) microflora in the Miocene; and
3. the decrease in the frequency of microplanktonic elements from west to east of the area.

From the distribution of the different taxa, it has been concluded that the basin was deeper towards the northeast from Borholla, the westernmost well. Largely shallow-marine to brackish-water conditions existed during Paleogene times and there was luxuriant vegetation growing in swamps, fresh-water lakes, along the coast and inland near-shore areas in a warm, humid, tropical to sub-tropical climate. The Neogene flora was essentially inland terrestrial, growing in moist, shady lowlands and cool uplands in a temperate to sub-tropical climate. This change in the microfloral contents in the Paleogene and Neogene is interpreted as indicative of orogenic activities in the northern parts of the area and regression of the sea southwards.

INTRODUCTION

TERTIARY stratigraphical palynology in India started about three decades back. Assam occupies a unique position in this respect. The first record of a fossil pollen from the Tertiary of India was from Assam (Ghosh, 1941). The first attempt at stratigraphical correlation of Tertiary strata in India by palynological means was on the oil-bearing strata of Assam (Sahni, Sitholey & Puri, 1947). Since then, a number of palynological studies on the Tertiary of Assam have been carried out by different workers (Sen, 1948; Meyer, 1958; Baksi, 1962, 1965; Biswas, 1962; Chatterjee & Ghosh, 1962; Ghosh & Banerjee,

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1963; Banerjee, 1964a, b, 1967; Ghosh, 1964, 1969; Sah & Dutta, 1966, 1967, 1968; Dutta & Sah, 1967; Srivastava & Banerjee, 1969; Banerjee & Misra, 1971 etc.). Most of these studies were, however, carried out on samples from Lower Assam. In the present note, a brief account of the palynological studies carried out during the last decade and more, mostly by one of us (D.B.), on the Tertiary subcrops of Upper Assam has been given.

MATERIAL & METHOD

One representative well from each of the Borholla, Naginijan, Teok, Amguri, Disangmukh, Rudrasagar, Geleki, Nazira & Lakwa structures in Sibsagar district of Upper Assam, has been included in the present report (Text-fig. 1). The samples, both cores and well cuttings, are mostly clays, shales, sandstones, and coal. These have been macerated following the techniques standardized in this laboratory, the microfossils mounted in glycerine jelly on slides and sealed with vinyl acetate dissolved in toluene, for microscopic examination.

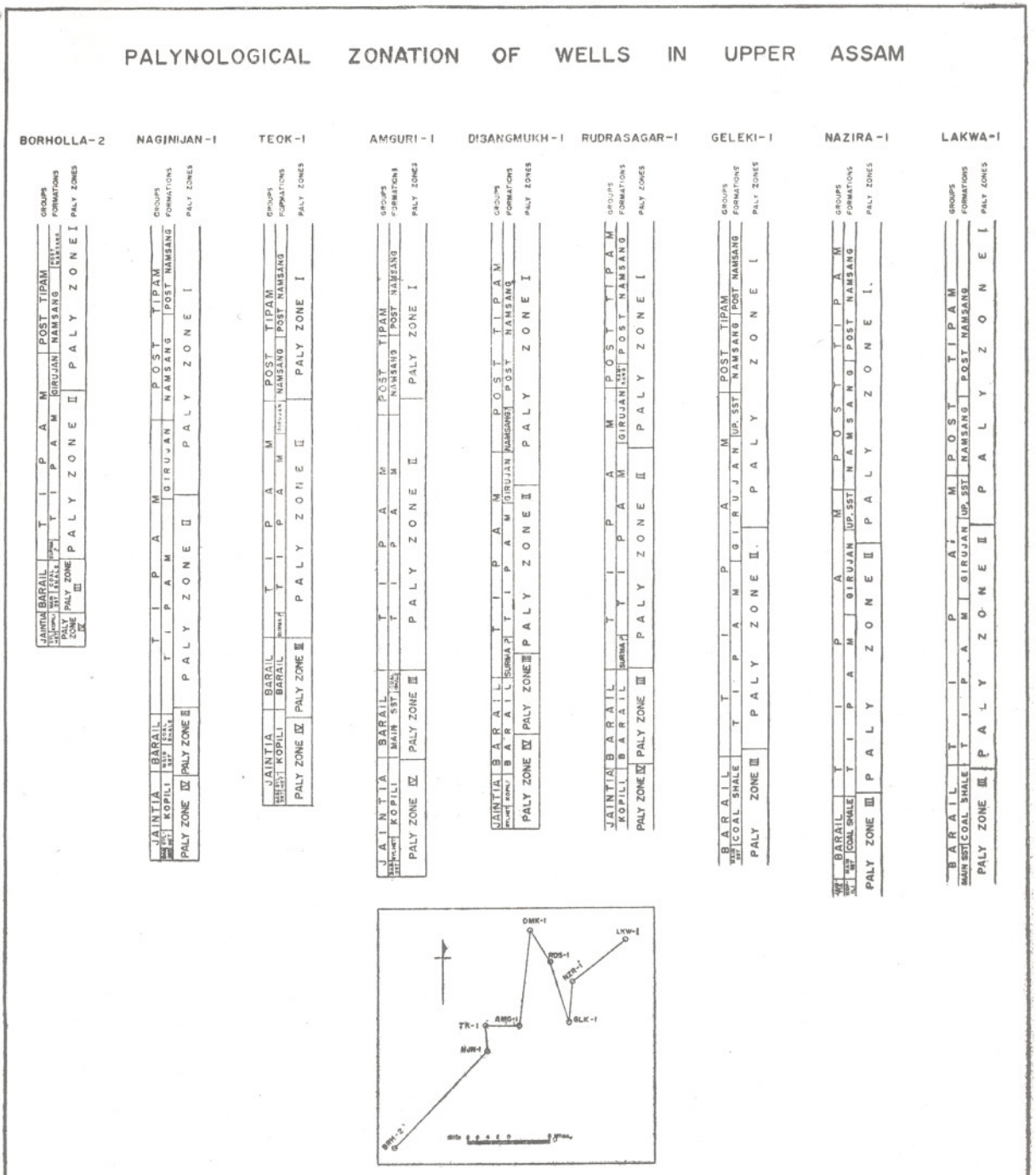
OBSERVATION & DISCUSSION

The samples have been found to be fairly to moderately rich in microflora, depending on the lithology. Pteridophytic, gymnospermous and angiospermous elements as well as microplanktons and fungal spores are represented. The various taxa recorded are: *Dicellaesporites, Multicellaesporites, Diporicellaesporites, Pluricellaesporites*; *Sporites circulus*; *Polypodiaceaesporites, Polypodiisporites, Monolites, Scabratriletes, Pteridacidites, Cyathidites, Dicksoniaceaesporites, Lycopodiumsporites, Acanthotriletes, Gleicheniidites, Biretisporites, Cicatricosisporites, Schizaeoisporites, Meyeripollis, Retialetes, Schizosporis, Cingulatisporites*; *Pinuspollenites, Podocarpidites, Alisporites, Pityosporites, Striatites, Parasaccites, Ephedripites*; *Graminidites, Juglanspollenites, Alnipollenites, Extratriporopollenites, Triorites, Anacolosidites, Palmaepollenites, Nymphaeaceaepites, Disulcites, Compositoipollenites, Quercoidites, Umbelliferaepites, Castaneapollenites, Ilexpollenites, Rostriapollenites, Palaeocaesalpiniaceaepites, Palaeorubiaceaepites, Sapotaceoidaepollenites, Myrtaceidites, Proteacidites, Tiliaepollenites, Impatiensidites, Stephanocolpites, Polycolpites, Nothofagidites, Polygalacidites, Striatopollis, Polygonacidites, Polyporina, Retipilonapites*; *Foldexina inaperturata*; *Simsangia, Veryhachium, Hystrichosphaeridium, Hystrichosphaera, Tenua, Pediastrum*, etc.

The taxa recorded are found to have varied distribution, both vertically and horizontally. Some have restricted occurrence only in a particular portion of the rock-sequence; others have varying percentages in a particular portion from structure to structure. Still others may be present throughout the sequence or in particular portions in all the structures. Basement was reached only in the wells at Borholla, Naginijan, Teok, Amguri and Disangmukh. On the basis of the distribution of the various taxa, the subsurface sequence has been divided into four palynological zones in Borholla, Naginijan, Teok, Amguri and Disangmukh wells. Three zones have been demarcated in Geleki, Nazira and Lakwa wells, while in Rudrasagar four zones have been demarcated in three wells only, the others having only three zones.

Paly. Zone IV: The lowest zone has been designated as Paly. Zone IV. This zone is distinguished from the overlying zones by the common occurrence of *Monolites mawkmaensis, Retialetes* spp., *Schizosporis* sp., *S. assamica, Palmaepollenites eocenicus, Palaeocaesalpiniaceaepites eocenica, Polycolpites cooksonii, P. obscurus, Nothofagidites* spp., *Palaeorubiaceaepites* sp., *Extratriporopollenites* sp., *Hystrichosphaeridium* spp. etc. in a rich assemblage composed, in addition, of *Dicellaesporites* sp., *Diporicellaesporites* sp., *Pluricellaesporites* sp., *Polypodiaceaesporites* spp., *Polypodiisporites* spp., *Schizaeoisporites* sp., *Biretisporites* spp., *Cicatricosisporites* sp., *Nymphaeaceaepites* sp., *Disulcites* sp., *Anacolosidites* sp., *Triorites* sp., *Proteacidites* sp., *Myrtaceidites* sp., *Tiliaepollenites* sp., *Polygalacidites* sp., *Retipilonapites* sp., *Hystrichosphaera* spp., *Tenua* sp., *Pediastrum* sp. etc. Sylhet and Kopili Formations constitute this zone and Middle to Upper Eocene age is assigned.

The Eocene strata of Assam have been studied by Ghosh (1941), Sen (1948), Biswas (1962), Baksi (1962), Banerjee (1964b), Sah & Dutta (1966, 1967 1968), Ghosh (1969), Sah, Kar & Singh (1970) and few others. All these studies are, however, confined mostly to the Shillong Plateau. Ghosh (1941) and Sen (*l.c.*) reported the presence of disaccate conifer pollen in the Cherra


PALYNOLOGICAL ZONATION OF WELLS IN UPPER ASSAM
BORHOLLA-2
NAGINIJAN-1
TEOK-1
AMGURI-1
DIGANGMUKH-1
RUDRASAGAR-1
GELEKI-1
NAZIRA-1
LAKWA-1
GROUPS
FORMATIONS
PALY ZONES
JAINTIA
BARAIL
KOPILI
TIPAM
GIRUJAN
POST TIPAM
NAMSANG
POST NAMSANG
PALY ZONE I
PALY ZONE II
PALY ZONE III
PALY ZONE IV
COAL SHALE
MAIN SST
UP. SST
SUBSIA
DMK-1
LXW-1
RDS-1
NZR-1
GLK-1
AMG-1
TR-1
NJN-1
BRH-2

TEXT-FIG. 1

Formation while Biswas (*l.c.*) reported such pollen from the Langpar and Tura Formations. Disaccate pollen have not been recorded by Baksi (*l.c.*), Banerjee (*l.c.*), Sah & Dutta (*l.c.*) and Ghosh (1969) from the Eocene and have not been observed in the present study also. Sah *et al.* (*l.c.*) reported microplanktons from the Langpar Formation (considered to be Paleocene in age). Biswas (*l.c.*) and Baksi (*l.c.*) have also reported hystrichosphaerids from the Paleocene and Eocene of Shillong Plateau. Hystrichosphaerids from the subsurface Eocene sediments of Upper Assam have been reported by Srivastava & Banerjee (1969). Baksi (*l.c.*) and Sah & Dutta (1968) have dealt with more or less complete stratigraphic sequences, which make it convenient for evaluating the extent of the different taxa in the sequences and consequently these are more suitable for comparison of assemblage. Hence, comparisons have been made in more details with these studies and it has been found that the assemblages compare well with the assemblage recorded in the present study.

Paly. Zone III: The next overlying zone, Paly. Zone III, is separated from the underlying and overlying zones on the basis of the appearance in abundance of *Meyeripollis* and *Foldexina inaperturata*, and absence of *Proteacidites* sp., *Triorites* sp., *Nothofagidites* spp., *Palaeorubiaceaepites* sp., *Polygalacidites* sp., *Schizaeoisporites* sp. etc. in this zone. A reduction in the frequency of the microplanktons than in the underlying zone is observed here. The assemblage is composed of *Multicellaesporites* sp., *Diporicellaesporites* sp., *Pluricellaesporites* sp., *Polypodiaceaesporites* spp., *Polypodiisporites* spp., *Biretisporites* sp., *Meyeripollis* sp., *Schizosporis* sp., *Cicatricosisporites* sp., *Gleicheniidites* sp., *Lycopodiumsporites* sp., *Nymphaeaceaepites* sp., *Palmaepollenites* sp., *Disulcites* sp., *Striatopollis* sp., *Rostriapollenites* sp., *Anacolosidites* sp., *Palaeocaesalpiniaceaepites* sp., *Polycolpites* sp. (not more than 5-6 colpi), *Stephanocolpites* sp., *Ephedripites* sp., *Retipilonapites* sp., *Foldexina inaperturata*, *Simsangia trispinosa*, *Veryhachium* spp., *Hystrichosphaeridium* sp., *Pediastrum* sp., stromata of Microthyriaceae etc. Barail Formation constitutes this zone and is dated as Oligocene.

Published accounts of the palynological studies on the Oligocene of Assam are very few. Meyer (1958) described a few palynomorphs from the Barail of Nahorkatiya and Baksi (1962, 1965) discussed about Barail-equivalent formation in the South Shillong Front. Sah & Dutta (1968) have given the range of occurrence of certain taxa in the Barail of Assam. Many taxa recorded by them have been commonly observed in our study.

Paly. Zone II: This zone is marked by a sharp change in the microfloral contents from the underlying zones. New taxa, viz., *Dicksoniaceaesporites*, *Pinuspollenites*, *Alnipollenites*, *Castancapollenites*, *Ericipites*, *Sapotaceoidaepollenites*, *Polygonacidites* etc. appear and a marked increase in *Cicatricosisporites* is observed. *Biretisporites*, *Retialetes*, *Schizosporis*, *Meyeripollis*, *Nymphaeaceaepites*, *Palmaepollenites*, *Disulcites*, *Anacolosidites*, *Polycolpites*, *Foldexina inaperturata*, *Retipilonapites* and the microplanktons have not been observed so far. The assemblage consists of *Polypodiaceaesporites* spp., *Polypodiisporites* spp., *Gleicheniidites* sp., *Cyathidites* sp., *Cingulatisporites* sp., *Dicksoniaceaesporites* sp., *Lycopodiumsporites* sp., *Cicatricosisporites* spp., *Acanthotriletes* sp., *Pinuspollenites* spp., *Podocarpidites* sp., *Alisporites* sp., *Pityosporites* sp., *Striatites* sp., *Parasaccites* sp., *Alnipollenites* sp., *Quercoidites* sp., *Castaneapollenites* sp., *Polygonacidites* sp., *Sapotaceoidaepollenites* sp., *Striatopollis* sp., *Graminidites* sp., *Ericipites* sp., *Ilexpollenites* sp., *Stephanocolpites* sp. etc. Tipam Formation and portions of Girujan Formation are included in this zone and Miocene (Mid. to Upp.) age is assigned to it. The presence of Surma Group could not be confirmed because the assemblages in the Bokabil and Tipam Formations are identical. The Bhuban Formation is not represented in the sequences studied.

An interesting feature noted in this zone in sequences examined is the occurrence of typical Lower Gondwana (Permo-Carboniferous) forms like *Pityosporites*, *Striatites*, *Parasaccites* in association with the assemblage, suggesting re-working of these older forms in the Miocene beds. Similar reworking of Lower Gondwana forms in the Miocene has also been reported from Tripura (Srivastava, 1967). Baksi (1962), Banerjee (1964a) and Sah & Dutta (1968) have given accounts of the Miocene microflora of Assam. It has been observed that the assemblage reported in this note is very similar to those reported by them.

Paly. Zone I: The topmost zone in the sequences studied includes portions of Girujan Formation and Namsang & Post-Namsang Formations. This zone is dated as Plio-Pleistocene to Recent. The microflora recorded are *Sporites circulus*, *Polypodiaceaesporites* spp., *Polypodiisporites* spp., *Scabratriletes* sp., *Cyathidites* sp., *Gleicheniidites* sp., *Pteridacidites* sp., *Graminidites* sp., *Juglanspollenites* sp., *Polyporina* sp., *Compositoipollenites* sp., *Polygonacidites* sp., *Impatiensidites* sp. etc.

A noteworthy feature in this zone in the sequences examined is the re-working of typical Barail forms like *Meyeripollis* and *Foldexina inaperturata* and Paleogene forms like *Palmaepollenites* and *Disulcites* in the Namsang. There are very few published accounts of the palynology of the Plio-Pleistocene of Assam. Sah & Dutta (1968) indicated the ranges of occurrence of certain taxa in the Plio-Pleistocene of Assam. Many of the forms reported by Sah & Dutta (*l.c.*) are comparable with those recorded in the present study.

PALEOECOLOGY

The distribution pattern of the various taxa, demarcating the different zones, is more or less the same in all the wells studied so far in this region. The significant taxa of each zone are common in all the wells. These facts suggest that the deposition of individual zones in all the wells took place under similar ecological conditions. *Paly. Zone IV*, having a good proportion of microplanktons, was deposited under shallow-marine to brackish-water conditions and the microfloral components were derived from luxuriant vegetation growing in swamps, fresh-water lakes or ponds, along the coast, and in inland near-shore areas in a warm, humid, tropical to sub-tropical climate. The existence of a flat topography is suggested by the absence of any high-altitude floral representatives in the assemblage. *Paly. Zone III* shows a decrease in the proportion not only of the microplanktons but also of the other microfloral constituents. The decrease in the proportion of microflora as compared to the underlying zone was probably due to onset of drier conditions during the deposition of this zone (Paly. Zone III). Deposition took place mainly under brackish-water conditions and the occurrence of coal-bands in tlhis zone suggests lagoonal deposits. The climate and topography remained more or less same as in Paly. Zone IV.

A marked change in the microflora from the underlying zones is noted in *Paly. Zone II*. The microplanktonic and coastal elements disappear, suggesting fresh-water conditions of deposition. The microflora recorded in this zone were derived from essentially terrestrial and swampy inland vegetation growing in moist shady lowlands and cool uplands in a sub-tropical to temperate climate. High altitude cold-loving plants recorded in this zone suggest the existence of elevated topography in the surroundings during deposition of the sediments. This is interpreted as indicative of orogenic activity in the northern parts of the area, and consequently regression of the sea southwards. Banerjee (1967, 1968) had discussed this phenomenon of orogenic activity, while dealing with the significance of saccate conifer grains in the Tertiary of Assam and with the Siwalik microflora of Punjab. *Paly. Zone I* microflora, having a dominance of representatives of herbaceous plants, suggests drier climatic conditions than in the underlying zone, which favoured the growth of grasses, chenopods, amaranths etc. commonly recorded in this zone (i.e. I).

From the disposition of the different zones in the wells and the distribution of the various taxa, it is concluded that the basin was deeper towards the northeast. This conclusion is in conformity with the disposition of the various formations that have been encountered in the wells, from the westernmost well at Borholla to the easternmost well at Lakwa.

REFERENCES

BAKSI, S. K. (1962). Palynological investigation of Simsang River Tertiaries, South Shillong Front, Assam. *Bull. geol. min. metall. Soc. India*, **26**: 1-22.

Idem (1965). Stratigraphy of Barail Series in southern part of Shillong Plateau, Assam, India. *Bull. Am. Ass. Petrol. Geol.*, **49** (12): 2282 2287.

BANERJEE, D. (1964a). A note on the microflora from Surma (Miocene) of Garo-Hills, Assam. *Bull. geol. min. metall. Soc. India,* **29**: 1-8.

Idem (1964b). A note on the polospores from Tura Formation, Simsang River Section, Assam. *Ibid,* **32:** 1-4.

Idem (1967). Significance of saccate grains in the Tertiary stratigraphy of Assam. *Seminar on Geology of NE India, Shillong* (Abstract), p. 18.

Idem (1968). Siwalik microflora from Punjab (India). *Rev. Palaeobot. Palynol.,* **6**: 171-176.

BANERJEE, D. & MISRA, C. M. (1971). Hystrichosphaerids in the Tertiary formations of Assam and Tripura. *Seminar on Palaeopalynology, Calcutta* (in press).

BISWAS, B. (1962). Stratigraphy of the Mahadeo, Langpar, Cherra and Tura formations, Assam, India. *Bull. geol. min. metall. Soc. India,* **25**: 1-48.

CHATTERJEE, N. N. & GHOSH, T. K. (1962). Fungal spores from Tertiary coals of Garo-Hills, Assam. *Q. Jl. geol. Min. metall. Soc. India,* **34**: 147-148.

DUTTA, S. K. & SAH, S. C. D. (1967). Palynostratigraphy of the sedimentary formations of Assam. **4**: Age of the Laitryngew-Mawkma coal-bearing sandstones and their relationship with the Cherra formation. *Seminar on Geology of NE India, Shillong* (Abstract), 10.

GHOSH, A. K. (1941). Fossil pollen in the Tertiary rocks of Assam. *Sci. & Cult.,* **6**: 674.

GHOSH, A. K. & BANERJEE, D. (1963). Pteridophytic spores (other than Parkeriaceae and Schizaeaceae) from the Tertiary of Assam, India. *Pollen et Spores,* **5**: 413-423.

GHOSH, T. K. (1964). On Tertiary coal from Daranggiri, Garo-Hills, Assam. *Q. Jl. geol. Min. metall. Soc. India,* **34**: 91-94.

Idem (1969). Early Tertiary plant microfossils from the Garo-Hills, Assam, India. *J. Sen mem., Vol.*: 123-138.

MEYER, B. L. (1958). Palynological examination of some samples from Nahorkatiya. *Jour. Pal. Soc. India,* **3**: 156-157.

SAH, S. C. D. & DUTTA, S. K. (1966). Palynostratigraphy of the sedimentary formations of Assam. **1**: Stratigraphical position of the Cherra Formation. *Palaeobotanist,* **15** (1 & 2): 72-86.

Idem (1967). Palynostratigraphy of the sedimentary formations of Assam. 3: Bio-stratigraphic zonation of the Cherra formation of South Shillong Plateau. *Seminar on Geology of NE India, Shillong* (Abstract): 9.

Idem (1968). Palynostratigraphy of the Tertiary sedimentary formations of Assam. **2**: Stratigraphic significance of spores and pollen in the Tertiary succession of Assam. *Palaeobotanist,* **16** (2): 177-195.

SAH, S. C. D., KAR, R. K. & SINGH, R. Y. (1970). Fossil microplankton from the Langpar Formation of Therriaghat, South Shillong Plateau, Assam, India. *Ibid,***18** (2): 143-150.

SAHNI, B., SITHOLEY, R. V. & PURI, G. S. (1947). Correlation of the Tertiary succession in Assam by means of microfossils. *J. Indian bot. Soc.,* **26** (4) 262-263.

SEN, J. (1948). Microfossils of Assam coalfields — 1. The coal seam at Laitryngew and the age of the Cherra Sandstone. *Bull. bot. Soc. Beng.,* **2** (2): 94-101.

SRIVASTAVA, N. C. (1967). Palynologic evidences of age and process of sedimentation of the Surma Group in Batchia, Tripura State. *Seminar on Geology of NE India, Shillong* (Abstract): 19.

SRIVASTAVA, N. C. & BANERJEE, D. (1969). Hystrichosphaerids from Tertiary subcrops of Assam, India. *J. Sen mem. vol.*: 101-108.