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PALYNOLOGY OF THE COAL-BEARING SEDIMENTS IN THE TIKAK PARBAT FORMATION FROM JEYPORE COLLIERY, DILLI-JEYPORE COALFIELDS, ASSAM, INDIA

B. D. MANDAOKAR

BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, 53, UNIVERSITY ROAD, LUCKNOW

ABSTRACT

Palynological analysis was undertaken on samples from five coal seams of the Tikak Parbat Formation from Jeypore colliery, Dibrugarh district Assam, India.The assemblage comprises 54 genera and 79 species.The palynofossils comprise a diverse assemblage of pteridophytic spores, gymnospermous and angiospermous pollen.The angiosperms are dominant (44%) and followed by the pteridophytic spores (40%).Fungal remains are represented by spores and thyriothecia. The dominant species are *Striatriletes susannae, Bombacacidites triangulatus, Meyeripollis naharkotensis, Polyadopollenites miocenicus, Trisyncolpites ramanujamii, Compositoipollenites conicus and Graminidites granulates*.The palynological assemblage suggests Oligocene age.The assemblage indicates the existence of warm coastal lowlands with a humid climate.

Key words : Palynology, Tikak Parbat Formation, Oligocene, Jeypore, Assam, India.

INTRODUCTION

Current knowledge of the Tertiary floras from fresh water sediments from the coal-bearing Tikak Parbat Formation, Jeypore colliery, Assam is largely based on spore-pollen assemblages. Water, rather than wind, is likely to have been the chief agent of dispersal of the palynomorphs into these sediments, leading to the preferential representation of riparian species and plant communities.

To date, no palynological research has been undertaken in this region.Therefore, it is proposed to provide for the first time a detailed account of palynomorphs recovered from the Tikak Parbat Formation in Jeypore colliery Assam. The objective of this paper is to fully document the palynomorph assemblages followed by comments on the age of the deposits, composition of the fossil assemblage, and interpretation of the palaeoenvironment.

REGIONAL SETTING AND AGE CONTROL

The Dilli-Jeypore coalfield derives its name from the Disang or Dilli river, which cuts across the coalfield and from Jeypore town (fig.1). The first detailed geological mapping of this coalfield was undertaken by Medlicott (1865). Mallet (1874-76) subsequently provided information on the structural set-up of the area. Further studies by Simpson (1906) and Hayden (1910) also helped in understanding the general geology of the area.The first regional drilling in this coalfield was taken up by Geological Survey of India during 1965-1967. Recently, the Department of Geology and Mining, Goverment of Assam has carried out further drilling both in Dilli and Jeypore sector.

Tertiary sediments exposed in this area are part of the thrust-belt sequence which extends from Haflong in the south of Namchik to Namphuk in the north-east. Owing to the geotectonic setting of this structurally disturbed belt, the lower part of the Barail Group and the underlying Disang Group are not exposed (Raja Rao, 1981). The general sequence in the area is shown in Table 1.

The Tikak Parbat Formation lies in the hilly terrain just adjoining the alluvial plains. The formation is developed in the Dilli-Jeypore area with the lower part missing because of Naga thrust. It comprises light grey to brownish, fine to medium-grained, well bedded sandstone, light grey shale, carbonaceous shale, and coal seams. The coal-bearing rocks occur within a continuous belt in the foot-hills region bordering the Sibsagar and Tinsukia districts, extending for over 33 km with a width of nearly 600 meters. It lies between the latitudes 27^0 03' to 27^0 20' and longitudes 95^0 10' to 95^0 30'. The area is approachable from Namrup railway station by road between Naharkotiya and Sonari.

Table 1: General Geological sequence in Dilli-Jeypore coalfield.

Age	Group	Lithology
Recent/	-	Alluvium and high level terraces clay, silt.
Pleistocene		Gravels and sand beds.
Pliocene	DIHING	Pebbly sandstone with thin greyish clays.
——————Unconformity——————		
Mio-Pliocene	-	Namsang Formation: Fine to coarse- grained sandstone with hard clays.
——————Unconformity——————		
Miocene	TIPAM	Girujan clay: Mottled clay with greyish sandstone.
		Tipam sandstone: Fine to coarse grained, ferruginous brownish to light green micaceous and feldspathic sandstone with clay and sandy bands.
——————Unconformity——————		
Oligocene	BARAIL	Tikak Parbat Formation: Fine to medium grained sandstone shale and coal seams.
——————THRUST CONTACT——————		

The outcroups of the coal seams are observed along the course of the Dilli river.They vary in thickness from 0.3 m to 12.0 m, because of the structural complexity and rapid lateral variations in thickness, the correlation of coal seams between outcrops is rather difficult. Rao (1981) reported seven coal seams in the area within the thickness range 0.3 m to 11.89, m but in the present study only five coal seams could be traced.

SEAM-I

Seam-I has been truncated in the Naga thrust and its lateral continuity cannot be traced along the belt.The total thickness of the seam is about 11.89 m.The seam outcroups in the vicinity of the bridge over the Dilli river and probably was worked near the outcrop by open cast method.

SEAM-II

The seam-I is succeeded by a 5 m thick clay unit with lenses and medium-grained sandstone. This unit is overlain by seam II which varies in thickness from 0.3-0.9 m.This seam is too thin to be of any economic importance.

SEAM-III

This seam is well developed in the southern part of Jeypore colliery near the Dilli river, where it has attained a thickness of 1.35 m.The seam is, however, split into two sections: a bottom section of 0.3 m thickness and a top section of about 0.75 m thickness with an intervening clay parting of 0.3 m.

SEAM-IV

It is the most persistant seam in the Jeypore area and has been extensively worked in Jeypore colliery.The thickness of the seam varies from 2.25 m to 4.00 m.The seam is however,a composite one and is intercalated with 3 to 4 dirt bands of 0.1-0.3 m thick.The total band thickness is about 0.6 m and the coal is 3.5 m thick. The seam has usually a clay roof.

SEAM-V

This overlies the seam IV with a parting of about 12 m to 20 m. This is an impersistent seam and has been worked in patches in the Jeypore colliery area. This seam ranges in thickness from 1.06-1.52 m with an intervening clay parting of about 0.3 m

MATERIAL AND METHOD

The palynologically productive samples are represented by coal, carbonaceous shale, grey shale, and mudstone. Sandstones were found to be barren. For the recovery of palynofossils, the shale samples were treated with 60% Hydrofluoric acid, followed by washings with 50% Hydrochloric acid and again concentrated Hydrochloric acid. The more carbonaceous samples were treated with fuming Nitric acid, followed by treatment with 10% potassium hydroxide (Schulze's solution) for coal samples. The slides were prepared with polyvinyl alcohol and mounted in canada balsam. The strewn slides were examined using Olympus BH2 photomicroscope. All the strewn slides and residues are housed in the repository of Birbal Sahni Institute of Palaeobotany, Lucknow.

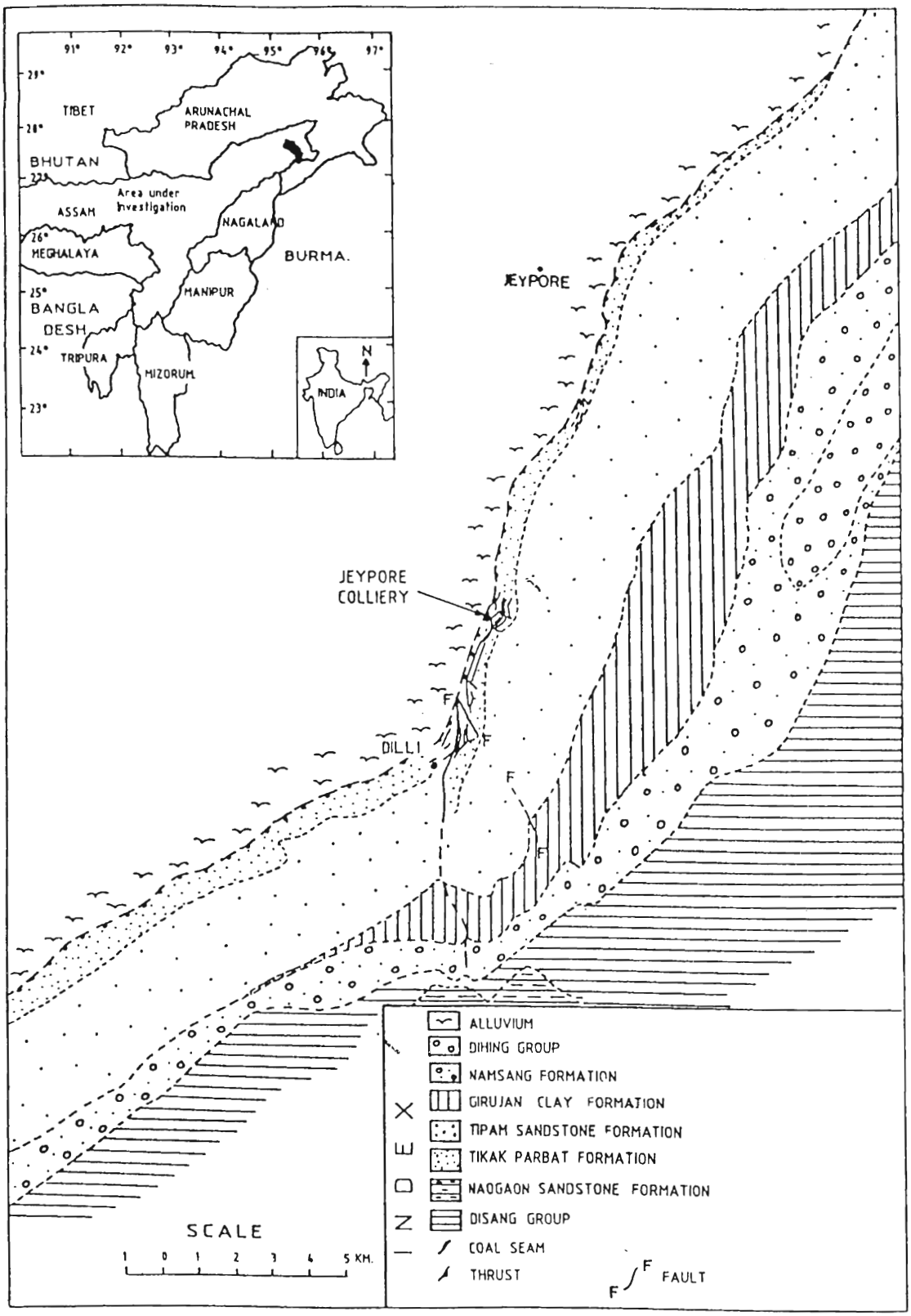


Fig. 1. Showing Geological Map of Dilli-Jeypore Coalfield, Assam.

PALYNOLOGY

Palynological assemblages recovered from the Tikak Parbat Formation of Jeypore colliery encompass 54 genera and 79 species. Palynotaxa are arranged alphabetically in four categories, viz, pteridophytes, gymnosperms, angiosperms and fungi. The important palynofloral elements are illustrated in Plates I-II. The qualitative results and distribution are shown in figs. 1-3. The check list of recorded species is given in appendix I

AGE CONNOTATION

The coal-bearing rocks comprise alternation of sandstone, siltstone, mudstone, carbonaceous shale, grey shale, clay and coal seams. Each such cycle

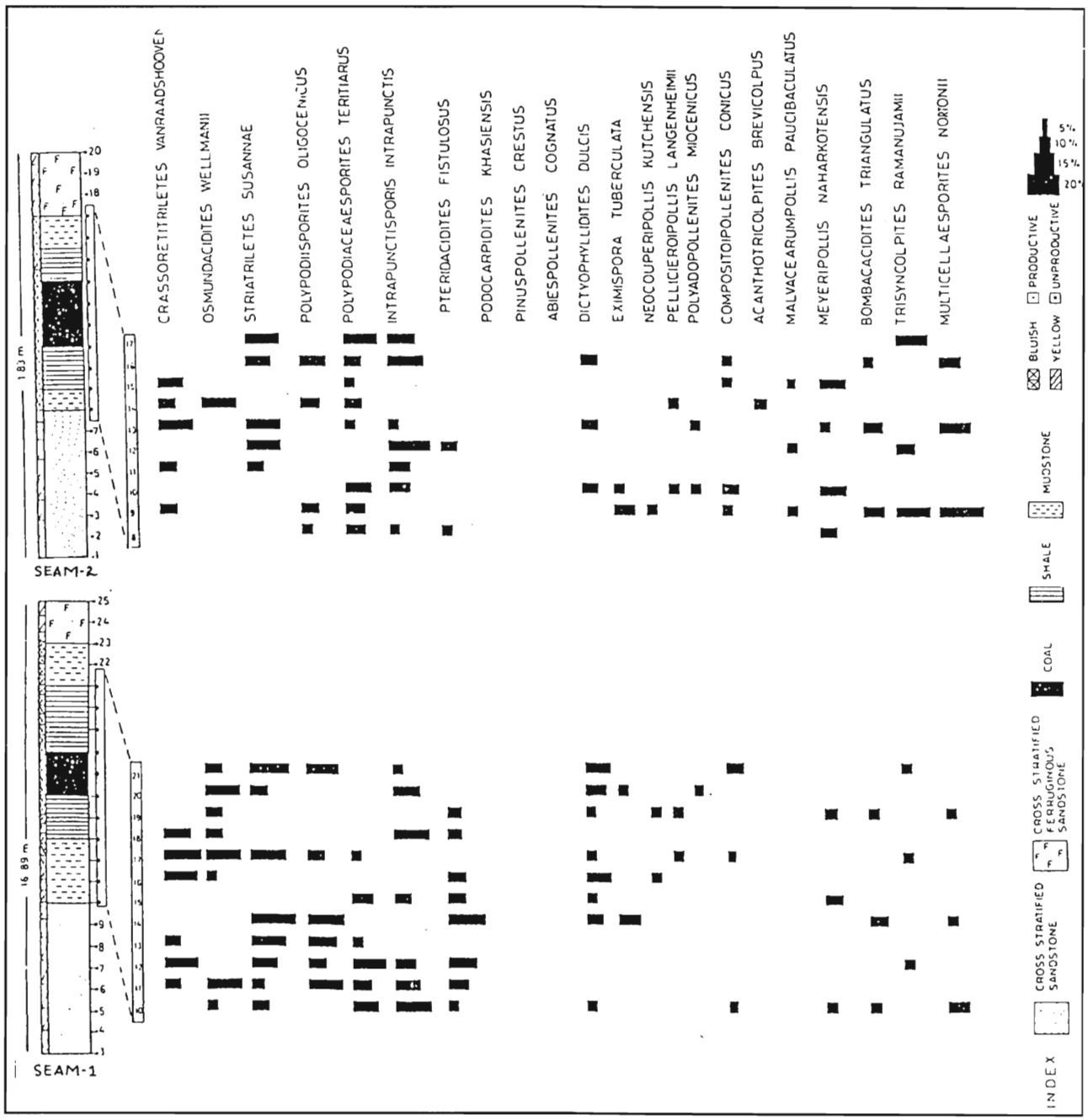


Fig. 2. Showing relative abundance of spore pollen species in coal seams no. 1&2.

commences from the sandstone band to next in the sequence. Evidence for the age of Jeypore colliery comes from two different sources : first, a review of the palynological data obtained from Jeypore colliery clearly demonstrated a number of taxa in common with those from Ledo colliery and Miabong (Mandaokar, 1987,1990), and secondly, comparable with Dangri Kumari Colliery assemblage (Mandaokar, 1993). In the Tikak Parbat Formation, which is dated as the Oligocene, the majority of the the taxa are know from Oligocene, although some of them have been reported from sediments ranging in age from Palaeocene to Miocene. Key taxa are *Crassoretitriletes vanraadshoovenii, Striatriletes susannae, Bombacacidites triangulus, Trisyncolpites ramanujamii, Meyeripollis naharkotensis* ,

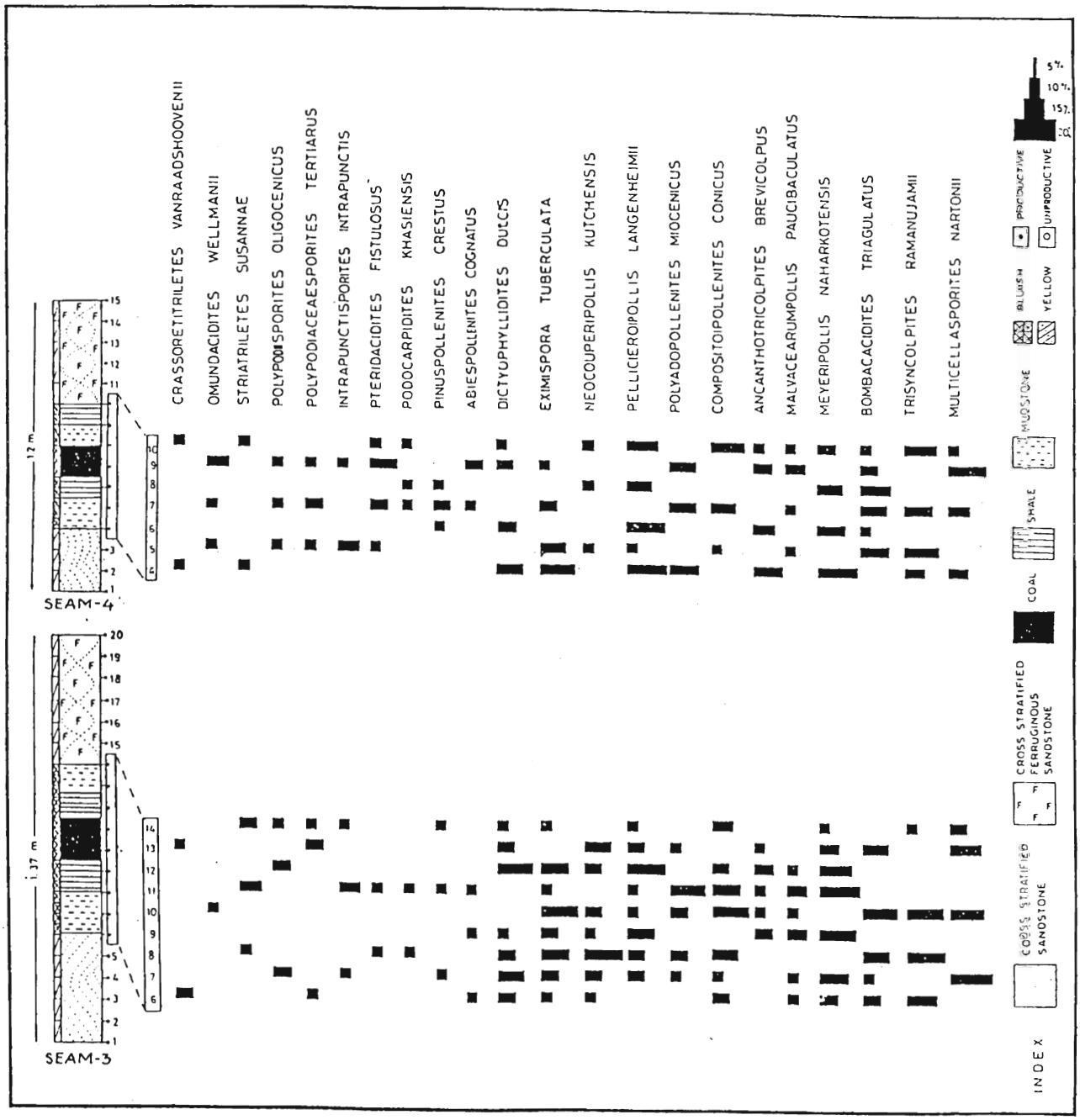


Fig. 3. Histogram showing frequency of spore pollen species in coal seams no. 3 & 4.

Polyadopollenites miocenicus and *Graminidites* sp. *Crassoretitriletes vanaraadshoovenii* was studied critically by Germeraad, Hopping and Muller (1968) who confirmed its presence for first time in the lower Oligocene sediments. *Bombacacidites bombaxoides* appears in the lower Oligocene and becomes gradually established in the upper Miocene (Couper,1960). Kar (1979) reported *Trisyncolpites ramanujamii* from the Oligocene sediments of Kachchh and considered it as an index fossil. Kar (1985) postulated that the genus *Ceratopteris* which produces *Striatriletes* (Parkeriaceae) spores, originated during middle-upper Eocene and attained abundance during Oligo-Miocene times in India, Venezuela, Caribbean region, Nigeria and Malaysia. Baksi and Venkatachala (1970) described *Meyeripollis naharkotensis* from Assam and designated its age as upper Eocene-lower Miocene.

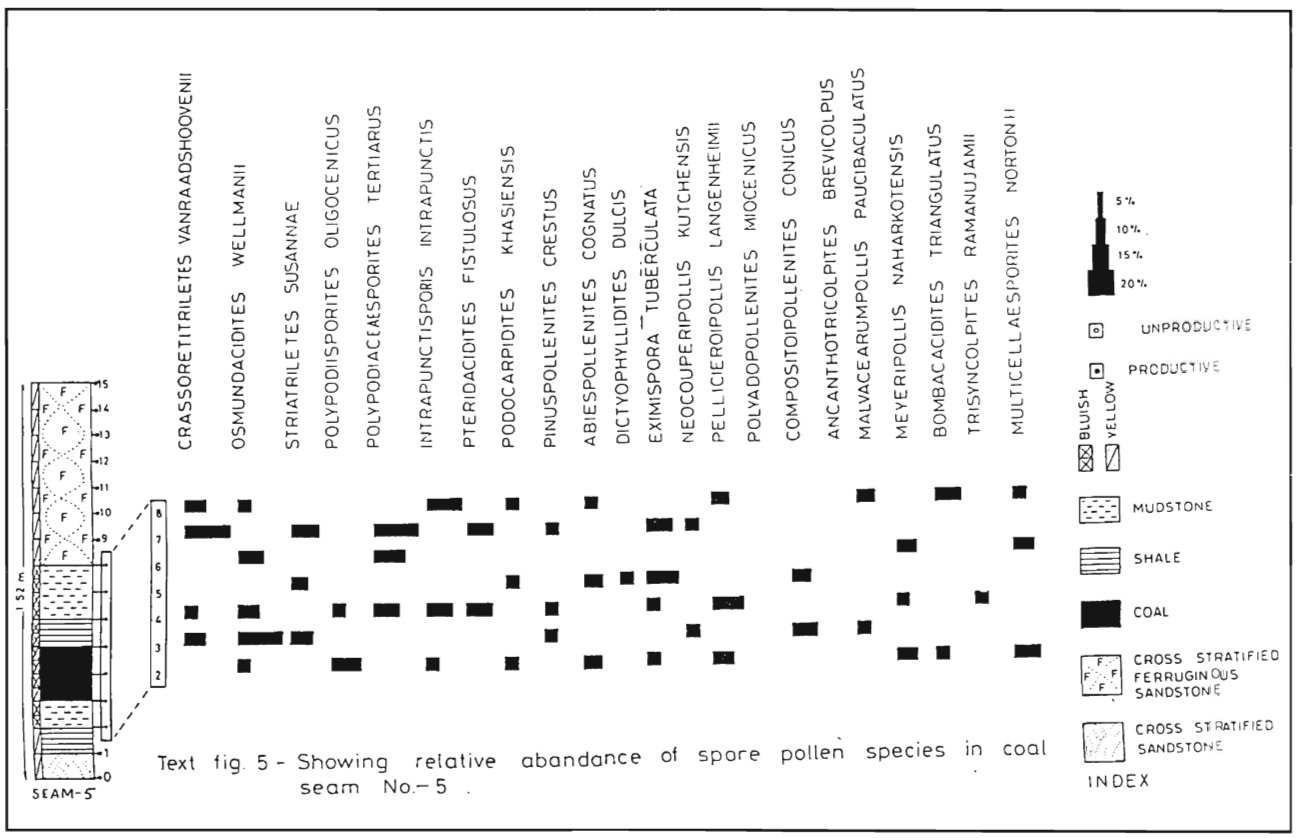
BOTANICAL AFFINITIES

The palynological assemblages are composed of pteridophytic spores, gymnospermous pollen, angiospermous pollen and fungal remains. The quantitative representation of individual taxa is very poor, thus it has not been possible to employ palynological data for stratigraphic zonation. However, on the basis of morphological similarities, some of the Jeypore colliery palynofossils have been affiliated with modern families to facilitate reconstruction of the past vegetation. The Appendix-II gives information on the botanical affinities, present-day distribution and geological age of various taxa recovered in the present study.

The modern taxa to which the fossil palynotaxa have been affiliated, suggest dominance of tropical elements.

PALAEOCLIMATIC INTERPRETATIONS

Palynological assemblages from the Jeypore colliery sediments indicate that the area was inhabited by tropical vegetation (Lakhanpal, 1970, Dutta and Sah, 1970, Saxena, 1980). Such inference has been drawn by the occurrence of *Parkeriaceae,*



Text fig. 5 - Showing relative abandance of spore pollen species in coal seam No.– 5 .

Fig. 4. Showing relative abandance of spore pollen species in coal seam No. 5.

Osmundaceae, Schizaeaceae, Polypodiaceae, Lycopodiaceae, Arecaceae, Bombacaceae, Ctenolophonaceae, Asteraceae and *Malvaceae*. The temperate gymnospermous elements referable to the families *Podocarpaceae* and *Pinaceae* represented in the assemblage, were transported to the site of deposition. Plant megafossils referable to the families *Laurinoxylon (Lauraceae), Koompassioxylon, Bauhinia, Adenantheroxylon (Leguminosae), Mangiferoxylon (Anacardiaceae) , Lagerstromioxylon (Lythraceae), Barringtonioxylon, Careyoxylon (Lecythidaceae), Artocarpoxylon (Moraceae), Myristicaceae* and a podocarpaceous gymnosperm are also known to occur commonly in the coal-bearing sediments of the area (Bande,1991). The plant fossil records indicate a humid tropical climate with high annual precipitation during the deposition of the coal-bearing sediments.

CONCLUSION

The quantitative analysis of the assemblage indicates that the angiospermic pollen and the pteridophytic spores are more or less equally represented in the basal part of the Tikak Parbat Formation. Both the coal seams I & II have more or less similar spore-pollen assemblages, mostly represented by *Intrapunctisporis intrapunctis, Pteridacidites vermiverrucatus, Crassoretitriletes vanraadshoovenii, Eximispora tuberculata, Polypodiaceaesporites tertiarus, Striatriletes susannae*, and *Polypodiisporites oligocenicus*. The pteridophytic spores are very common and contribute almost three fourths of the total population. However, in the coal seams III & IV & V the angiospermic pollen are better represented than the pteridophytes. The dominant species are *Malvacearumpollis paucibaculatus, Meyeripollis naharkotensis, Polyadopollenites miocenicus, and Crassoretitriletes vanaraadshoovenii* .

The gradual reduction of the pteridophytic elements and the subsequent increase of the angiosperms points towards a change in flora, perhaps due to change in climate. The ecological grouping of the palynomorphs exhibits an uniformity in the three lower coal seams. The palynomorphs are generally represented by coastal and lowland swampy vegetation. viz, *Neocouperipollis, Proxapertites, Palmaepollenites, Palmidites, Bombacacidites, Malvacearumpollis, Meyeripollis, Polyadopollenites and Pellicieroipollis.*

In the two upper coal seams, the different species of *Striatriletes* are found in significant percentage, indicating a flood plain fresh water deposits. The change from coastal, low land vegetation found in the three lower coal seams to flood plain fresh water deposits in the upper two seams is attributed to the regressive phase of deposition. The fairly dominant occurrence of microthyriaceous fungi and fruiting bodies throughout the coal seams suggests a warm and humid climate during the time of deposition. The temperate gymnospermic elements present in the assemblage indicate an elevated topography not very far from the basin.

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APPENDIX I

PTERIDOPHYTIC SPORES

Genus - *Intrapunctisporis Krutzsch*, 1959
Intrapunctisporis apunctis Krutzsch,1959
Intrapunctisporis intrapunctis Krutzsch,1959

Genus - *Osmundacidites* Couper,1953
Osmundacidites wellmanii Couper,1953
Osmundacidites cephalus Saxena,1978
Osmundacidites kutchensis Sah & Kar,1969

Genus - *Pteridacidites* Sah,1967
Pteridacidites fistulosus Sah,1967
Pteridacidites triangulatus Sah,1967
Pteridacidites vermiverrucatus Sah,1967

Genus - *Crassoretitriletes* Germeraad,Hopping & Muller,1968
Crassoretitriletes vanraadshoovenii Germeraad,Hopping & Muller,1968
Crassoretitriletes sp.

Genus- *Striatriletes* Van der Hammen emend Kar,1979
Striatriletes susannae Kar,1979
Striatriletes aidaensis Kar,1985
Striatriletes multicostatus Kar & Saxena,1981

Genus - *Lycopodiacidites* Potonie',1956
Lycopodiacidites cerebrus Kar &Kumar, 1986
Lycopodiacidites sp.

Genus - *Lygodiumsporites* Potonie',1956
Lygodiumsporites lakiensis Sah & Kar,1969
Lygodiumsporites eocenicus Dutta & Sah,1970

Genus - *Dictyophyllidites* (Couper) Dettman,1963
Dictyophyllidites kyrtomatus Kar,1985
Dictyophyllidites dulcis Kar,1985
Dictyophyllidites sp.

Genus - *Todisporites* Couper,1958
Todisporites major Couper,1958
Todisporites kutchensis Sah & Kar,1968
Todisporites giganticus Mandaokar,1987

Genus - *Lycopodiumsporites* Thiergart ex Delcourt & Sprumont,1955
Lycopodiumsporites speciosus Dutta & Sah,1970
Lycopodiumsporites globatus Kar,1985

Genus - *Cyathidites* Couper,1953
Cyathidites minor Couper,1953
Cyathidites australis Couper,1958

Genus - *Dandotiaspora* Sah,Kar & Singh,1971
Dandotiaspora dilata Sah,Kar & Singh,1971
Dandotiaspora plicata Sah,Kar & Singh,1971

Genus - *Eximispora* Salujha,Kindra & Rehman,1972
Eximispora tuberculata Salujha,Kindra & Rehman,1972

Genus - *Polypodiaceaesporites* Thiergart,1940
Polypodiaceaesporites tertiarus Dutta & Sah,1970
Polypodiaceaesporites chatterjee Kar,1979
Polypodiaceaesporites levis Sah,1967

Genus - *Polypodiisporites* Potonie'1934
Polypodiisporites repandus Takahashi,1964
Polypodiisporites ornatus Sah,1967
Polypodiisporites oligocenicus Sah & Kar,1969
Polypodiisporites sp.

Genus - *Pilamonoletes* Kar,1990
Pilamonoletes excellensus Kar,1990
Pilamonoletes moderatus Kar,1990

Genus - *Cheilanthoidspora* Sah & Kar,1974
Cheilanthoidspora monoleta Sah & Kar,1974
Cheilanthoidspora reticulatus Sah & Kar,1974

Genus - *Schizaeoisporites* Potonie'1951
Schizaeoisporites crassimurus Dutta & Sah,1970

Genus - *Proxapertites* Van der Hammen,1954
Proxapertites assamicus (Sah & Dutta) Singh,1975
Proxapertites crassimurus Sah & Dutta,1966

GYMNOSPERMOUS POLLEN

Genus - *Podocarpidites* Cookson emend Potonie'1959
Podocarpidites cognatus Kar,1979
Podocarpidites densicorpus Kar,1985

Genus - *Pinuspollenites* Raatz,1937
Pinuspollenites crestus Kar,1985

Genus - *Abiespollenites* Thiergart,1937
Abiespollenites cognatus Kar,1985

ANGIOSPERMOUS POLLEN

Genus - *Magnamonocolpites* Kar,1985

Magnamonocolpites miocenicus Kar,1985

Genus - *Palmaepollenites* Potonie' 1951
Palmaepollenites ovatus Venkatachala & Kar,1969
Palmaepollenites nadhamunii Venkatachala & Kar,1969

Genus - *Neocouperipollis* Kar & Kumar,1986
Neocouperipollis kutchensis Kar & Kumar,1986
Neocouperipollis achinatus Kar & Kumar,1986
Neocouperipollis spinorobustus Kar & Kumar,1986

Genus - *Retitrescolpites* Sah,1967
Retitrescolpites crassimurus Sah,1967
Retitrescolpites bellus Sah,1967

Genus - *Compositoipollenites* Potonie',1959
Compositoipollenites conicus Sah,1967

Genus - *Tricolpites* (Erdtman) Potonie',1960
Tricolpites reticulatus Cookson,1947
Tricolpites minutus Sah & Kar,1970

Genus - *Pellicieroipollis* Sah & Kar,1970
Pellicieroipollis langenheimii, Sah & Kar,1970
Pellicieroipollis minutus Mandaokar,1987

Genus - *Hibisceaepollenites* Kar,1985
Hibisceaepollenites robustispinosus Kar,1985

Genus - *Lakiapollis* Venkatachala & Kar,1969
Lakiapollis ovatus Venkatachala & Kar,1969

Genus - *Malvaceaerumpollis* Nagi.1962
Malvaceaerumpollis paucibaculatus Venkatachala & Rawat,1973

Genus - *Acanthotricolpites* Kar,1985
Acanthotricolpites brevicolpus Kar,1985

Genus - *Rhoipites* Wodehouse,1933
Rhoipites kutchensis Venkatachala & Kar,1969

Genus - *Meliapollis* Sah & Kar,1970
Meliapollis quadrangularis (Ramanujam) Sah & Kar,1970

Genus - *Spinizonocolpites* Muller,1968
Spinizonocolpites echinatus Muller,1968

Genus - *Triporopollenites* Thomson & Pflug,1953
Triporopollenites exactus Salujha,Kindra & Rehman,1972

Genus - *Ctenolophonidites* Van Hoeken-Klinkenberg,1966
Ctenolophonidites sp.

Genus - *Meyeripollis* Baksi & Venkatachala,1970
Meyeripollis naharkotensis Baksi & Venkatachala,1970

Genus - *Bombacacidites* Couper,1960
Bombacacidites triangulatus Kar,1985

Genus - *Polyadopollenites* Thomson & Pflug,1953
Polyadopollenites miocenicus Ramanujam,1966

Genus - *Trisyncolpites* Kar,1979
Trisyncolpites ramanujamii Kar,1979

Genus - *Cupuliferoipollenites* Potonie',1951
Cupuliferoipollenites ovatus Venkatachala & Kar,1969

Genus - *Engelhardtioidites* Potonie',Thomson & Thiergart,1950
Engelhardtioidites parvus Sah & Dutta,1966

Genus - *Graminidites* Cookson,1947
Graminidites granulatus Kar,1985

Genus - *Tricolporopollenites* Thomson & Pflug,1953
Tricolporopollenites kruschii Thomson & Pflug,1953

FUNGI

Genus - *Multicellaesporites* (Elsik) Sheffy & Dilcher,1971
Multicellaesporites nortonii Elsik,1968

Genus - *Pluricellaesporites* (Van der Hammen) Clarke,1965
Pluricellaesporites planus Trivedi & Verma,1969

Genus - *Monoporisporites* Sheffy & Dilcher,1971
Monoporisporites sp.

Genus - *Inapertisporites* Elsik,1968
Inapertisporites kedvesii Elsik,1968

Genus - *Polyporina* (Naumova) Potonie',1960
Polyporina multiporosa Kar,1985

Genus - *Phragmothyrites* (Edwards) Kar & Saxena,1976
Phragmothyrites eocenicus Kar & Saxena,1976

Genus - *Cucurbitariaceites* Sah,Kar & Singh,1971
Cucurbitariaceites bellus Sah,Kar & Singh,1971

Genus - *Dicellaesporites* Sheffy & Dilcher,1971
Dicellaesporites sp.

The genera *Meyripollis, Pellicieroipollis, Bombacacidites, Compositoipollenites, Hibisceaepollenites and Malvaceaerumpollis* show considerable morphological variation.

APPENDIX II

Fossil Palynotaxa	Present distribution	Botanical affinity	Age
FUNGI			
Phragmothyrites eocenicus	Warm & Humid Tropical climate	Fungal fruiting bodies,micro-thyriaceae	Palaeocene- Mid Miocene
Dicellaesporites fusiformis *Multicellaesporites nortonii*	-- do --	Fungal spores and mycelia (Ascomycetes , Basidiomycetes, Deuteromycetes	-- do –
Cucurbitariaceites bellus	-do-	Trichothyriaceae	- -- do--.
PTERIDOPHYTES			
Osmundacidites wellmanii	Cosmopolitan	Osmundaceae	Mid Eocene – Mid Miocene.
Dictyophyllidites kyrtomatus	Tropical -subtropical	Dicksoniaceae	Palaeo-Mid Miocene
Lygodiumsporites lakiensis	-- do --	Schizaeaceae	--do--
Striatriletes susannae	-- do --	Parkeriaceae	Eocene-Miocene

Fossil Palynotaxa	Present distribution	Botanical affinity	Age
Lycopodiacidites cerebrus	Cosmopolitan	Lycopodiaceae	Palaeo-Miocene.
Pteridacidites fistulosus	-- do--	Adiantaceae	Mid-Eocene –Mid Miocene
Monolites mawkmaensis	-- do --	--- do --	-- do --
Polypodiaceaesporites levis	Cosmopolitan	Polypodiaceae	Late Eocene
P.levis	-- do --	-- do --	-- do --
Polypodiisporites ornatus	-- do --	-- do --	Late Miocene
P.oligocenicus	-- do --	-- do --	-- do --
P.repandus	-- do --	-- do --	-- do --
Intrapunctisporis apunctis	Tropical-subtropical	Schizaeceae	Mid Eocene
Todisporites major	Tropical -Temperate	Osmundaceae	Mid Miocene
Crassoretitrialetes vanraadshoovenii	-- do --	Schizaeaceae	Mid-Eocene-Mid Miocene
Cyathidites minor	-- do --	Cyatheaceae	Palaeo-Eocene
Cyathidites australis	-- do --	-- do --	
Gleicheniidites sp.	-- do --	Glecheniaceae	Palaeo- Oligocene
Schizaeoisporites crassimurus	-- do --	Schizaeaceae	Mid-Eocene-Mid Miocene.
GYMNOSPERMS			
Podocarpidites khasiensis	Subtropical -Temperate	Podocarpaceae	Late Eocene-Mid-Miocene
Pinuspollenites crestus	Temperate	Pinaceae	-- do --
Abiespollenites sp.	Temperate	-- do --	-- -do --
ANGIOSPERMS-MONOCOTYLEDONS			
Palmidites maximus	Tropical	Arecaceae	Early Eocene
Magnamonocolpites miocenicus	-- do --	-- do --	
Neocouperipollis kutchensis	--do --	-- do --	
Proxapertites assamicus	Tropical-Temperate	Araceae	Palaeo- Eocene
Spinizonocolpites sp.	Tropical-subtropical	--do --	Early Eocene
Graminidites granulites	---do --	Poaceae	Mid Eocene
DICOTYLEDONS			
Tricolpites reticulatus	Cosmopolitan	Gunneraceae	Eocene-Miocene
Retitrescolpites bellus	--do --	Oleaceae	-- do --
Lakiapollis ovatus	Tropical- subtropical	Bombacaceae	Mid-Eocene-Miocene
Favitricolporites retiformis	Cosmopolitan	Gentianaceae	Late Oligocene
Malvacearumpollis sp.	Tropical -subtropical	Malvaceae	Oligo-Miocene
Polyadopollenites sp.	---do---	Mimosaceae	Early Mio-Pliocene
Compositoipollenites sp.	--- do ---	Asteriaceae	Late Eocene-Miocene
Ctenolophonidites costatus	Cosmopolitan	Ctenolophonaceae	Eocene-Miocene
Tricolporopollis rubra	Tropical-subtropical	Bombacaceae	Mid-Eocene-Miocene
Meliapollis sp.	---do---	Meliaceae	Eocene-Miocene
Malvacearumpollis paucibaculatus	---do ---	Malvaceae	Mid Late Miocene
Rhoipites kutchensis	---do ---	Anacardiaceae	Early-Mid Tertiary
Pellicieroipollis langenheimii	-- do ---	Alangiaceae	Mid Eocene-Miocene
Retitricolporites` sp	-- do ---	Verbenaceae	Late Eocene-Oligocene
Tricolporopollenites sp.	----do ---	Moraceae	Mid Miocene
Bombacacidites triangulatus	---do ---	Bombacaceae	Early-Mid Eocene
Hibisceaepollenites robustispinosus	--- do --	Malvaceae	Mid-Late Eocene
Trisyncolpites ramanujamii	--- do ---	Caesalpiniaceae	Early Mid-Eocene -Miocene.

EXPLANATION OF PLATES

Plate I

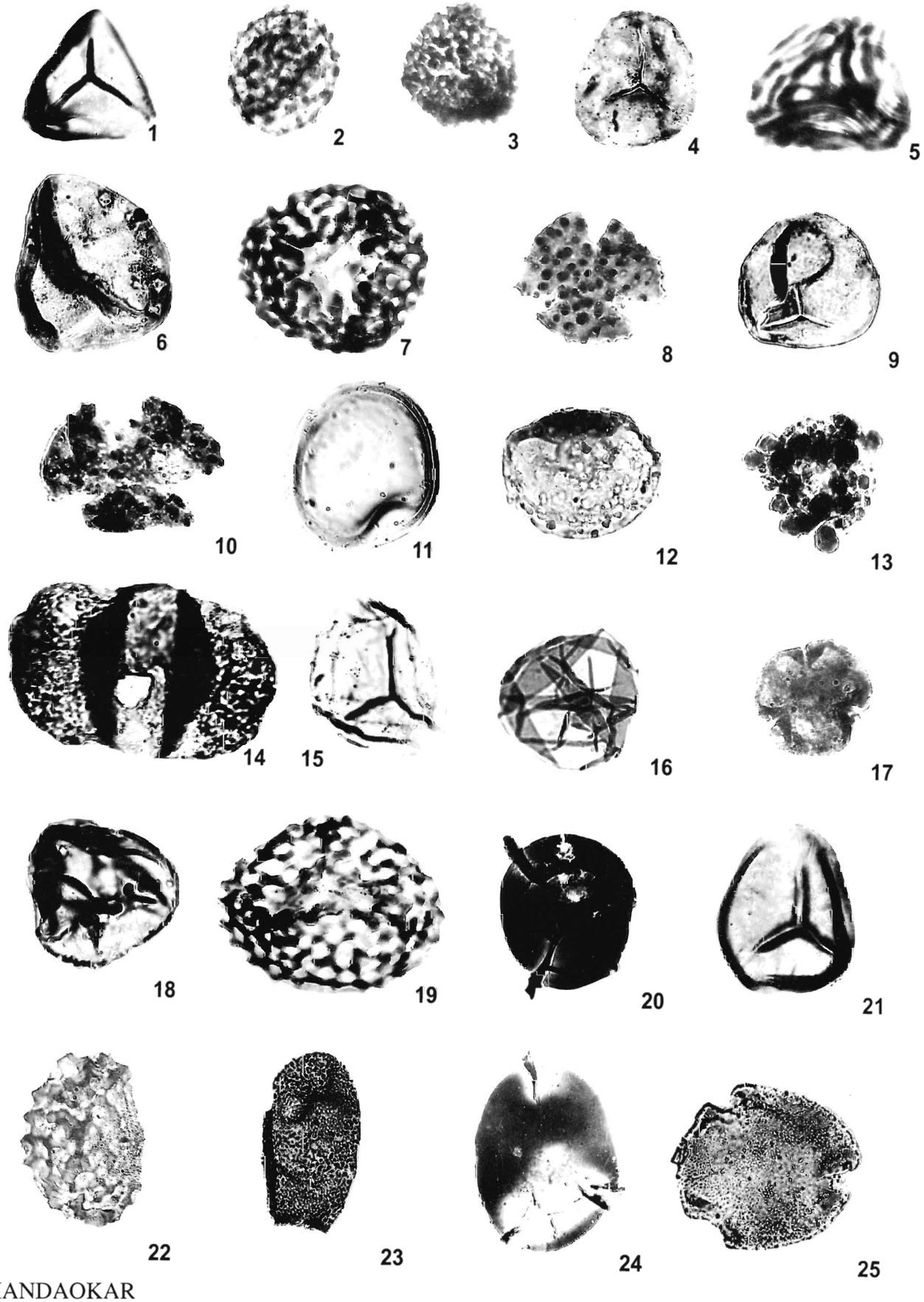
(All photomicrographs are magnified x 500)

1. *Alsophilidites kerguelensis* Cookson
2. *Hibisceaepollenites robustispinosus* Kar
3. *Lycopodiumsporites parvireticulatus* Sah & Dutta
4, 9. *Cyathidites australis* Couper
5, 15 *Striatriletes susannae* Kar
6. *Lygodiumsporites lakiensis* Sah & Kar
7, 19. *Crassoretitriletes vanraadshoovenii* Germeraad, Hopping & Muller
8, 10. *Conitricolporites triangulus* Kar
11. *Intrapunctisporis apunctis* Krutzsch.
12. *Polypodiisporites oligocenicus* Sah & Kar.
13. *Meyeripollis naharkotensis* Baksi & Venkatachala
14. *Podocarpidites cognatus* Kar
16. *Inapertisporites kedvesii* Elsik
17. *Tricolpites minutus* Sah & Kar
18. *Eximispora tuberculata* Salujha, Kindra & Rehman
20, 21. *Cucurbitariaceites bellus* Sah, Kar & Singh
22. *Polypodiisporites repandus* Takahashi
23. *Lacrimaesporonites* sp.
25. *Pellicieroipollis langenheimii* Sah & Kar.

Plate II

(All microphotographs are magnified x 500)

1,3.4. *Verrucolporites verrucus* Sah & Kar
2,8,25. *Retitrescolpites crassimurus* Sah
5. *Tricolporopilites robustus* Kar
6,10. *Pellicieroipollis langenheimii* Sah & Kar
7, 32. *Dermatobrevicolporites exaltus* Kar
9,16,22,57. *Marginipollis kutchensis* Kar
11,19.43. *Pellicieroipollis* sp.
12,42,44,48,58,61. *Polybrevicolporites cephalus* Venkatachala & Kar
13. *Spinizonocolpites echinatus* Muller
14,15. *Neocouperipollis spinorobustus* Kar & Kumar
18. *Neocouperipollis echinatus* Kar & Kumar
17. *Palmaepollenites nadhamunii* Venkatachala & Kar
20. *Lakiapollis ovatus* Venkatachala & Kar.
21,49. *Tricolpites reticulatus* Cookson.
23. *Dicolpopollis kockelii* Pflanzl.
24. *Retitrescolpites* sp.
26. *Retitrescolpites bellus* Sah
27,29,45. *Pellicieroipollis minutus* Mandaokar
28,40. *Rhoipites psilatus* Venkatachala & Kar
53. *Dicolpopollis* sp.
36. *Rhoipites kutchensis* Venkatachala & Kar
47. *Cupuliferoipollenites ovatus* Venkatachala & Kar
30,54. *Tricolporopollenites kruschii* Thomson & Pflug
31,38. *Tricolpites* sp.
33. *Meyeripollis naharkotensis* Baksi & Venkatachala
34. *Malvacearumpollis paucibaculatus* Venkatachala & Rawat
35. *Lygodiumsporites eocenicus* Dutta & Sah.
39,51. *Compositoipollenites conicus* Sah.
41. *Retitrescolpites typicus* Sah.
50,52,56,59. *Engelhardtioidites parvus* Sah & Dutta.
55. *Trisyncolpites ramanujamii* Kar
60. *Tricolpites minutus* Sah & Kar



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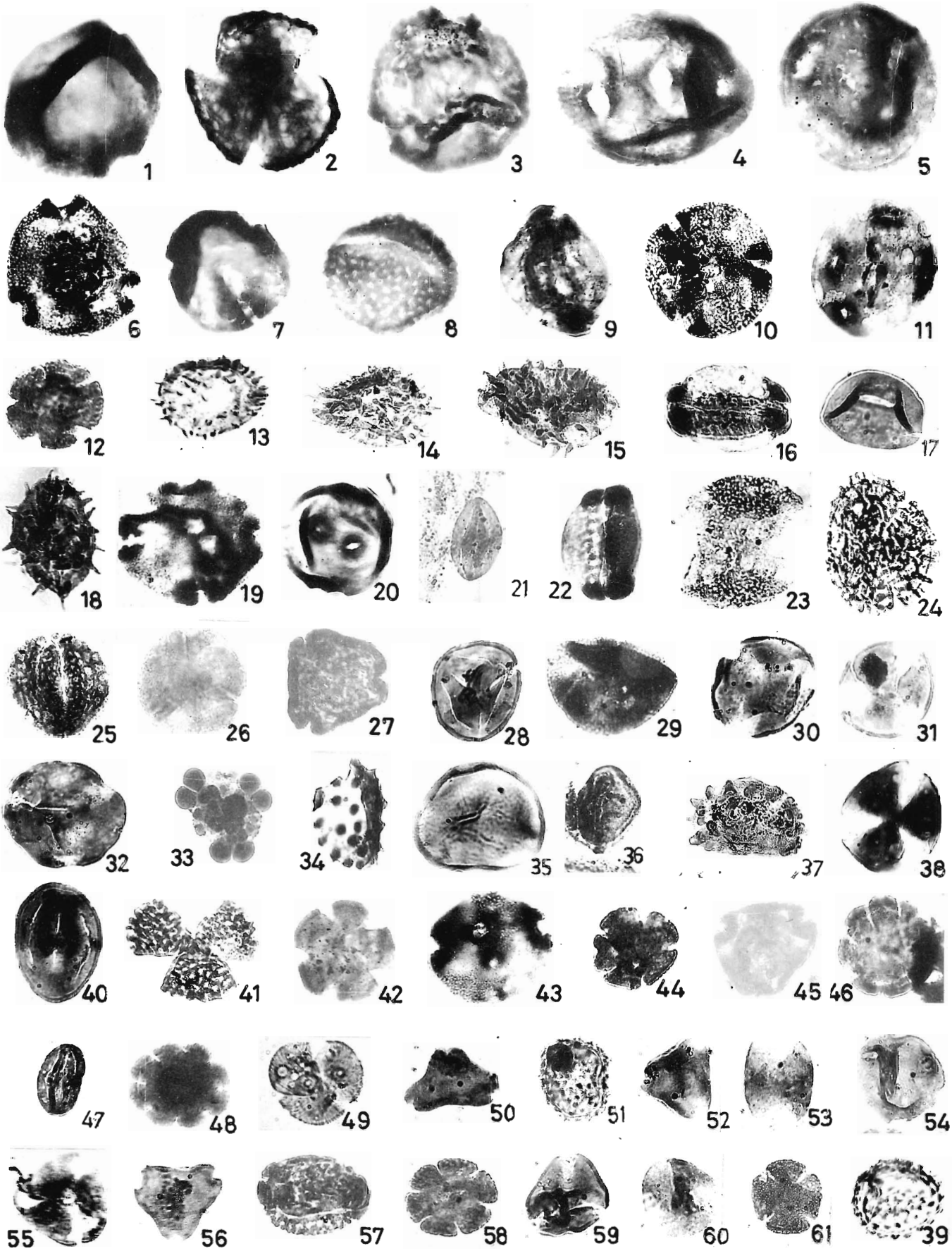
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