The Palaeobotanist, **26** (1): 16-49, 1979

PALYNOLOGICAL FOSSILS FROM THE OLIGOCENE SEDIMENTS AND THEIR BIOSTRATIGRAPHY IN THE DISTRICT OF KUTCH, WESTERN INDIA

R. K. KAR

Birbal Sahni Institute of Palaeobotany, Lucknow-226 007, India

ABSTRACT

Palynological microfossils obtained from the Barkhana nala cutting; cart-track junction of the villages Goela-Walasar and Fulai-Ramania and the exposure in the nala near the villages Ber-Mota and Maniyara Fort have been described. They consist of pteridophytic spores, gymnospermous and angiospermous pollen, fungal elements and microplanktons. The microfossils have been described under 39 genera and 33 identifiable species. Amongst them, 12 genera and 11 species belong to pteridophytic group, 1 genus and 1 species to gymnosperms and 12 genera and 9 species to angiospermic pollen grains. Besides, 7 genera and 6 species belong to fungi and 7 genera and 6 species to microplanktons.

The section from the Barkhana nala cutting yielded all types of microfossils whereas from the section near the cart-track junction mostly microplanktons could be recovered. The exposure near the Ber-Mota Village is very poor in spore-pollen and only a few fungal spores and microplanktons could be recovered. Three palynological zones have been proposed and a percentage chart has been given for the important palynological taxa. The palynological assemblages have also been compared with the Eocene, Oligocene and Miocene biostratigraphic assemblages of Kutch, Assam and South India.

Key-words — Palaeopalynology, Fungal elements, Microplanktons, Oligocene, Kutch (India).

सारांश

कच्छ जनपद, पश्चिमी भारत के ऑलिगोसीन अवसादों से प्राप्त परागाणविक जीवाश्म एवं उनकी जीवस्तरिकी—रणजीत कुमार कर

बरखाना नाले की कटान, गोयला-वालसर श्रौर फुलाई रमानिया गांवों के कच्चे रास्तों के संगम तथा बेरमोटा श्रौर मनियारा फोर्ट गांवों के समीपवर्ती नाले के श्रनावरण से प्राप्त परागाणविक जीवाश्मों का वर्णन किया गया है। इनमें टेरिडोफाइटी-बीजाणु, श्रनावृतबीजी एवं श्रावृतबीजी परागकण, कवकी श्रवयव तथा सूक्ष्म प्लवक पाये जाते हैं। इन सूक्ष्म-जीवाश्मों को 39 प्रजातियों व 33 श्रभिज्ञेय जातियों के श्रन्तर्गत् वर्णित किया गया है। इनमें से 12 प्रजातियाँ व 11 जातियां टेरिडोफाइटी वर्ग की, 1 प्रजाति व 1 जाति श्रनावृतबीजी तथा 12 प्रजातियां व 9 जातियां श्रावृतबीजी की हैं। इनके श्रतिरिक्ति 7 प्रजातियां व 6 जातियां कवक तथा 7 प्रजातियां व 6 जातियां सूक्ष्मप्लवकों की हैं।

बरखाना नाला कटान के खंड से विभिन्न प्रकार के सूक्ष्म-जीवाश्म उपलब्ध हुए हैं। जबकि कच्चे रास्ते वाले खंड से श्रधिकतर सूक्ष्म-प्लवक प्राप्त किये जा सके हैं। बेरमोटा गांव के पास वाले श्रनावरण में बीजाणु एवं परागकण श्रत्याल्प मात्रा में हैं तथा बहुत कवकी बीजाणु श्रौर सूक्ष्म-प्लवक प्राप्त किये जा सके हैं। तीन परागाणविक मण्डल प्रस्तुत किये गये हैं तथा मुख्य वर्गकों के लिए एक प्रतिशत सारणी भी दी गई है। परागाणु-समुच्चयों की तुलना कच्छ, श्रासाम व दक्षिण भारत के ईश्रोसीन, श्रॉलिगोसीन तथा मायोसीन जीवस्तरिकीय समुच्चयों से भी की गई है।

INTRODUCTION

THE Tertiary sediments in Kutch are mostly found in south and south-western part of the district and are well-known for their rich animal fossils. Sowerby (1840) described for the first time many invertebrate fossils and Grant (1840) made a preliminary geological report of this region; Wynne (1872) divided the Tertiary rocks of Kutch into Subnummulitic, Eocene, Miocene and ?Pliocene rocks. He did not suspect that in Kutch there was any Oligocene rock. Medlicott and Blanford (1879) also failed to recognize any definite Oligocene sediments though they referred the arenaceous groups of Wynne (1872) into ?Nari Stage. It was Nuttal (1926) who for the first time could detect Oligocene rocks in Kutch by studying the fossils. He divided the Tertiary sediments in Kutch as follows:

Oligocene	— Nari Limestone containing *Nummulites intermedius, N. clipeus, N. subclipeus, N. fischteli.*
Lower part of Middle Kirthar	— Well-bedded white limestone containing *Nummulites acutus, N. maculatus, Assilina exponens, Alveolina elliptica, Discocyclina dispansa, D. avana* var. *indica, D. sowerbyi, Actinocyclina alticostata, Dictyoconoides cooki, N. djokdjokartae.*
	Shales
	....
	Laterite
	Deccan Trap

Vredenburg (1925, 1928) also recognized the occurrence of the Nari (Oligocene) Stage in Kutch. But Krishnan (1943) and Wadia (1953) put the Nari beds of Nuttal (1926) and Vredenburg (1925, 1928) either to the Kirthar (Eocene) or the Gaj (Miocene) stages.

Tewari (1957) investigated the geology and stratigraphy of the area between the Waghopadar and Cheropadi, in Kutch but did not recognize any Oligocene sediments in this region.

Poddar (1959) thought that the presence of Oligocene was doubtful in Kutch and he subdivided the Tertiary rocks as under:

AGE	FORMATION	THICKNESS	TYPE OF SEDIMENTS
Pliocene	Manchhar Series	250 m ±	Partially marine
....	Unconformity	....	....
Miocene	Argillaceous beds	300 m ±	Marine
	Arenaceous beds	50 m ±	Estuarine
....	Unconformity	....	....
?Oligocene		10 m ±	Marine
	Nummulitic limestone	200 m ±	Marine
	Gypseous shale, etc.		
Eocene	Lateritic clays and laterite	30 m ±	Terrestrial

Sen Gupta (1964) studied the biostratigraphy of Lakhpat and adjacent regions and found Oligocene beds. In his opinion, between Eocene and Oligocene there is a paraconformity because between the two there is an abrupt change of fossil contents. The Oligocene is characterized by the dominance of *Nummulites fischteli* and not one of the numerous larger foraminifera of Eocene is found in Oligocene. Moreover, in his opinion, forms like *Pellatispira* which indicate the uppermost Eocene in India (Nagappa, 1951; Biswas, 1954) have not been found either in the Kirthar or in the Nari strata of Lakhpat. The mollusks, echinoids and the corals that are found in abundance in Oligocene are in no case preceded by ancestral forms in the older strata. Besides, Sen Gupta (1964) also could not observe any significant difference between the lithologies of the Eocene and Oligocene limestones. So far the Oligocene-Miocene unconformity is concerned, he could observe both faunal and lithic changes. *Miogypsina* occurs in plenty in the Miocene and also some new mollusks too appear.

The Miocene limestones contain a high percentage of sand-size terrigenous material and occasionally the base of the strata is marked by conglomerates.

Biswas (1965) equated Nari Series of Sind-Baluchistan with Lakhpat Series and placed it to the Oligocene. Biswas and Deshpande (1970) replaced Lakhpat Series by Ber Moti Series and subdivided into Ramania and Waior stages. Biswas and Raju (1971) also put forward a lithostratigraphic classification of Oligocene rocks in Kutch as follows:

FORMATION	MEMBER	LITHOLOGY
MANIYARA FORT	Ber Moti Member	Upper — Foraminiferal limestones and marlite Lower — Argillaceous, glauconitic sandstone
FORMATION	Coral Limestone Member	White, nodular, foraminiferal limestones, glauconitic biomicrites and biospartites
	Lumpy Clay Member	Lumpy claystones with occasional limestone bands
	Basal Member	Glauconitic claystones and siltstones

They observed an unconformity between the Eocene and the Oligocene rocks and found the Oligocene and the Miocene rocks as conformable.

Chatterji and Mathur (1966) also established Oligocene-Lower Miocene sequence in Kutch demarcating the Lattorfian, the Stampian and the Aquitanian horizons.

Poddar (1963) recorded for the first time the palynological fossils from the Oligocene of Kutch. He described Microthyrites, Stegmatachytes, Hystrichosphaerids and some angiospermic pollen.

Chandra and Chatterji (1972) reported trilete and monolete spores, various types of angiospermic pollen and microplanktons from the upper part of the Nari beds exposed about a kilometer south of the village Sarangwara (Sanosra) (23°27′: 68°43′) in the Barkhana nala cutting.

The miospores described here have been recovered from the type locality of Ramania Stage (Lower Oligocene) proposed by Biswas and his colleagues; carbonaceous shales exposed on the southern side of the village Sarangwara (Sanosra) already reported by Chandra and Chatterji (1972) and the type locality of Maniyara Fort Formation exposed near the Maniyara Fort in the vicinity of the village Ber Mota. Besides, samples from the exposures near the village Waior were also macerated but they did not yield any microfossil.

The Lower Oligocene rocks are exposed about 2 km west of the village Ramania at the cart-track junction of the villages Goela-Walasar and Fulai-Ramania. The rocks consist mostly of limestone with thin partings of grey — slightly carbonaceous shales full of *Nummulites*. The limestones are yellowish in colour and thus could easily be distinguished from the white to yellowish-white marl and limestones of Eocene exposed in the neighbourhood. The Ramania Limestone forms a few hillocks and have mostly been taken away by the villagers for using as building material.

Mention may be made here that the cart-track of Fulai-Ramania is not being used for a number of years due to the construction of a water reservoir in this area. The locality is now situated on the southern side of the eastern gate of the reservoir. The distance from the gate is not more than 200 m. From this locality mostly the microplanktons could be recovered from the shale samples.

On the southern side of the village Sarangwara in the Barkhana nala cutting, a good exposure of Upper Oligocene rocks is observed. The same rocks could also be seen in the canal cutting near the nala. The lowermost part of the exposure is made up of carbonaceous shale about 3-4 m thick. This shale is gypseous and in some places very light, tuffaceous and may even be lignitic. In appearance, this shale unit looks like the gypseous shale of Eocene age. The upper part of the exposure comprises sandy shale which may be of various colour at places. This unit is also about 3-4 m thick. Samples were collected at close intervals but only the lower carbonaceous shale yielded spores, pollen grains, fungal remains and microplanktons.

The nala besides the dilapidated fort of Maniyara exposes a good section of Upper Oligocene rocks. Its basalmost part seems to be shale full of *Nummulites*. This is overlain by coral limestone. The corals are of huge sizes and could be observed lying here and there in the nala. Above this unit, is the calcareous marl with shale partings at places. This is overlain by dirty limestone which is full of invertebrate fossils. Samples were macerated from all the lithologic units but only a few microplanktons and fungal remains could be recovered from the shale partings.

All the slides have been deposited in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC PALYNOLOGY

Anteturma — *Sporites* H. Potonié, 1893
Turma — *Triletes* (Reinsch) Potonié & Kremp, 1954
Subturma — *Azonotriletes* Luber, 1935
Infraturma — *Laevigati* (Bennie & Kidston) Potonié, 1956

Genus — *Cyathidites* Couper, 1953

Type Species — *Cyathidites australis* Couper, 1953.

Cyathidites cf. *C. australis* Couper, 1953

Pl. 1, fig. 1

Description — Spores triangular with broadly rounded apices, 47-59 μ. Trilete well-developed, rays extending up to three-fourths radius; exine up to 2·5 μ thick, laevigate, exoexine sometimes present.

Remarks — *Cyathidites australis* Couper (1953) is very common in the Upper Mesozoic strata (Potonié & Gelletich, 1933; Bolkhovitina, 1953; Dettmann, 1963; Venkatachala, 1967, 1969, 1970; Venkatachala & Kar, 1969, 1972 & others). It is, however, uncommon in the Palaeogene sediments. For this reason the specimens, studied here come closest to *Cyathidites australis*, have only been compared with it and not included within the species.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Cyathidites cf. *C. minor* Couper, 1953

Pl. 1, fig. 2

Description — Spores subtriangular, 51-69 μ, apices bluntly rounded. Trilete distinct, rays extending up to two-thirds radius; exine laevigate.

Remarks — *Cyathidites minor* Couper (1953) has smaller size range than the specimens investigated here. Besides, they have also concave-straight interapical margin.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Intrapunctisporis* Krutzsch, 1959

Type Species — *Intrapunctisporis intrapunctis* Krutzsch, 1959.

Intrapunctisporis sp.

Pl. 1, fig. 3

Description — Spore triangular, 70 μ, apices acutely rounded, interapical margin straight. Trilete well-developed, rays extending up to equator. Exine about 1·5 μ thick, laevigate and intrapunctate.

Comparison — The present species is distinguished from *Intrapunctisporis intrapunctis* Krutzsch (1959) by its well-developed trilete rays.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Punctatisporites* (Ibrahim) Potonié & Kremp, 1954

Type Species — *Punctatisporites punctatus* Ibrahim, 1933.

Punctatisporites sarangwaraensis sp. nov.

Pl. 1, figs 4, 5

Holotype — Pl. 1, fig. 4, size 72 μ; Slide no. 5075/2.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Spores circular, 68-93 μ, trilete well-developed, extending up to two-thirds equator. Exine laevigate and closely intrapunctate.

Comparison — ?*Punctatisporites* sp. described by Venkatachala and Kar (1969b) from the Eocene sediments of Kutch resembles the present species in shape and nature of the trilete mark; but the latter is easily distinguished by its larger size range and closely intrapunctate structure.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Punctatisporites sp.

Pl. 1, fig. 6

Description — Subcircular, spore 48 μ. Trilete rays extending up to 2/3 radius. Exine about 1 μ thick, weakly intrapunctate.

Comparison — *Punctatisporites* sp. described here comes near to *Punctatisporites sarangwaraensis* in general organisation but is differentiated by its much smaller size.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Infraturma — *Toriati* Krutzsch, 1959

Genus — *Toroisporis* Krutzsch, 1959

Type Species — *Toroisporis torus* (Pflug) Krutzsch, 1959.

Toroisporis dulcis sp. nov.

Pl. 1, figs 7, 8

Holotype — Pl. 1, fig. 7, size 60 μ; Slide no. 5077/4

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Spores triangular, 53-78 μ. Trilete distinct, extending up to 3/4 radius, bifurcating at tips. Exine thickened around trilete, laevigate.

Comparison — *Toroisporis longitorus* Krutzsch (1959) is comparable to the species described here in triangular shape, size range and extension of the tori up to 3/4 radius; but the former is separated by its intrapunctate exine and the trilete rays also do not bifurcate at tips.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Remarks — Krutzsch (1959) instituted *Toroisporis* to accommodate triangular-subtriangular, laevigate, trilete spores with thickened area (tori) along the trilete rays. He selected *Laevigatisporites neddeni* subsp. *torus* Pflug, 1953 as the type species for the genus. He observed that the spores assignable to *Toroisporis* are found from Keuper (Upper Triassic) to Oligocene. Besides, he also proposed *Toripunctisporis* and *Toripustulatisporites* to include punctate and sculptured spores with thickened margin around the haptotypic mark respectively. These two genera, in his opinion, are mostly restricted to various Tertiary sediments.

Couper (1958) christened *Dictyophyllidites* and later emended by Dettmann (1963) for the triangular, laevigate to faintly patterned trilete spores with thickenings around the laesurate margin. Dettmann (1963) described *Dictyophyllidites pectinataeformis* (Dettmann, 1963, pl. 2, figs 9-12) which was previously described by Bolkhovitina (1953) as *Matonia pectinataeformis* (Bolkhovitina, 1953, pl. 8, fig. 23). This species seems to be very similar to *Toroisporis irregularis* (Pflug) Krutzsch (1959, pl. 10, figs 73, 74). Dettmann (1963) also mentioned that *Dictyophyllidites* is comparable to *Toroisporis*, *Toripunctisporis* and *Toripustulatisporites* but she did not point out the difference of the former from the latter genera.

It may be mentioned here that the spores similar to *Toroisporis* are found in different geographical regions and geological strata. Recently, Kar and Bose (1976) have described such spores under ?*Dictyophyllidites* sp. (Kar & Bose, 1976, pl. 1, figs 4-6) from *assise à couches de houille* (Permian) from Greinerville region, Zaïre.

Genus — *Lygodiumsporites* (Potonié, Thomson & Thiergart) Potonié, 1956

Type Species — *Lygodiumsporites adriennis* (Potonié & Gelletich) Potonié, Thomson & Thiergart, 1950.

Lygodiumsporites lakiensis Sah & Kar, 1969

Remarks — Spores are subtriangular with convex interapical margin, specimens studied here are bigger in size range (56-74 μ) than those originally described by Sah and Kar (1969) from the underlying Eocene sediments. Triletes are generally unequal, rays extending up to 2/3 radius.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Todisporites* Couper, 1958

Type Species — *Todisporites major* Couper, 1958.

Todisporites kutchensis Sah & Kar, 1969

Remarks — Spores assignable to *Todisporites kutchensis* Sah & Kar (1969) are subcircular in shape and have a larger size range, viz., 75-101 μ than those first reported by Sah and Kar (1969) from the Naredi Formation (Lower Eocene). Trilete rays are distinct-indistinct and they do not extend more than 2/3 of the radius.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Biretisporites* (Delcourt & Sprumont) Delcourt, Dettmann & Hughes, 1963

Type Species — *Biretisporites potoniaei* Delcourt & Sprumont, 1955.

Biretisporites convexus Sah & Kar, 1969

Pl. 1, fig. 9

Remarks — The exine in the specimens studied here referable to *Biretisporites convexus* Sah & Kar (1969) is slightly granulose in the contact area; otherwise they are very much similar to the above mentioned species.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Infraturma — *Apiculati* (Bennie & Kidston) Potonié, 1956

Genus — *Leptolepidites* Couper, 1953

Type Species — *Leptolepidites verrucatus* Couper, 1953.

Leptolepidites chandrae sp. nov.

Pl. 1, figs 10, 11

Holotype — Pl. 1, fig. 10, size 46 μ; Slide no. 5080/8.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Spores triangular-subtriangular, 34-56 μ; trilete, rays extending up to 3/4 equator. Exine verrucose, verrucae smaller in contact area but robustly built at margin and on distal side.

Comparison — *Leptolepidites* sp. A and B described by Sah and Kar (1969) are proximally psilate. The present species proposed here is distinguished from all the known species of *Leptolepidites* by its presence of smaller verrucae at the haptotypic area and the larger ones at equatorial margin and on the distal side.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Derivation of Name — After Sri A. Chandra, Geological Survey of India, Calcutta.

Leptolepidites sp.

Pl. 1, fig. 12

Description — Spore triangular, 36 μ; trilete distinct, rays extending up to 2/3 radius. Exine about 2 μ thick, proximally laevigate, distally verrucose, verrucae smaller in size, interspersed with pila and bacula.

Comparison — *Leptolepidites chandrae* has verrucae of different sizes and thus can easily be distinguished from the present species. *Leptolepidites* sp. A and B described by Sah and Kar (1969) have very well-developed and closely placed verrucae on the distal surface.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Infraturma — *Murornati* Potonié & Kremp, 1955

Genus — *Striatriletes* van der Hammen, 1956 emend.

Type Species — *Striatriletes susannae* van der Hammen, 1956 emend.

1958 *Ceratopteris* Meyen, p. 156.

1962 *Cicatricosisporites* Potonié & Gelletich: Biswas, p. 35.
1962 *Schizaeaceaesporites* Baksi, p. 19.
1962 *Ceratopteris* Baksi, p. 20.
1962 *Parkeriaceaesporites* Baksi, p. 20.
1964 *Striatriletes* van der Hammen: Banerjee, p. 3.
1964 *Mohria* Ghosh, Jacob & Lukose, p. 26.
1964 *Ceratopteris* Ghosh, Jacob & Lukose, p. 26.
1965 *Schizaea* (in parts) Ghosh, Jacob & Lukose, p. 24.
1965 *Anemia* Ghosh, Jacob & Lukose, pp. 24-26.
1965 *Schizaeaceaesporites* Baksi: Baksi, p. 2286.
1965 *Parkeriaceaesporites* Baksi: Baksi, p. 2286.
1968 *Cicatricosisporites* Potonié & Gelletich: Sah & Dutta, p. 185.
1968 *Magnastriatites* Germeraad, Hopping & Muller, p. 288.
1972 *Cicatricosisporites* Potonié & Gelletich: Salujha, Kindra & Rehman, p. 272.
1975 *Magnastriatites* Germeraad, Hopping & Muller: Salujha, Kindra & Rehman, p. 272.
1975 *Cicatricosisporites* Potonié & Gelletich: Nandi, p. 415.

Remarks — van der Hammen (1956) validly published *Striatriletes* to include trilete spores with triangular-subcircular shape and costae on both the surfaces. He thought that the genus resembles the extant spores of *Anemia* in some features. But he also did not rule out its relationship to the spores of Parkeriaceae. Later in 1957, he stressed its stratigraphic importance because the genus in Colombia and neighbouring countries first found in Lower Oligocene and shows its maximum development in Middle and Upper Oligocene.

In the Tertiary sediments of India, the spores assignable to *Striatriletes* are found from various regions. The first report of spores referable to this genus was by Meyer (1958) from the Barail Series (Oligocene). He reported it as *Ceratopteris* type spore (Meyer, 1958, pl. 24, fig. 1) and observed it as a most common type of spore occurring in the series.

Biswas (1962) also reported parkeriaceous spores from Langpar Formation (Upper Cretaceous-Palaeocene) of the Um Sohryngkew River section. He, however, described them as *Cicatricosisporites* sp. (Biswas, 1962, pl. 3, fig. 41; pl. 4, fig. 53; pl. 5, fig. 54). He observed that *Schizaeaceaesporites* starts from Kopili Formation (Upper Eocene) and continues up to Surma (Miocene) while *Parkeriaceaesporites* begins at Barail and ends at Surma. He instituted *Schizaeaceaesporites* making *Schizaeaceaesporites knoxi* as the type species of the genus (Baksi, 1962, p. 19, pl. 3, fig. 41). The other genus, viz., *Parkeriaceaesporites* also proposed by him is lacking a type species and proper description. Baksi in the same paper also described *Ceratopteris macrocostata* Biswas very much resembling *Schizaeaceaesporites* and *Parkeriaceaesporites* (Baksi, 1962, p. 20, pl. 4, fig. 53).

It may be mentioned here that Thiergart (1940) already proposed the name *Schizaeaceaesporites* for triangular-subcircular trilete spores without any costae (Thiergart, 1940, pl. 6, figs 5-7). Potonié and Kremp (1955) designated *Schizaeaceaesporites adriensis* as the type species of the genus. But later, Potonié (1956) commented that the said species is not the genotype and so the genus is without a type species.

Banerjee (1964) while describing palynological fossils from the Surma (Miocene) of Garo Hills also reported some spores of *Striatriletes*. He described them as *Striatriletes* sp. A (Banerjee, 1964, p. 3, pl. 1, figs 11, 16, 17) and *Striatriletes* sp. B (Banerjee, 1964, p. 4, pl. 1, fig. 18).

Ghosh, Jacob and Lukose (1964) described spores resembling the spores of extant Parkeriaceae assignable to *Striatriletes* and Schizaeaceae from the various Tertiary sediments of India. They described 8 species of fossil *Schizaea*, 4 species of *Anemia*, 1 species of *Mohria* and 2 species of *Ceratopteris*. Most of the *Schizaea* species described by them have monolete but at least one of them seems to have trilete (Ghosh *et al.*, 1964, p. 24, pl. 1, fig. 5; text-fig. 2). This is a folded spore belonging to Parkeriaceae and in the present preparation many spores having similar configurations have been recovered along with the normal proximo-distally flattened specimens. The different species of *Anemia* and *Mohria* described by them also are not distinguishable morphologically from *Ceratopteris* sp. (Ghosh *et al.*, 1964, pp. 24-26, pl. 2, figs 13-20; text-figs 11-16).

Baksi (1965) also maintained *Schizaeaceaesporites* and *Parkeriaceaesporites* while dealing with the stratigraphy of Barail Series in southern part of Shillong Plateau, Assam. He, however, did not elucidate the difference between the two genera. From the text-figures it seems that *Schizaeaceaesporites* described by him are the folded specimens of *Parkeriaceaesporites* (Baksi, 1965, p. 2286, fig. 2).

Sah and Dutta (1968) pointed out the stratigraphic significance of various palynological taxa in the Tertiary succession of Assam. They placed *Ceratopteris macrocostatus* Biswas described by Baksi (1962) into *Cicatricosisporites macrocostatus* (Baksi) Sah & Dutta.

Salujha, Kindra and Rehman (1972) described two new species of fossil spores of Parkeriaceae, viz., *Cicatricosisporites venustus* (Salujha *et al.*, 1972, pl. 1, figs 22-23) and *C. pudens* (Salujha *et al.*, pl. 1, figs 24,25) from the Palaeogene of Garo Hills, Assam. In 1974, they transferred *Cicatricosisporites venustus* to *Magnastriatites venustus* (Salujha *et al.*, 1974, pl. 1, fig. 16). They, however, also maintained and described spores under *Cicatricosisporites* sp. (Salujha *et al.*, 1974, pl. 1, fig. 17). The spore described and illustrated by them as *Cicatricosisporites* does not show much difference from those described by them as *Magnastriatites*.

Nandi (1975) observed the occurrence of *Cicatricosisporites* in the Siwaliks of Punjab (Nandi, 1975, pl. 1, fig. 10) and found it as one of the stratigraphic markers for the Lower Siwalik (Miocene) in that region.

It may be mentioned here that the genus *Cicatricosisporites* was proposed by Potonié and Gelletich (1933) from the Eocene brown coal of Dorog, near Budapest, Hungary. *Cicatricosisporites dorogenesis* Potonié & Gelletich (1933) was designated as the type species of the genus (Potonié & Gelletich, 1933, pp. 522-523, pl. 1, figs 1-5). This genus is not restricted to Tertiary but also found in abundance in the Mesozoic sediments throughout the world. This genus is meant to accommodate the fossil spores of schizaeaceous ferns, viz., *Ruffordia goepperti* (Dunk) Seward: Couper, 1958 and *Pelletiaria valdensis* Seward: Couper, 1958 which have spores very much similar to *Cicatricosisporites*. Similar spores have also been described under *Schizaeopsis americana* Berry and *Anemia colwellensis* Chandler (1955) from Neocomian and Eocene sediments respectively.

The spores of Schizaeaceae, particularly those of *Anemia* and *Mohria*, are costate like that of *Ceratopteris* (Parkeriaceae). They are triangular to subcircular in shape and have almost the same size range (60-90 μ). The differences between them are rather subtle and as a consequence a good deal of confusion has been resulted in dealing with the dispersed spores.

The extant spores of *Anemia* and *Mohria* have been investigated by Nayar (1967). He also studied the spores of *Ceratopteris* in detail. It has been observed that in all the species of *Anemia* and *Mohria*, there are two distinct sets of costae on proximal and distal surfaces. One set of costae does not continue on the other side but are confined within the respective inter-radial area. They may sometime, coalesce with each other to form triangular area. In *Anemia adiantifolia* (Linn.) Seward, the proximal costae are nearly parallel to the laesura and those on the contact surfaces join together to form a triangular area on the proximal side. The succeeding costae also coalesce on both the sides forming successive concentric triangles. The spores of *Mohria caffrorum* (Linn.) Dev do not differ much from that of *Anemia*. They also have distinct sets of costae for proximal and distal sides. They can, however, be distinguished from *Anemia* by the presence of paired costae. Each pair is separated from the other by a narrow depression simulating a slit-like appearance while the adjacent pairs have more space in between.

The spores of *Ceratopteris thalictroides*, *C. cornuta* and *C. siliqulosa* of Parkeriaceae are also costate. In these species costae, however, arise on the proximal side at the inter-radial area or at least at ray ends and proceed on the distal side forming more or less successive concentric rings. There is no separate set of costae for the proximal and distal surfaces; on the contrary, same sets are present on both surfaces at each inter-radial area producing thereby three sets of costae.

It is apparent from above description that though the spores of Schizaeaceae and Parkeriaceae are similar they are quite distinct from the organisational point of view. Realising this basic difference, Germeraad, Hopping and Muller (1968) instituted a form genus *Magnastriatites* to accommodate fossil spores of Parkeriaceae. They restricted *Cicatricosisporites* Potonié & Gelletich (1933) for Schizaeaceous spores.

They diagnosed the genus *Magnastriatites* as " Spherical, trilete, coarsely striate, except on the proximal contact area which is surrounded by a circular ridge. Striae continuous, grooves about as wide as ridges, size around 100 μ."

As has already been mentioned, van der Hammen (1954, 1956, 1957) described similar spores of Parkeriaceae under the name *Striatriletes* from the Lower-Middle Oligocene of Colombia. In 1956, he validly published the genus *Striatriletes* and selected *Striatriletes susannae* as the type species for the genus (van der Hammen, 1956, pl. 2, fig. 5). He described the type species as " Trilete spore. Sculpture-type striate. Size of type specimen 82×75 μ, but rather variable within the species. The arms of the tetrad-mark are relatively long, but in general do not reach the limit of the proximal and distal sides. Tetrad-mark sometimes slightly opened. Breadth of the striae 2-3 μ. The distance between the striae is smaller than the breadth of the striae. The majority of the striae leave divergating from the ends of the arms of tetrad-mark. Bifurcations and little pronounced constrictions of the striae can be observed sometimes."

From the above description as well as illustration provided by van der Hammen mentioned earlier, it is apparent that *Magnastriatites* proposed by Germeraad *et al.* (1968) is a junior synonym of *Striatriletes* van der Hammen (1956).

The spores assignable to *Striatriletes* are found in abundance in the different Tertiary formations of India. In Assam, they first appear at the top of Tura Formation (Eocene) and flourish in Barails (Oligocene) and Surmas (Lower Miocene). They gradually dwindle in Tipam (Middle Miocene). In Kutch, they are not found in Harudi Formation (Middle Eocene) and so far known only from Maniyara Fort Formation (Oligocene). While studying the dispersed spores of Parkeriaceae, it was felt that the generic description provided by van der Hammen (1956) is rather insufficient to accommodate all types of Parkeriaceous spores. This necessitated the present author to elaborate and emend the diagnosis of *Striatriletes* so that all the hitherto known spores assignable to Parkeriaceae may be accommodated.

Emended Diagnosis — Spores triangular-subcircular in polar view, 40-140 μ, trilete distinct-indistinct; costate, costae 3-7, generally arise at inter-radial area or at ray ends and continue on respective distal side as successive concentric rings, costae sparsely or closely placed, laevigate or ornamented.

Description — Spores generally subtriangular with rounded apices and straight to slightly convex interapical margin. Spores seem to be lighter proximally due to extension of costae more on distal side, resulting variously folded specimens in preparations. Proximal exine opposite to one of the apices generally folded providing a cordate appearance, sometimes one of the apices covers some minor to major part of the proximal side forming semicircular to reniform shape, in fact, proximo-distally fully flattened specimens rare. Trilete generally discernible, rays equal, uniformly broad, slightly raised, sometimes open, extending from half to 3/4 radius; commissure distinct. Exine 2-8 μ thick, mostly laevigate, rarely intrapunctate, sometimes infected by bacteria or fungi specially on proximal side forming pseudoornamentational pattern. Costae appear as bands, running ±parallel to each other in one inter-radial area and its corresponding distal side. Generally, at least one set of costae found in each inter-radial area on proximal side, they may be juxtaposed but never coalesce each other, sometimes up to 3 sets of costae may be observed proximally in full proximo-distally flattened specimens. The rest sets of costae arise at ray ends and depending on the extension of them, the costae vary in length on proximal side; in some specimens while trilete rays extend up to 3/4, the costae may hardly be visible on proximal side as they arise almost at apical margin. The whole proximal surface in this case may be without any proper costae though sometimes they may be replaced by minor folds. Three sets of costae on the distal polar region come very close to each other forming a triangular area. Costae may be flat, lacinate or rope-like, generally closely placed but allowing some space in between them; in some specimens, however, they are very adjacent to each other without any space in between them. Costae generally laevigate, but sometimes punctate or weakly intrastructured and branched.

Striatriletes susannae van der Hammen, 1956 emend.

Pl. 1, fig. 13a, b

1968 *Magnastriatites howardii* Germeraad, Hopping & Muller, p. 288, pl. 3, fig. 1.
1972 *Cicatricosisporites venustus* Salujha, Kindra & Rehman, p. 272, pl. 1, figs 22, 23.
1974 *Magnastriatites venustus* (Salujha, Kindra & Rehman) Salujha, Kindra & Rehman, p. 272, pl. 1, fig. 16.

Holotype — van der Hammen, 1956, pl. 2, fig. 5.

Type Locality — Sample Ha-607, Colombia (Lower-Middle Oligocene).

Emended Diagnosis — Spores, anisopolar, triangular-subcircular in polar view with rounded apices and slightly convex interapical margin, 77-113 μ. Trilete, rays extending up to 2/3 radius. Exine costate, costae 4-7, a few arising at inter-radial area and rest at ray ends and continue on distal side forming continuous, successive, parallel, concentric rings. Costae of each inter-radial area never coalesce with other on proximal as well as on distal side. Costae ribbon-like, sometimes branched, not very closely placed, ± laevigate.

Striatriletes cf. *S. susannae* van der Hammen, 1956 emend.

Pl. 1, figs 14, 15

Description — Spores triangular-subcircular generally with convex margin, 87-110 μ. Trilete indistinct not extending more than 2/3 of radius. Costae ill-developed, flattened, narrow, sometimes bifurcating.

Remarks — The present specimens compare favourably with *Striatriletes susannae* van der Hammen (1956), emended here, in size range and shape but differs in possessing ill-developed, flattened costae.

Striatriletes sp.

Pl. 1, figs 16, 17

Description — Proximal side of spores generally caved in on distal side forming various shapes. Costae well-developed, occasionally branched, costae as well as inter-costate region punctate, puncta distinct, closely placed.

Comparison — *Striatriletes susannae* described earlier is distinguished from the present species by its laevigate costae. The exine in the former species is also psilate.

Turma — *Monoletes* Ibrahim, 1933
Subturma — *Azonomonoletes* Luber, 1935
Infraturma — *Psilamonoleti* van der Hammen, 1955

Genus — *Laevigatosporites* (Ibrahim) Schopf, Wilson & Bentall, 1944

Type Species — *Laevigatosporites vulgaris* Ibrahim, 1933.

Laevigatosporites lakiensis Sah & Kar, 1969

Remarks — The spores assignable to this species are larger (72-89 μ) than those recorded by Sah and Kar (1969). Besides, monolete is less developed and the exine is generally irregularly folded.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Polypodiaceaesporites* Thiergart, 1940

Type Species — *Polypodiaceaesporites haardti* Thiergart, 1940.

Polypodiaceaesporites chatterjii sp. nov.

Pl. 2, figs 18, 19

1969 *Polypodiaceaesporites* sp. Sah & Kar, p. 118, pl. 2, fig. 25.

Holotype — Pl. 2, fig. 18, size 76 μ; Slide no. 5079/1.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Spores bean-shaped, 61-87 μ. Monolete generally ill-developed, extending not more than two-thirds along longer axis. Exine up to 2·5 μ thick, laevigate.

Comparison — *Polypodiaceaesporites tertiarus* Sah & Dutta (1966) resembles the present species in shape but is distinguished by its smaller size range and scabrate exine.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Derivation of Name — After Dr A. K. Chatterji, Geological Survey of India, Calcutta.

Infraturma — *Sculptatomonoleti* Dybova & Jachowitz, 1957

Genus — *Polypodiisporites* Potonié, 1934

Type Species — *Polypodiisporites favus* Potonié, 1934.

Polypodiisporites constrictus sp. nov.

Pl. 2, figs 20, 21

Holotype — Pl. 2, fig. 20, size 48 μ; Slide no. 5087/4.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Spores bean-shaped, 33-58 μ, monolete extending up to three-fourths along longitudinal axis. Exine closely verrucose, verrucae 2-4 μ long, sometimes coalesce together.

Comparison — *Polypodiisporites* sp. described by Sah and Kar (1969) is subcircular and thus can easily be separated from the present species. *P. repandus* Takahasi (1964) described by Dutta and Sah (1970) and *P. mawkmaensis* Dutta & Sah (1970) are bigger in size range and generally not bean-shaped. Besides, the verrucae are also in these two species, robustly built and not so closely placed.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Cheilanthoidspora* Sah & Kar, 1974

Type Species — *Cheilanthoidspora enigmata* Sah & Kar, 1974.

Cheilanthoidspora monoleta Sah & Kar, 1974

Pl. 2, fig. 22

Remarks — Spores are more or less of same size as reported by Sah and Kar (1974) from the Palana lignites (Lower Eocene), Rajasthan. But the monolete mark in the present specimens is better developed and almost extends from one end to other.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

SPORE TYPE — 1

Pl. 2, fig. 23

Description — Spore triangular, 22 μ; trilete distinct, rays narrow extending up to equator. Exine pilate, pila up to 4 μ long, sparsely placed on both sides.

Remarks — The spore resembles *Meyeripollis* Baksi & Venkatachala (1970) in outward appearance; but *Meyeripollis* as designated by Baksi and Venkatachala (1970) is trisyncolpate and has large tubercles at apices.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Anteturma — *Pollenites* Potonié, 1931
Turma — *Saccites* Erdtman, 1947
Subturma — *Disaccites* Cookson, 1947
Infraturma — *Podocarpoiditi* Potonié, Thomson & Thiergart, 1950

Genus — *Podocarpidites* (Cookson) Potonié, 1958

Type Species — *Podocarpidites ellipticus* Cookson, 1947.

Podocarpidites cognatus sp. nov.

Pl. 2, figs 24, 25

Holotype — Pl. 2, fig. 24, size 78×38 μ; Slide no. 5091/2.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Haploxylonoid, bilateral, disaccate pollen grains, 51-84×33-45 μ. Central body distinct, microreticulate. Proximal attachment of sacci to central body equatorial, distal attachment straight covering major part of central body. Sacci hemispherical, intrareticulate.

Comparison — *Podocarpidites classicus* Salujha, Kindra & Rehman (1972) described from the Palaeogene of Garo Hills, Assam resembles the present species in size range and general organisation. But the central body in *P. classicus* is foveolate whereas in the present species it is microreticulate.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Infraturma — *Sphaerozonisulcates* Venkatachala & Kar, 1969

Genus — *Proxapertites* (van der Hammen) van der Hammen, 1965

Type Species — *Proxapertites operculatus* (van der Hammen) van der Hammen, 1956.

Proxapertites scabratus Jain, Kar & Sah, 1973

Pl. 2, fig. 26

Remarks — Only a solitary specimen could be recovered. The spore is about 90 μ in size and has a suture by which it splits into two. Exine is about 1 μ thick and more or less laevigate.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Proxapertites microreticulatus Jain, Kar & Sah, 1973

Remarks — The spore is badly-preserved and the intramicroreticulate structure of the exine is not clearly discernible.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Turma — *Plicates* (Naumova) Potonié, 1960
Subturma — *Monocolpates* Iversen & Troels-Smith, 1950

Genus — *Couperipollis* Venkatachala & Kar, 1969

Type Species — *Couperipollis perspinosus* (Couper) Venkatachala & Kar, 1969.

Remarks — *Spinizonocolpites* Muller (1968) outwardly resembles *Couperipollis* by its shape and sculptural elements. But the former has a continuous equatorial colpus and it splits the pollen grains into two slightly unequal parts. This phenomenon is not found in *Couperipollis*.

Couperipollis microreticulata sp. nov.

Pl. 2, figs 27, 28

1972 *Monocolpites* van der Hammen: Chandra & Chatterji, p. 31, pl. 6, figs 26, 27.

Holotype — Pl. 2, fig. 27, size 60 μ; Slide no. 5093/1.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Pollen grains ± subcircular-broadly oval, 53-75 μ. Sulcus broad, extending from one end to other. Spines with broad base and pointed tip, sparsely placed; exine finely microreticulate.

Comparison — *Couperipollis gemmatus* (Couper) Venkatachala & Kar (1969) has very big sculptural elements. *C. rarispinosus* (Sah & Dutta) Venkatachala & Kar (1969) comes close to the present species by its sparsely placed spines but is distinguished by its elliptical shape and laevigate interspinal exine.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Subturma — *Triptyches* (Naumova) Potonié, 1960

Genus — *Tricolpites* (Erdtman) Couper, 1953

Type Species — *Tricolpites thomasii* Cookson & Pike, 1954.

Tricolpites sp. 1

Pl. 2, fig. 29

Description — Pollen grain subcircular, tricolpate, 60 μ. Colpi well-developed, funnel-shaped. Exine thick, baculate, bacula sparsely placed, interbacular exine laevigate.

Comparison — *Tricolpites brevis* Sah & Kar (1970) and *T. minutus* Sah & Kar (1970) are differentiated from the present specimen by their triangular-subtriangular shape and scrobiculate structure.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Tricolpites sp. 2

Pl. 2, fig. 30

Description — Pollen grain subcircular, tricolpate, 59 μ. Colpi wide at equator, constricted at polar region. Exine reti-baculate.

Comparison — *Tricolpites* sp. 1 resembles the present specimen in subcircular shape but is separated by its bacular sculptural elements.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Retitricolpites* Pierce, 1961

Type Species — *Retitricolpites vulgaris* Pierce, 1961.

Retitricolpites delicatus sp. nov.

Pl. 2, figs 31, 32

Holotype — Pl. 2, fig. 31, size 32×24 μ; Slide no. 5097/4.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Pollen grains mostly found in equatorial view, 18-36×14-30 μ. Tricolpate, colpi narrow, extending almost from one margin to another. Exine micro-reticulate.

Comparison — *Retitricolpites robustus* Sah & Kar (1970) resembles the present species in shape in equatorial view but is characterized by broad, reticulate pattern which is duplibaculate in nature.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Trisyncolpites* gen. nov.

Type Species — *Trisyncolpites ramanujamii* sp. nov.

Generic Diagnosis — Pollen grains trisynmargocolporate, margocolpi broad, thickened, providing the appearance of triradiate ridge in equatorial view. Exine pilate-baculate, sometimes retipilate-retibaculate, nexine very much thicker than sexine, intrapunctate.

Description — Pollen grains subcircular in polar view and more or less elliptical in equatorial view; pollen in polar view more common than equatorial one, 51-87 μ. Pila-bacula up to 6 μ long, closely placed, providing retipilate to retibaculate appearance. Nexine almost double than sexine, minutely intrapunctate. Margocolpi very well-developed, in equatorial view they extend from pole to pole, in polar view they join together in middle, margocolpi very broad, appear as a dark triradiate ridge. Pores elliptical, elongate.

Comparison — *Myrtaceidites* (Cookson & Pike) Potonié (1960) resembles *Trisyncolpites* in the presence of trisyncolpate nature but the former is easily distinguished by its triangular shape and laevigate-granulate exine. *Meyeripollis* Baksi & Venkatachala (1970) though trisyncolpate is also triangular in shape and has tubercles as sculptural pattern. *Marginipollis* Clarke & Frederiksen (1968) approximates *Trisyncolpites* in trisyncolpate nature and subcircular shape in polar view. But in *Marginipollis*, the colpi margin is thickened which in equatorial view projects like beak. Besides, the exine is also foveolate. *Retisyncolporites* Guzman (1967) is trisyncolporate, reticulate and the colpi are not thickened. *Trisyncolpites* proposed here is distinguished from all the genera by its broad trisynmargocolporate nature, pilate-baculate sculptural pattern, thickened nexine, and intrapunctate structure.

Remarks — Trisyncolpate pollen grains are found in number of families of the extant angiosperms. This phenomenon is common in *Blechum laxiflorum* of Acanthaceae; *Caryocar tessmannii* of Caryocaraceae; *Nymphoides indica* of Gentianaceae; *Heteropyxis natalensis* of Hernandiaceae; *Barringtonia acutangula* and *Planchonia crenata* of Lecythidaceae; *Eucalyptus ficifolia* of Myrtaceae, *Matayba apetala* of Sapindaceae and others (vide Erdtman, 1952). *Blechum laxiflorum* is reticulate and *Caryocar tessmannii*, *Nymphoides indica*, *Heteropyxis natalensis*, *Eucalyptus ficifolia* and *Matayba apetala* are all parasyncolpate.

The present genus is somewhat comparable to the pollen grains of Lecythidaceae by its subcircular shape in polar view and presence of broad colpi in syncolpate condition. Venkatachala and Kar (1968) have studied the living and fossil pollen of *Barringtonia*. According to them, the pollen grains of *Barringtonia acutangula* are trisyncolpate with crassimarginate colpi and colpi margin terminating in oroid extension possessing nexinous thickenings at the poles with tegillar mesocolpial sexine simulating areoloidate pattern in surface view. In *Planchonia crenata*, sexine is slightly thicker than nexine and is partially covered by three, slightly raised, mesocolpial sexine projections tapering towards the poles. The colpi margins are markedly thickened and the sexine is areoloidate in appearance.

The pollen grains described under *Trisyncolpites* do not show the characters enumerated above. But the general organisation shows some resemblance to the pollen grains of Lecythidaceae.

It may be mentioned here that the pollen grains assignable to Lecythidaceae have been described by Venkatachala and Kar (1968) from the Eocene sediments of Kutch. Besides, Baksi (1962) and Salujha, Kindra and Rehman (1972) have also described similar pollen grains from the Palaeogene of Assam. It would be no wonder, therefore, if some form of pollen grains representing Lecythidaceae are also found in the Oligocene of Kutch.

Muller (1973) studied intensively the pollen morphology of *Barringtonia calyptrocalyx* K. Sch. and traced the evolutionary tendency of the pollen grains in Lecythidaceae. In his opinion, basic tricolpate prototype occurring in Foetidioideae, Napoleonoideae and Lecythidioideae gave rise to trisyncolpate *Barringtonia calyptrata* type. From this type arose trisyncolpate type with marginal ridges and grooves found in *Careya* and *Planchonia*. The ultimate evolution of trisyncolpate type is found in *Barringtonia calyptrocalyx* where the marginal ridges, polar cushions and marginal grooves are all very well-developed. The pollen grains described in the present paper show broad resemblance to *Barringtonia calyptrata* in general organisation but differs in ornamentational pattern.

The pollen grains described here, however, resemble very closely to the living pollen grains of *Poinciana pulcherrima* of Eucaesalpiniaeae described and illustrated by Tsukada (1963, pl. 10, figs 173-175). These pollen grains are also trisynmargocolporate, baculate and punctitegillate. The pores are elliptical and lolongate. *Poinciana pulcherrima* grows in India and its pollen grains have been described by Nair and Sharma (1962).

Trisyncolpites ramanujamii sp. nov.

Pl. 2, figs 33-37

Holotype — Pl. 2, fig. 33, size 57 μ; Slide no. 5099/6.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Pollen grains subcircular in polar and elliptical in equatorial view, 51-87 μ. Trisynmargocolporate, margocolpi broad, thickened, united to provide a pseudotriradiate ridge like pattern. Exine pilatebaculate, in some specimens retipilate-retibaculate, nexine almost double than sexine, intrapunctate. Pores lolongate.

Remarks — Similar type of pollen have also been found by Dr C. G. K. Ramanujam from South India.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Derivation of Name — After Dr C. G. K. Ramanujam, Botany Department, Osmania University, Hyderabad, India.

Infraturma — *Prolati* Erdtman, 1943

Genus — *Araliaceoipollenites* Potonié, 1951

Type Species — *Araliaceoipollenites euphorii* (Potonié) Potonié, 1951.

Araliaceoipollenites sp.

Pl. 2, fig. 38

Description — Pollen grain oval in equatorial view, 56 μ, seems to be pentacolporate, pore distinct, circular, colpi extending 3/4 along longitudinal axis. Exine laevigate.

Comparison — *Araliaceoipollenites matanamadhensis* Venkatachala & Kar (1969) approximates the present species in shape but is tricolporate.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Retibrevitricolpites* van Hoeken-Klinkenberg, 1966

Type Species — *Retibrevitricolpites triangulatus* van Hoeken-Klinkenberg, 1966.

Retibrevitricolpites sp.

Pl. 2, fig. 39

Description — Pollen grain subcircular in polar view, 49 μ. Tricolporate, colpi funnel-shaped, pore distinct. Exine reticulate.

Comparison — The present species is distinguished from *Retibrevitricolpites triangulatus* van Hoeken-Klinkenberg (1966) by its larger size and retibaculate exine.

Remarks — Germeraad, Hopping and Muller (1968) reported this genus from Nigeria and Caribbean area. They found *R. triangulatus* as tricolporate and not tricolpate as mentioned by van Hoeken-Klinkenberg (1966).

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Paleosantalaceaepites* Biswas, 1962

Type Species — *Paleosantalaceaepites primitiva* Biswas, 1962.

Paleosantalaceaepites ellipticus Sah & Kar, 1970

Remarks — Only a single pollen grain could be recovered assignable to this species. The colpi are well-developed, extending almost end to end and the ora are lalongate. The sexine is much thicker than the nexine.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Paleosantalaceaepites minutus Sah & Kar, 1970

Pl. 2, figs 40, 41

Remarks — The pollen grains which could be referred to the above mentioned species are more elliptical in equatorial view than the specimen illustrated by Sah and Kar (1970) from the Lower Eocene of Kutch. Colpi are also comparatively well-developed and the ora are distinct. The exine is laevigate in all the specimens studied here.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Turma — *Poroses* (Naumova) Potonié, 1960

Subturma — *Monoporines* (Naumova) Naumova, 1939

Genus — *Monoporopollenites* (Meyer) Potonié, 1960

Type Species — *Monoporopollenites gramineoides* Meyer, 1956.

Monoporopollenites sp.

Pl. 2, fig. 42

Description — Pollen grain subcircular, 56 μ. Pore distinct, circular, margin thickened. Exine about 1 μ thick, irregularly folded, granulose.

Comparison — *Monoporopollenites gramineoides* Meyer (1956) illustrated by Ramanujam (1966) from the South Arcot District, Madras is much smaller in size (22-25 μ) though the pore has thickened margin. *Monoporopollenites* sp. described by Venkatachala and Kar (1969) from the Eocene sediments of Kutch is laevigate and devoid of any thickening around the margin.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Subturma — *Triporines* (Naumova) Potonié, 1960

Genus — *Triporopollenites* (Pflug) Thomson & Pflug, 1953

Type Species — *Triporopollenites coryloides* Thomson & Pflug, 1953.

Triporopollenites exactus Salujha, Kindra & Rehman, 1972

Pl. 2, fig. 43

Remarks — Only a single pollen grain assignable to this species could be found. Pores are distinct and the exine is more or less laevigate.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Triporopollenites sp.

Pl. 2, fig. 44

Description — Pollen grain subcircular, 16 μ. Triporate, pores distinct. Exine laevigate.

Comparison — *Triporopollenites exactus* Salujha, Kindra & Rehman (1972) is bigger in size range than the present specimen. *T. communis* Salujha, Kindra & Rehman (1972) is oval in shape and thus can easily be distinguished from the species described here.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Subturma — *Polyporines* (Naumova) Potonié, 1960

Infraturma — *Stephanoporiti* (van der Hammen) Potonié, 1960

Genus — *Stephanoporopollenites* Pflug, 1953

Type Species — *Stephanoporopollenites hexaradiatus* (Thiergart) Thomson & Pflug, 1953.

Stephanoporopollenites sp.

Pl. 2, fig. 45

Description — Pollen grain subcircular, 56 μ. Tetraporate, pore distinct, elliptical, margin thickened. Exine about 1 μ thick, granulose.

Comparison — *Stephanoporopollenites solitus* Salujha, Kindra & Rehman (1972) somewhat resembles the present specimen in shape but is hexaporate and foveolate. *S. proprius* also instituted by Salujha, Kindra and Rehman (1972) is pentaporate and microreticulate. *Polyporina excellens* Sah & Dutta (1968) has about 50 pores distributed all over the body.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Malvacearumpollis* Nagy, 1962

Type Species — *Malvacearumpollis bakonyensis* Nagy, 1962.

Malvacearumpollis rudis sp. nov.

Pl. 2, figs 46, 47

1972 *Polyporites* Chandra & Chatterji, p. 32, pl. 7, fig. 4.

Holotype — Pl. 2, fig. 46, size 65 μ; Slide no. 5049/4.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Pollen grains subcircular, 52-76 μ, panporate, pore ± elliptical. Exine spinose, spine with bulbous base and pointed tip; nexine thicker than sexine, latter with rod-like processes extending up to base of spines.

Comparison — *Malvacearumpollis grandis* Sah (1967) described from the Upper Neogene of Rusizi Valley, Burundi is very much larger in size (115-139 μ), the pores are numerous and distinct. *M. africana* Sah (1967) is also much bigger in size range (97-110 μ) and comparatively less spinose. The spines are quite different from the present species as they are devoid of bulbous base and pointed tip.

Remarks — Germeraad, Hopping and Muller (1968) have proposed *Echiperiporites estelae* for pollen grains which show characters similar to the pollen grains of Malvaceae (Germeraad *et al.*, 1968, pl. 10, fig. 1). This species shows close resemblance to *Malvacearumpollis* Nagy (1962).

Occurrence — Barkhana nala cutting, near the village Sarangwara.

FUNGI

Genus — *Phragmothyrites* (Edwards) Kar & Saxena, 1976

Type Species — *Phragmothyrites eocaenicus* (Edwards) Kar & Saxena, 1976.

Phragmothyrites eocaenicus (Edwards) Kar & Saxena, 1976

Remarks — The specimens assignable to *P. eocaenicus* (Edwards) Kar & Saxena (1976) are rare in the present material. Pseudoparenchymatous cells in middle region are rarely observed in the specimens studied here.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Notothyrites* Cookson, 1947

Type Species — *Notothyrites setiferus* Cookson, 1947.

Notothyrites sp.

Pl. 3, fig. 48

Description — More or less subcircular ascostromata, 92 μ, dimidiate, ostiolate, cells surrounding ostiole few cells thick, ostiole margin thickened. Hyphae radially arranged, interconnected to form squarish, pseudoparenchymatous cells. Pores generally present.

Remarks — Only one specimen could be obtained from the present preparation. It is distinguished from *Notothyrites setiferus* Cookson (1947) by its presence of squarish, generally porate, peripheral cells. In *N. amorphus* Kar & Saxena (1976), the hyphae do not anastomose to form distinct pseudoparenchymatous cells.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Kutchiathyrites* gen. nov.

Type Species — *Kutchiathyrites eccentricus* sp. nov.

Generic Diagnosis — Ascostromata eccentric in development, no free hyphae present, dimidiate, nonostiolate. Radially arranged hyphae thick, dark, diverging from one another, transverse hyphae comparatively thinner, ± translucent, interconnecting radial ones to form squarish, pseudoparenchymatous cells without any pore.

Description — Microthyriaceous ascostromata approximate semicircular shape in most specimens, in others they look like fish scales, size range 64-110 × 41-73 μ. Upper surface of ascostromata darker than inner one; radial hyphae also well-pronounced in former. Radial hyphae look like dark strands; transverse hyphae ill-developed, sometimes hardly discernible at places.

Comparison — *Phragmothyrites* (Edwards) Kar & Saxena (1976) resembles *Kutchiathyrites* in the presence of dimidiate, nonostiolate ascostromata; but the former is distinguished by its subcircular-circular shape and in possessing pore in the pseudoparenchymatous cells. *Parmathyrites* Jain & Gupta (1970) is also nonostiolate but has prominent spines in the peripheral pseudoparenchymatous cells. *Paramicrothallites* Jain & Gupta (1970) and *Notothyrites* Cookson (1947) are distinctly ostiolate. *Kutchiathyrites* proposed here is differentiated from all the known microthyriaceous ascostromata by its eccentric development of stromata, dark, strongly developed, divergent radial hyphae and absence of pore in the pseudoparenchymatous cells.

Kutchiathyrites eccentricus sp. nov.

Pl. 3, figs 49-52

Holotype — Pl. 3, fig 49, size 72 × 49 μ; Slide no. 5106/6.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Microthyriaceous ascostromata eccentrically developed, 64-110 × 41-73 μ. Stromata dimidiate, nonostiolate; radial hyphae diverging, dark, better-developed than transverse ones; hyphae interconnecting each other to form squarish, nonporate, pseudoparenchymatous cells.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Inapertisporites* (van der Hammen) Elsik, 1968

Type Species — *Inapertisporites typicus* van der Hammen, 1954.

Inapertisporites kedvesii Elsik, 1968

Pl. 3, fig. 57

Genus — *Pluricellaesporites* (van der Hammen) Elsik, 1968

Type Species — *Pluricellaesporites typicus* van der Hammen, 1954.

Pluricellaesporites planus Trivedi & Verma, 1969

Pl. 3, fig. 53

Remarks — Individual cells are ± square in shape, eleven cells could be counted. Pore is distinct, margin is thickened and cells are bigger in size in middle region.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Dyadosporonites* Elsik, 1968

Type Species — Dyadosporonites schwabii Elsik, 1968.

Dyadosporonites constrictus sp. nov.

Pl. 3, figs 54, 55

Holotype — Pl. 3, fig. 54, size 82×32 μ; Slide no. 5109/2.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Spore diporate, 65-89×31-39 μ, uniseptate. Pores distinct, circular, margin thickened, spore coat laevigate, generally constricted in middle.

Comparison — Psilodiporites bharadwaji originally described by Varma and Rawat (1963) and later transferred by Elsik to *Dyadosporonites* resembles the present species in general organization but is distinguished by its elliptical shape which has no constriction in the septate region.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Lacrimasporonites* (Clarke) Elsik, 1968

Type Species — Lacrimasporonites clarke Elsik, 1968.

Lacrimasporonites longus sp. nov.

Pl. 3, fig. 56

Holotype — Pl. 3, fig. 56, size 74×36 μ; Slide no 5111/1.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Spores 67-132×32-47 μ, elliptical, carrot-shaped, monoporate, pore circular, distinct, margin slightly thickened, a lid-like projection present above pore; spore coat laevigate.

Comparison — Lacrimasporonites basidii Elsik (1968), *L. westii* Elsik (1968) and *L. stoughii* Elsik (1968) are differentiated from the present species by their smaller size ranges.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

MICROPLANKTONS

Genus — *Polysphaeridium* Davey & Williams, 1966

Type Species — Polysphaeridium subtilum Davey & Williams, 1966.

Polysphaeridium (*Hystrichosphaeridium*) *microtriainum* (Klumpp) comb. nov.

Pl. 4, figs 63a-65

1953 *Hystrichosphaeridium microtriaina* Klumpp, p. 390, pl. 17, figs 6-7.
1968 *Cordosphaeridium microtriaina* (Klumpp): Coninck, p. 31, pl. 8, figs 26-29; pl. 9, figs 1-4.
1972 *Baltisphaeridium* sp. cf. *B. multispinosum* Singh: Kar, Singh & Sah, p. 146, pl. 1, fig. 1.

Remarks — Davey and Williams (1966) studied intensively the various species assigned to *Hystrichosphaeridium* Deflandre (1938) and *Cordosphaeridium* Eisenack (1963). In their opinion, *Hystrichosphaeridium* should include subcircular cysts possessing a reflected tabulation of 4′ (−5′), 6″, 6C, 5-6‴, 1p, 1⁗ and a variable number of sulcal processes. Processes are hollow, open distally and have one process per plate. Number of processes do not exceed 30 and the archaeopyle is apical.

For *Cordosphaeridium* they advocated that the chorate cysts should be subcircular with central bodies having two distinct layers. The periphragm is variably developed forming well-developed processes reflecting a tabulation of 1′, 6″, 6C, 6‴, (1p), 1⁗. The number of sulcal processes is variable, the archaeopyle is apical, haplotabular and never possesses a zigzag margin.

It is obvious from the above two diagnosis of *Hystrichosphaeridium* and *Cordosphaeridium* that the specimens described as *Hystrichosphaeridium microtriaina* by Klumpp (1953) and *Cordosphaeridium microtriaina* (Klumpp) Coninck (1968) can not be accommodated in both the genera. The specimens described by them can, however, be placed in *Polysphaeridium* instituted by Davey & Williams (1966).

The specimens belonging to *Polysphaeridium microtriainum* in the present preparation have subcircular shape, size range of the central body varies from 35-65 μ, processes are slender, translucent and generally with bifurcated tips. The archaeopyle in most of the specimens is distinct, it is apical in position and possesses more or less a triangular shape.

It may be mentioned here that some of the specimens described as *Hystrichosphaeridium mineralosum* by Varma and Dangwal (1964, pl. 1, figs 8, 9) from the different Tertiary horizons of India might also belong to *Polysphaeridium microtriainum*.

Occurrence — Barkhana nala cutting, near the village Sarangwara; near the junction of Ramania-Fulai and Goela-Walasar cart-tracks; in the nala cutting, near the village Ber Mota.

Polysphaeridium cephalum sp. nov.

Pl. 4, figs 66a-67

Holotype — Pl. 4, fig. 66a, size 59 μ; Slide no. 5118/1.

Type Locality — Barkhana nala cutting, near the village Sarangwara, Oligocene, Kutch.

Diagnosis — Central body subcircular, 51-64 μ, processes numerous, slender, 4-8 μ long, central body generally intrapunctate; archaeopyle mostly distinct, apical, triangular-subtriangular with straight margin.

Comparison — *Polysphaeridium microtriainum* (Klumpp) comb. nov. resembles the present species in subcircular shape of the central body and the nature of the archaeopyle but the latter is easily distinguished by its very slender processes and intrapunctate central body. *P. subtilum* Davey & Williams (1966) is bigger in size and has longer, spongy, tubular processes.

Occurrence — Barkhana nala cutting, near the village Sarangwara; near the junction of Ramania-Fulai and Goela-Walasar cart-tracks.

Polysphaeridium sp.

Pl. 4, fig. 68

Description — Central body subcircular, 78 μ, processes numerous, conied-granulose, not more than 3 μ high; archaeopyle not observed.

Comparison — The present specimen is comparable to *Polysphaeridium cephalum* in the presence of numerous slender processes; but in the latter, though the processes are slender but never conied or granulose. The other species like *P. microtriainum*, *P. subtilum* and *P. pastielsi* Davey & Williams (1966) have all bigger processes.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Cleistosphaeridium* Davey, Downie, Sarjeant & Williams, 1966

Type Species — *Cleistosphaeridium diversispinosum* Davey, Downie, Sarjeant & Williams, 1966.

Cleistosphaeridium heteracanthum (Deflandre & Cookson) Davey, Downie, Sarjeant & Williams, 1966

Remarks — Microplanktons assignable to this species have subcircular central body, size range is 51-69 μ; processes are numerous and slender, weakly bifid at tips, processes seem to be more on distal side, very closely placed. Archaeopyle is apical and distinct in most of the specimens.

Occurrence — Near the junction of Ramania-Fulai and Goela-Walasar cart-tracks; Barkhana nala cutting near the village Sarangwara; in the nala cutting, near the village Ber Mota.

Genus — *Spiniferites* (Mantell) Sarjeant, 1970

Type Species — *Spiniferites ramosus* (Ehrenberg) Mantell, 1950.

Spiniferites ramosus cf. var. *multibrevis* (Davey & Williams) Sarjeant, 1970

Pl. 4, fig. 69

Description — Central body oval, 62 μ, processes long, slender, generally trifurcate at gonal and bifurcate at sutural parts; tabulation not distinct; archaeopyle precingular

Comparison — *Spiniferites ramosus* var. *multibrevis* (Davey & Williams) Sarjeant (1970) has more robustly built processes than the present species. Besides, the tabulation is also more clear in the former one.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Membranilarnacia* Eisenack, 1963

Type Species — *Membranilarnacia leptoderma* (Cookson & Eisenack) Eisenack, 1963.

Membranilarnacia delicata sp. nov.

Pl. 4, figs 70, 71

Holotype — Pl. 4, fig. 70, size 70 μ; Slide no. 5120/2.

Type Locality — Near the junction of Ramania-Fulai and Goela-Walasar cart-tracks, Oligocene, Kutch.

Diagnosis — Central body subcircular, 61-86 μ, generally finely intrastructured. Processes numerous, tubular, up to 12 μ high, joined by a translucent membrane distally; archaeopyle apical.

Comparison — *Membranilarnacia reticulata* Williams & Downie (1966) is not much comparable to the present species because the former has only a few, long, tubular processes which are embedded by a reticulate membrane on the distal side.

Occurrence — Near the junction of Ramania-Fulai and Goela-Walasar cart-tracks; Barkhana nala cutting, near the village Sarangwara.

Membranilarnacia sp.

Pl. 4, fig. 72

Description — Central body subcircular, 76 μ, processes few, short, strongly built, bifid, attached by an envelope on distal side, shell coat thin, smooth; archaeopyle not observed.

Comparison — *Membranilarnacia delicata* described earlier has many slender processes and thus is easily separated from the present species. *M. reticulata* Williams & Downie (1966) though has few processes but is characterized by the presence of a reticulate envelope on the distal side.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Homotryblium* Davey & Williams, 1966

Type Species — *Homotryblium tenuispinum* Davey & Williams, 1966.

Homotryblium sp.

Pl. 4, fig. 73

Description — Central body subcircular, 58-82 μ, processes long, slender, many, capitate; archaeopyle when observed seems to be epitractal.

Comparison — *Homotryblium tenuispinosum* Davey & Williams (1966) and *H. pallidum* Davey & Williams (1966) have bigger and stouter processes.

Occurrence — Near the junction of Ramania-Fulai and Goela-Walasar cart-tracks; Barkhana nala cutting, near the village Sarangwara.

Genus — *Fromea* Cookson & Eisenack, 1958

Type Species — *Fromea amphora* Cookson & Eisenack, 1958.

Fromea pachyderma sp. nov.

Pl. 4, fig. 75

Holotype — Pl. 4, fig. 75, size 79 μ; Slide no. 5077/3.

Type Locality — Barkhana nala cutting, near the village Sarangwara.

Diagnosis — Microplankton subcircular, thickening of shale up to 6 μ ± laevigate; cingulum hardly traceable; archaeopyle apical, well-pronounced.

Comparison — *Fromea acambra* Sah, Kar & Singh (1970) described from the Langpar Formation of Therriaghat, Assam is distinguished from the present species by its pitcher shape, thin shell coat with granulose sculptural elements. *F. amphora* Cookson & Eisenack (1958) has also thin shell coat, elliptical shape and grana.

Remarks — The specimens assignable to *Fromea* are very rare in the present material.

Occurrence — Barkhana nala cutting, near the village Sarangwara.

Genus — *Aplanosporites* gen. nov.

Type Species — *Aplanosporites robustus* sp. nov.

Generic Diagnosis — Spore generally subcircular, irregularly folded, inaperturate, laevigate. A tail-like appendage present in most specimens.

Description — Fully flattened specimens without folds rare, spores take various shapes due to haphazard foldings, 68-134 μ. Spore coat up to 2 μ thick. Characteristic appendage-like projection probably forms from original hyphae, terminal part of which swollen to form spore (?aplanospore). In some specimens (Pl. 3, fig. 58) this hyphae like growth seems to originate from other hyphae. Appendage-like structure may be preserved terminally but may also be adpressed to body of spores (Pl. 3, figs 61, 62).

Comparison — *Inapertisporites* (van der Hammen) Elsik (1968) resembles the present genus in inaperturate nature but the latter can easily be distinguished by its tail-like flagellum. *Inaperturopollenites* (Pflug) Potonié (1966) is also inaperturate, but has intrapunctate exine and most probably gymnospermous in origin. *Thecaspora* Elsik (1966) apparently resembles *Aplanosporites* in having a tail-like projection but has a distinct trilete mark and the spinose perispore drawn out proximally into a trifolium.

Remarks — *Aplanosporites* proposed here resembles some of the planktonic forms. Jen (1958) described a supposedly fungal spore from the Lower Cretaceous of Southern Hunan, China which resembles the present genus. Besides, Kar and Sah (1970) described *plankton* type-1 from Vemavaram (Upper Jurassic) which is also characterized by a long appendage. Kar and Bose (1976) also reported another *plankton* type-1 with a very long appendage from *assise á couches de houille* of Greinerville region, Zaïre.

Aplanosporites robustus sp. nov.

Pl. 3, figs 58-62

Holotype — Pl. 3, fig. 58, size 98 μ; Slide no. 5112/3.

Type Locality — Nala cutting, near the village Ber Mota, Oligocene, Kutch.

Diagnosis — Spores originally subcircular but due to irregular folds take various shapes, 68-127 μ. Spore coat up to 2 μ thick, laevigate. A tail-like appendage which seems to be remnant of hyphae present in most specimens.

Occurrence — Nala cutting, near the village Ber Mota.

DISCUSSION

The palynological assemblages recovered from the Barkhana nala cutting, near the village Sarangwara; cart-track junction of the villages Goela-Walasar and Fulai-Ramania and the exposure near the village Ber-Mota and Maniyara Fort comprise pteridophytic spores; gymnospermic and angiospermic pollen grains; fungal spores, hyphae, microthyriaceous ascostromata and microplanktons. They have been placed into 39 dispersed genera and 33 identifiable species. Of them, 12 genera and 11 species belong to pteridophytes, 1 genus and 1 species to gymnosperms, 12 genera and 9 species to angiosperms, 7 genera and 6 species to fungi and 7 genera and 6 species to microplanktons.

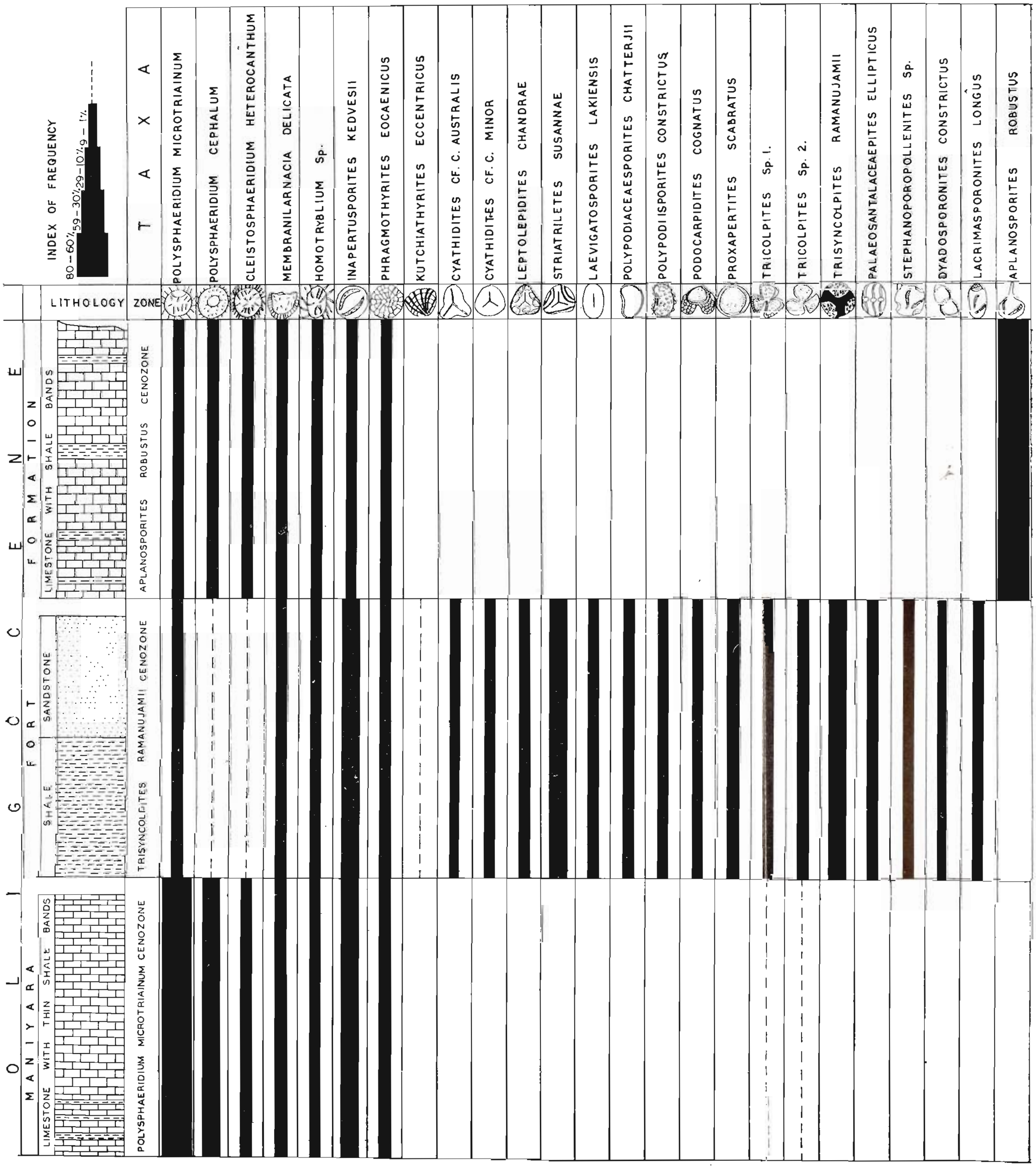
The samples from the Barkhana nala cutting were the most productive and they yielded almost all the genera and species enumerated above. The samples from the cart-track junction of the villages Goela-Walasar and Fulai-Ramania produced only the microplanktons except a few angiospermic pollen and fungal bodies whereas those near the village Ber-Mota were meagrely represented by few fungal bodies and microplanktons.

The palynological assemblage recovered from the Barkhana nala cutting is dominated by angiospermic pollen grains (50 %) followed by pteridophytic spores (29 %). The fungi contribute 15 per cent while microplanktons and gymnospermic pollen share 4 and 2 per cent respectively. Of the angiosperms, *Trisyncolpites* is most common and contributes 37 per cent to the assemblage. *Tricolpites* (9 %) comes next in abundance. *Paleosantalaceaepites* represents only 2 per cent, while *Proxapertites* and *Stephanoporopollenites* each contribute 1 per cent. Amongst the pteridophytic spores, *Striatriletes* (13 %) is quite common and *Laevigatosporites* (3 %) and *Polypodiaceaesporites* (3 %) are occasionally found. *Leptolepidites* and *Polypodiisporites* each share 2 per cent to the assemblage. Of the fungi, *Inapertisporites* (10 %) is most common. *Dyadosporonites* (2 %) and *Lacrimasporonites* (2 %) are rarely met with and *Phragmothyrites* is found only in 1 per cent. Microplanktons are represented by *Polysphaeridium* (2 %), *Membranilarnacia* (1 %) and *Homotryblium* (1 %).

The miospore assemblage from Goela-Walasar and Fulai-Ramania cart-track junc-

TABLE 1

PALYNOSTRATIGRAPHIC ZONATION OF MANIYARA FORT FORMATION, KUTCH



tion, as has already been stated, is overwhelmingly dominated by microplanktons (89%) and poorly followed by fungi (11%). No angiospermic pollen are encountered within the percentage count. Amongst the microplanktons, *Polysphaeridium* (72%) is most abundant. *Cleistosphaeridium* (9%) comes next while *Membranilarnacia* and *Homotryblium* represent 5 and 3 per cent respectively. *Inapertisporites* (10%) generally contributes for the fungi except *Phragmothyrites* which contributes only 1 per cent.

The fungal elements (76%) are most dominant in the assemblage recovered from the nala cutting near the village Ber-Mota and Maniyara Fort. Of them, *Aplanosporites* is found 73 per cent and *Inapertisporites* contributes only 3 per cent. Microplanktons represent 24 per cent out of which *Polysphaeridium* (17%) contributes the bulk. *Cleistosphaeridium* shares 4 per cent while *Membranilarnacia* and *Homotryblium* each share 1 per cent to the assemblage.

Palynostratigraphic Zonation

From the foregoing data, it is apparent that the assemblages can be divided into 3 distinct cenozones as under:

3. *Aplanosporites robustus* Cenozone.
2. *Trisyncolpites ramanujamii* Cenozone.
1. *Polysphaeridium microtriainum* Cenozone.

Polysphaeridium microtriainum Cenozone

Reference Locality — Near the cart-track junction of Ramania-Fulai and Goela-Walasar villages.

Lithology — Limestone with thin shale bands.

Lower Contact — The basal member of *Polysphaeridium microtriainum* Cenozone is a thin shale band full of invertebrate animal fossils.

Upper Contact — The upper contact of this cenozone is also a thin shale band within the limestone.

Characteristic Species of the Cenozone — *Polysphaeridium cephalum*, *Cleistosphaeridium heterocanthum*, *Membranilarnacia delicata*, *Homotryblium* sp., *Inapertisporites kedvesii* and *Phragmothyrites eocaenicus*.

Indicator of the Cenozone — *Polysphaeridium microtriainum* is found in 60 per cent in the samples and by its dominance alone this cenozone can be distinguished from the overlying *Trisyncolpites ramanujamii* Cenozone (Table 1).

Trisyncolpites ramanujamii Cenozone

Reference Locality — The Barkhana nala cutting, near the village Sarangwara.

Lithology — Lower part shale, upper part sandy shale and sandstone.

Lower Contact — The carbonaceous shale at the base of the section constitutes the basal unit.

Upper Contact — The sandy shale below the sandstone provides the upper contact.

Characteristic Species of the Cenozone — *Leptolepidites chandrae*, *Striatriletes susannae*, *Laevigatosporites lakiensis*, *Polypodiaceaesporites chatterjii*, *Polypodiisporites constrictus*, *Podocarpidites cognatus*, *Proxapertites scabratus*, *Paleosantalaceaepites ellipticus*, *Dyadosporonites constrictus* and *Lacrimasporonites longus*.

Indicator of the Cenozone — *Trisyncolpites ramanujamii* is very common and contributes 37 per cent to the assemblage. Besides, *Striatriletes susannae* is also frequently met with. By the common occurrence of these two species, this cenozone can be differentiated from the underlying and overlying cenozones.

Aplanosporites robustus Cenozone

Reference Locality — The nala cutting near the village Ber-Mota and Maniyara Fort.

Lithology — The shale bands between the limestones.

Lower Contact — The lower shale band forms the basal unit of this cenozone.

Upper Contact — The upper shale band is the topmost unit.

Characteristic Species of the Cenozone — *Polysphaeridium microtriainum*, *Polysphaeridium cephalum*, *Cleistosphaeridium heterocanthum*, *Membranilarnacia delicata*, *Homotryblium* sp., *Inapertisporites kedvesii* and *Phragmothyrites eocaenicus*.

Indicator of the Cenozone — The very high frequency (73%) of *Aplanosporites* *robustus* is alone sufficient to identify this cenozone.

Comparison with Other Assemblages

The palynological assemblage of the Lower Eocene sediments of Kutch described by Sah and Kar (1969, 1970) and Venkatachala and Kar (1969) have 21 genera and 30 species of pteridophytic spores, 4 genera and 4 species of gymnospermic and 42 genera and 65 species of angiospermic pollen grains and some fungal elements. Of the trilete genera *Cyathidites*, *Intrapunctisporis*, *Lygodiumsporites*, *Todisporites*, *Biretisporites*, *Leptolepidites*, *Laevigatosporites*, *Polypodiaceaesporites* and *Polypodiisporites* are common to both the assemblages. But *Striatriletes*, one of the most significant genera, found in the present assemblage has not been reported in the Lower Eocene.

Amongst gymnospermic genera, only *Podocarpidites* is common to both the assemblages. Angiospermic elements are, by far, better represented in Eocene of Kutch than in Oligocene. A few stratigraphically insignificant genera like *Couperipollis*, *Tricolpites*, *Araliaceoipollenites*, *Paleosantalaceaepites* and *Monoporopollenites* are found common in the two assemblages. But majority of the important genera of Lower Eocene, viz., *Cryptopolyporites*, *Umbelliferoipollenites*, *Polybrevicolporites*, *Sastriipollenites*, *Pseudonothofagidites*, *Sonneratioipollis*, *Lakiapollis*, *Verrucolporites*, *Pellicieroipollis*, *Meliapollis*, *Striacolporites*, *Ghoshiacolpites* and *Thymelaepollis* are absent in the present material. Of the fungi, the microthyriaceous genus *Phragmothyrites* and *Inapertisporites* are occasionally met with in both the assemblages.

Baksi (1962, 1965) investigated the microfossils from the Oligocene sediments around Shillong Plateau, Assam and proposed Simsang Palynological Zone III. In his opinion, this zone is characterized by the (i) abundance of 'gemmate-syncolpate' pollen, later designated by Baksi and Venkatachala (1970) as *Meyeripollis*, (ii) first appearance of finely striate-tricolpate pollen, (iii) frequent association of tubercle bearing monolete belonging to Polypodiaceae, (iv) very frequent occurrence of smooth *Leiotriletes*, (v) occasional presence of schizaeaceous/parkeriaceous spores, (vi) presence of some granular pollen tetrads, and (vii) frequent occurrence of monocolpate spinose pollen.

It may be mentioned here that *Meyeripollis*, the most abundant genus of Oligocene in Assam, is conspicuous by its absence in the present assemblage. Besides, striated-tricolpate pollen and granular pollen-tetrads are also not observed in the latter. But the frequent occurrence of parkeriaceous spores and smooth, triangular trilete spores are recorded in both the assemblages. But *Trisyncolpites* — a prominent angiospermic genus in the present assemblage is not reported from the Oligocene in Assam.

Baksi (1972) also established Bengal Palynological Zone IV for the Oligocene sediments of Bengal Basin comprising Burdwan and a part of Memari formations. This zone is quite similar to the Simsang Palynological Zone III of Baksi (1962) except the abundance of minute tricolpate, tricolporate and triporate pollen grains in the former. According to Baksi (1972), the entire Assam area contains a distinct *Meyeripollis* peak zone at the base succeeded by *Polypodiisporites oligocenicus* and *Cicatricosisporites* cenozones. All these three cenozones are found condensed into one in the Oligocene sediments of Bengal.

The Bengal Palynological Zone IV of Baksi (1972) is not much comparable to the present miospore assemblage because of the poor representation of minute sized tricolpate, tricolporate and triporate pollen grains. Besides, the microplanktons of Bengal Basin is generally represented by *Simsangia* whereas in the present material they are constituted by *Polysphaeridium*, *Cleistosphaeridium*, *Spiniferites*, *Membranilarnacia*, *Homotryblium* and *Fromea*.

The Bengal Palynological Zone V of Baksi (1972) is of Miocene age and does not show much similarity to the present assemblage because of its explosive abundance of small tricolpate, tricolporate and triporate pollen and its first appearance of a few diagnostic pollen species assignable to *Barringtonia*, Polygonaceae and *Bauhinia*. The microplanktons recorded by Baksi (1972) as dinoflagellate and hystrichosphaerid species are also seen to be different from the present one.

Venkatachala and Rawat (1973) proposed *Magnastriatites cauveriensis* zone for the subsurface sediments of Madanam and

Karaikal wells of Oligocene age. This zone is characterized by the appearance of *Cicatricosisporites macrocostatus*, *Monoporopollenites gramineoides*, *Foveotricolpites perforatus*, *Proteacidites granulatus* and *Magnastriatites cauveriensis*. Besides, in the opinion of Venkatachala and Rawat (1973) the abundance of *Verrucatosporites sparsus*, *Polypodiisporites ornatus*, *Costatipollenites pauciornatus* and *Myricipites harrissi* can easily distinguish this cenozone from Eocene and Miocene sediments.

A perusal of the above list indicates that the present palynological assemblages are not much comparable to those described by Venkatachala and Rawat (1973) except the presence of *Striatriletes* (*Magnastriatites*), *Polypodiisporites* and *Monoporopollenites*.

The *Lacrimapollis pilosus* zone instituted by Venkatachala and Rawat (1973) for Miocene sediments from the same wells does not show any resemblance to the present one as the important palynological taxa of the former zone like *Lacrimapollis pilosus*, *Costatipollenites pauciornatus*, *Caryapollenites cauveriensis* and *Verrucatosporites bullatus* are totally absent in the Kutch assemblage.

REFERENCES

BAKSI, S. K. (1962). Palynological investigation of Simsang River Tertiaries, South Shillong Front, Assam. *Bull. geol. Soc. India*, **26**: 1-21.

BAKSI, S. K. (1965). Stratigraphy of Barail Series in southern part of Shillong Plateau, Assam, India. *Bull. Am. Ass. Petrol. Geol.*, **49** (12): 2282-2288.

BAKSI, S. K. (1972). On the palynological biostratigraphy of Bengal Basin. *Proc. Sem. Palaeopalynol. Indian Stratigr. Calcutta, 1971*: 188-206.

BAKSI, S. K. & VENKATACHALA, B. S. (1970). *Meyeripollis*, a new genus from the Tertiary sediments of Assam. *J. geol. Soc. India*, **11** (1): 81-83.

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

BISWAS, B. (1954). On the occurrence of *Hantkenina alabamensis* from the Khasi Hills, Assam, India. *J. Palaeont.*, **28**: 791-795.

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

BISWAS, S. K. (1965). A new classification of Tertiary rocks of Kutch, Western India. *Bull. geol. Soc. India*, **35**: 1-6.

BISWAS, S. K. & DESHPANDE, S. V. (1970). Geological and tectonic maps of Kutch. *Bull. Oil Nat. Gas Commn*, **7** (2): 115-116.

BISWAS, S. K. & RAJU, D. S. N. (1971). Note on the rock-stratigraphic classification of the Tertiary sediments of Kutch. *Q. Jl geol. Min. metall. Soc. India*, **43** (3): 177-180.

BOLKHOVITINA, N. A. (1953). Spore-pollen characteristics of the Cretaceous sediments of the central region of the U.S.S.R. (in Russian). *Trudy In-Ta Geol. Nayuk SSSR.*, **61**: 1-145.

CHANDLER, M. E. (1955). The Schizaeaceae of the South of England in Early Tertiary times. *Bull. Brit. Mus. (Nat. Hist.) Geol.*, **2** (7): 291-314.

CHANDRA, A. & CHATTERJI, A. K. (1972). Microflora of the Nari Series of Kutch. *Rec. geol. Surv. India*, **99** (2): 27-34.

CHATTERJI, A. K. & MATHUR, U. B. (1966). Note on the Nari Series of Kutch. *Bull. geol. Soc. India*, **3** (1):

CLARKE, R. T. & FREDERIKSEN, N. O. (1968). Some new sporomorphs from the Upper Tertiary of Nigeria. *Grana palynol.*, **8** (1): 210-224.

CONINCK, J. DE (1968). Dinophyceae et Acritarcha de l'yprésien du sondage de Kallo. *Mém. Inst. r. Sci. Natur. Belgique*, **161**: 1-67.

COOKSON, I. C. (1947). Plant microfossils from the lignites of Kerguelen archipelago. *Rep. B.A.N.Z. antarct. Exped.* Ser. A : 129-142.

COOKSON, I. C. & EISENACK, A. (1958). Microplankton from Australian and New Guinea Upper Mesozoic sediments. *Proc. R. Soc. Vict.*, **70**: 19-79.

COOKSON, I. C. & PIKE, K. M. (1954). The pollen morphology of *Nothofagus* Blume subsection *Bipartitae* Steen. *Aust. J. Bot.*, **3**: 197-206.

COUPER, R. A. (1953). Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. *Bull. N. Z. geol. Surv. palaeont.*, **22**: 1-77.

COUPER, R. A. (1958). British Mesozoic microspores and pollen grains. A systematic and stratigraphic study. *Palaeontographica*, **103B**: 75-179.

DAVEY, R. J. & WILLIAMS, G. L. (1966). The genus *Hystrichosphaeridium* and its allies, in: *Mesozoic & Cainozoic dinoflagellate cysts* by Davey, R. J., Downie, C., Sarjeant, W. A. S. & Williams, G. L. *Bull. Br. Mus. nat. Hist. (Geol.)*, **3**: 1-248.

DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S. & WILIAMS, G. L. (1966). Studies on Mesozoic and Cainozoic dinoflagellate cysts. *Bull. Br. Mus. (Nat. Hist.) Geol.*, **3**: 1-248.

DEFLANDRE, G. (1938). Microplankton des mers jurassiques conservé dans les marnes de Villers-sur-Mer (Calvados). *Trav. Stat. zool. Wimer.*, **13**: 147-200.

DELCOURT, A. F. & SPRUMONT, G. (1955). Les spores et grains de pollen du Wealdien du Hainaut. *Mém. Soc. Belge. Géol.*, **4**: 73.

DELCOURT, A. F., DETTMANN, M. E. & HUGHES, N. F. (1963). Revision of some Lower Cretaceous microspores from Belgium. *Palaeontology*, **6**: 282-292.

DETTMANN, M. E. (1963). Upper Mesozoic microfloras from south-eastern Australia. *Proc. R. Soc. Vict.*, **77** (1): 1-148.

DUTTA, S. K. & SAH, S. C. D. (1970). Palynostratigraphy of the Tertiary sedimentary formations of Assam. 5. Stratigraphy and palynology of South Shillong Plateau. *Palaeontographica*, **131B** (1-4): 1-62.

DYBOVA, S. & JACHOWICZ, A. (1957). Microspores of the Upper Silesian Coal Measures. *Wydaw. Geol.*,: 1-326.

EISENACK, A. (1963). Zür *Membranilarnasi* Frage. *Mh. Neu. Geol. Paläeont.*, **2**: 98-103.

ELSIK, W. C. (1966). New sporomorph genera from the Upper Cretaceous of Peru. *Pollen Spores*, **8**: 553-564.

ELSIK, W. C. (1968). Palynology of a Palaeocene Rockdale lignite, Milam county, Texas. 1. Morphology and taxonomy. *Pollen Spores*, **10** (2): 263-314.

ERDTMAN, G. (1943). *An Introduction to Pollen Analysis*. Waltham Mass, U.S.A.

ERDTMAN, G. (1947). Suggestions for the classification of fossil and recent pollen grains and spores. *Svensk. bot. Tidskr.*, **41** (1): 104-114.

ERDTMAN, G. (1952). *Pollen Morphology and Plant Taxonomy. Angiosperms*, pp. 1-539. Stockholm.

GERMERAAD, J. H., HOPPING, C. A. & MULLER, J. (1968). Palynology of Tertiary sediments from tropical areas. *Rev. Palaeobot. Palynol.*, **6** (3 & 4): 189-348.

GHOSH, A. K., JACOB, K. & LUKOSE, N. G. (1964). On the spores of Parkeriaceae and Schizaeaceae from India. *Bull. bot. Soc. Bengal*, **17** (1 & 2): 23-28.

GRANT, C. W. (1840). Memoir to illustrate a geological map of Cutch. *Trans. geol. Soc. Lond.*, Ser. 2, **5**: 289-326.

GUZMAN, A. E. G. (1967). A palynological study on the Upper Los Cuervos and Mirador formations (Lower and Middle Eocene; Tibu area, Colombia). *Akad. Proefs*: 1-68.

IBRAHIM, A. C. (1933). Sporenformen des Aegirhorizonts des Ruhr-Reviers. *Diss. Konard Triltsch, Wurzburg*,: 1-47.

IVERSEN, J. & TROELS-SMITH (1950). Pollenmorfologiske definitioner og typer Danmarks. *Geol. Unders.*, **4** (8).

JAIN, K. P. & GUPTA, R. C. (1970). Some fungal remains from the Tertiaries of Kerala coast. *Palaeobotanist*, **18** (2): 177-182.

JAIN, K. P., KAR, R. K. & SAH, S. C. D. (1973). A palynological assemblage from Barmer, Rajasthan. *Geophytology*, **3** (2): 150-165.

JEN, H. (1958). Spore-pollen complex and geological age of the red beds of Wenmingsze, Jucheng of Southern Hunan (in Chinese). *Acta palaeont. sin.*, **6** (2): 141-158.

KAR, R. K. & BOSE, M. N. (1976). Palaeozoic *Sporae dispersae* from Zaïre (Congo) XII. Assise á couches de houille from Greinerville region. *Annls Mus. r. Afr. cent. Ser* 8°. *Sci. geol.*, **77**: 21-133.

KAR, R. K. & SAH, S. C. D. (1970). Palynological investigation of the Gondwana outcrop from Vemavaram, with remarks on the age of the bed. *Palaeobotanist*, **18** (2): 103-117.

KAR, R. K. & SAXENA, R. K. (1976). Algal and fungal microfossils from Matanomadh Formation (Palaeocene), Kutch, India. *Palaeobotanist*, **23** (1): 1-15.

KAR, R. K., SINGH, R. Y. & SAH, S. C. D. (1972). On some algal and fungal remains from Tura Formation of Garo Hills, Assam. *Palaeobotanist*, **19** (2): 146-154.

KLUMPP, B. (1953). Beiträg zur kenntnis der Mikrofossilien des Mittleren und Oberen Eozän. *Palaeontographica*, **103** (A): 377-406.

KRISHNAN, M. S. (1943). *Geology of India and Burma*. Madras.

KRUTZSCH, W. (1959). Mikropaläontologische (sporenpaläontologische) Untersuchungen in der Braunkohle des Geiseltales. *Geologie*, **21-22**: 1-425.

LUBER, A. A. (1935). Les types petrographiques de charbons fossiles du Spitzbergen. *Chim. combust. solide*, **6**.

MANTELL, G. A. (1950). A pictorial Atlas of fossil remains consisting of coloured illustrations selected from Parkinson's "*Organic remains of a former world*", and Artis's "*Antediluvian phytology*." London. pp. 1-207.

MEDLICOTT, H. B. & BLANFORD, W. T. (1879). *A Manual of the Geology of India*. Calcutta.

MEYER, B. L. (1956). Mikrofloritsche Untersuchungen an jungtertiaren Braunkohlen im östlichen Bayern. *Geol. Bav.*, **25**: 100-128.

MEYER, B. L. (1958). Palynological investigations of some samples from Nahorkatiya, Assam. *Jl palaeont. Soc. India*, **5** (3): 156-157.

MULLER, J. (1968). Palynology of the Pedawan and Plateau sandstone formations (Cretaceous-Eocene) in Sarawak, Malaysia. *Micropaleontology*, **14**: 1-37.

MULLER, J. (1973). Pollen morphology of *Barringtonia calyptrocalyx* K. Sch. (Lecythidaceae). *Grana*, **13** (1): 29-44.

NAGAPPA, Y. (1951). The stratigraphical value of *Miscellanea* and *Pellatispira* in India, Pakistan and Burma. *Proc. Indian Acad. Sci.*, **33**: 41-48.

NAGY, E. (1962). New pollen species from the Lower Miocene of the Bakony mountain (Varpalota) of Hungary. *Acta bot.*, **8** (1-2): 153-163.

NAIR, P. K. K. & SHARMA, M. (1962). Pollen grains of Indian plants IV. Leguminosae (part 1). *Bull. natn. bot. Gdn, Lucknow*, **65**: 1-37.

NANDI, B. (1975). Palynostratigraphy of the Siwalik Group of Panjab. *Him. Geol.*, **5**: 411-424.

NAUMOVA, S. N. (1939). The spores and pollen of the coals of U.S.S.R. *Rec. 17th int. geol. Congr., Moscow*: 353-364.

NAYAR, B. K. (1967). A comparative study of the spore morphology of *Ceratopteris*, *Anemia*, and *Mohria*, and its bearing on the relationship of the Parkeriaceae. *J. Indian bot. Soc.*, **47** (1-2): 246-255.

NUTTALL, W. L. F. (1926). The zonal distribution and description of the larger foraminifera of the Middle and Lower Kirthar Series (Middle Eocene) of parts of western India. *Rec. geol. Surv. India*, **59**: 115-164.

PFLUG, H. (1953). Zur Entstehung und Entwicklung des angiospermiden pollens in der Erdgeschichte. *Palaeontographica*, **95B**: 60-71.

PIERCE, R. L. (1961). Lower Upper Cretaceous plant microfossils from Minnesota. *Bull. geol. Surv. Minn. Univ.*, **42**: 1-86.

PODDAR, M. C. (1959). Stratigraphic sequence in the vicinity of peninsula of Kutch, in Foraminifera from the Upper Jurassic deposits of Rajasthan (Jaisalmer) and Kutch, India by Subbotina, N. N., Dutta, A. K. & Srivastava, B. N. *Bull. geol. min. metall. Soc. India*, **23**: 1-48.

PODDAR, M. C. (1963). Geology and oil possibilities of the Tertiary rocks of western India. *Min. Res. Div.*, Ser., 18, **1**: 226-236.

POTONIÉ, H. (1893). Uber einige carbonfarne Pt. IV. *Jb. Kgl. preuss. Geol.*,: 1-11, 1892.

POTONIÉ, R. (1931). Zur Mikroskopie der Braunkohlen. I-Z. *Braunkohle*, **30**: 554-556.

POTONIÉ, R. (1934). Zur Mikrobotanik des eocänen Humodils des Geiseltals (in Zur Mikrobotanik der Kohlen und ihrer Verwandten). *Presuss. Geol. Land.*, **4**: 25-125.

POTONIÉ, R. (1951). Pollen-und sporenformen als Leitfossilien des Tertiärs. *Mikroskopie*, **6**: 272-283.

POTONIÉ, R. (1956). Synopsis der Gattungen der *Sporae dispersae* 1. Teil: Sporites. *Beih. Geol. Jb.*, **23**: 1-103.

POTONIÉ, R. (1960). Synopsis der Gattungen der *Sporae dispersae* III. Teil: Nachträge Sporites, Fortsetzung Pollenites mit generalregister zu Teil I-III. *Beih. Geol. Jb.*, **39**: 1-189.

POTONIÉ, R. (1966). Synposis der Gattungen der *Sporae dispersae*. IV Teil: Nachträge zu allen Gruppen (Turmae). *Beih. Geol. Jb.*, **72**: 1-244.

POTONIÉ, R. & GELLETICH, J. (1933). Uber Pteridophyten-Sporen einer eözanen Braunkohle aus Dorog in Ungarn. *S.B. Gesch. naturf. Fr. Berl.*, **33**: 517-526.

POTONIÉ, R. & KREMP, G. (1954). Die Gattungen der palaeozoischen *Sporae dispersae* und ihre Stratigraphie. *Geol. Jb.*, **69**: 111-194.

POTONIÉ, R. & KREMP, G. (1955). Die *Sporae dispersae* des Rukrkarbons ihre Morphographie und Stratigraphie mit ausblicken auf arten anderer gebiete und zeitabschnitte. Teil. 1. *Palaeontographica*, **98B**: 1-136.

POTONIÉ, R., THOMSON, P. W. & THIERGART, F. (1950). Zur nomenklatur und klassifikation des neogenen sporomorphae (Pollen und Sporen). *Geol. Jb.*, **65**: 35-70.

RAMANUJAM, C. G. K. (1966). Palynology of the Miocene lignite from South Arcot District, Madras, India. *Pollen Spores*, **8** (1): 149-203.

SAH, S. C. D. (1967). Palynology of an Upper Neogene profile from Rusizi Valley (Burundi). *Annls Mus. r. Afr. cent.*, Ser. 8°, **57**: 1-173.

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.

SAH, S. C. D. & DUTTA, S. K. (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. (1969). Pteridophytic spores from the Laki Series of Kutch, Gujarat State, India. *J. Sen Mem. Vol.*, Bot. Soc. Bengal, Calcutta: 109-121.

SAH, S. C. D. & KAR, R. K. (1970). Palynology of the Laki sediments in Kutch. 3. Pollen from the bore-holes around Jhulrai, Baranda and Panandhro. *Palaeobotanist*, **18** (2): 127-142.

SAH, S. C. D. & KAR, R. K. (1974). Palynology of the Tertiary sediments of Palana, Rajasthan. *Palaeobotanist*, **2** (2): 163-188.

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

SALUJHA, S. K., KINDRA, G. S. & REHMAN, K. (1972). Palynology of the South Shillong front part-1. The Palaeogene of Garo Hills. *Proc. Sem. Palaeopalynol. Indian Stratigr.*,: 265-291.

SARJEANT, W. A. S. (1970). Recent developments in the application of fossilized planktonic organisms to problems of stratigraphy and palaeoecology. *Palaobotanik*, **43**: 669-682.

SCHOPF, J. M., WILSON, L. R. & BENTALL, R. (1944). An annotated synopsis of Palaeozoic fossil spores and the definition of generic groups. *Rep. Illinois St. geol. Surv.*, **91**: 1-66.

SEN GUPTA, B. K. (1964). Tertiary biostratigraphy of a part of north-western Kutch. *Jl geol. Soc. India.*, **5**: 138-158.

SOWERBY, J. C. (1840). Systematic list of organic remains. Appendix to Grant, C. W., Memoir to illustrate a geological map of Cutch. *Trans. geol. Soc. Lond.*, **5**: 327-329.

TAKAHASHI, K. (1964). Sporen und pollen der oberkretazeischen Hakobouchi-Schichtengruppe, Hokkaido. *Mem. Fac. Sci. Kyushu Univ.* Ser. D., *Geol.*, **14** (3): 159-271.

TEWARI, B. S. (1957). Geology and stratigraphy of the area between Waghopadar and Cheropadi, Kutch, western India. *Jl palaeont. Soc. India*, **2**: 136-148.

THIERGART, F. (1940). Die Mikropaläontologie als pollenanalyse im Dienst der Braunkohlenforschung. *Brenn. geol.*, **13**: 1-82.

THOMSON, P. W. & PFLUG, H. (1953). Pollen und sporen des Mitteleuropäischen Tertiärs. *Palaeontographica*, **94**: 1-138.

TRIVEDI, B. S. & VERMA, C. L. (1969). Fungal remains from Tertiary coal bed of Malaya. *J. Palynol.*, **5**: 68-73.

TSUKADA, M. (1963). Pollen morphology and identification 1. Eucaesalpinieae. *Pollen Spores*, **4** (2): 239-284.

VAN DER HAMMEN, T. (1954). El desarrollo de la Flora Colombiana en los periodos Geologicos 1. Maestrichtiano Hasta Terciario mas Inferior. *Boln geol., Bogotá*, **11** (1): 49-106.

VAN DER HAMMEN, T. (1955). Principios para la nomenclatura palinologica sistematica. *Inst. Geol. nac. Columbia, Bot. Geol.*, **2** (2): 12.

VAN DER HAMMEN, T. (1956). A palynological systematic nomenclature. *Boln geol., Bogotá*, **4** (2 & 3): 63-101.

VAN DER HAMMEN, T. (1957). Climatic periodicity and evolution of South American Maestrichtian and Tertiary floras. *Boln geol., Bogotá*, **5** (2): 49-91.

VAN HOEKEN-KLINKENBERG, P. M. J. (1966). Maestrichtian, Paleocene and Eocene pollen and spores from Nigeria. *Leid. geol. Meded.*, **38**: 37-48.

VARMA, C. P. & DANGWAL, A. K. (1964). Tertiary hystrichosphaerids from India. *Micropaleontology*, **10** (1): 63-71.

VARMA, C. P. & RAWAT, M. S. (1963). A note on some diporate grains recovered from Tertiary horizons of India and their potential marker value. *Grana Palynol.*, **4** (1): 130-139.

VENKATACHALA, B. S. (1967). Palynology of the Umia plant beds of Kutch, western India, 1. Stratigraphic palynology of the Bhuj exposures near Walkamata (Kutch District, Gujarat State). *Rev. Palaeobot. Palynol.*, **5**: 169-177.

VENKATACHALA, B. S. (1969). Palynology of the Umia plant beds of Kutch, W. India-2. Bhuj exposures near Walkamata, Kutch District, Gujarat State — Systematic palynology. *Palaeobotanist*, **17** (1): 1-8.

VENKATACHALA, B. S. (1970). Palynology of the Mesozoic sediments of Kutch, W. India-7. Reworked Permian pollen from the Upper Jurassic sediments — A discussion. *Palaeobotanist*, **18** (1): 45-49.

VENKATACHALA, B. S. & KAR, R. K. (1968). Fossil pollen comparable to pollen of *Barringtonia* from the Laki sediments of Kutch. *Pollen Spores*, **10** (2): 335-339.

VENKATACHALA, B. S. & KAR, R. K. (1969a). Palynology of the Tertiary sediments of Kutch-1. Spores and pollen from bore-hole no. 14. *Palaeobotanist*, **17** (2): 157-178,

VENKATACHALA, B. S. & KAR, R. K. (1969b). Palynology of the Tertiary sediments in Kutch-2. Epiphyllous fungal remains from the bore-hole no. 14. *Palaeobotanist*, **17** (2): 179-183.

VENKATACHALA, B. S. & KAR, R. K. (1972). Palynology of the Mesozoic sediments of Kutch, W. India-9. Palynological fossils from the Bhuj exposures near Dayapar, Kutch District, Gujarat State. *Proc. Sem. Palaeopalynol. Indian Stratigr., Calcutta, 1971*: 166-171.

VENKATACHALA, B. S. & RAWAT, M. S. (1973). Palynology of the Tertiary sediments in the Cauvery Basin — 2. Oligocene-Miocene palynoflora from the subsurface. *Palaeobotanist*, **20** (2): 238-263.

VREDENBURG, E. W. (1925). Descriptions of Mollusca from the post-Eocene Tertiary formation of north-western India: Cephalopoda, Opisthobranchiata, Siphonostomata. *Mem. geol. Surv. India*, **50** (1): 1-350.

VREDENBURG, E. W. (1928). Descriptions of Mollusca from the post-Eocene Tertiary formation of north-western India: Gastropoda (in part) and Lamelibranchiata. *Mem. Geol. Surv. India*, **50** (2): 351-506.

WADIA, D. N. (1953). *Geology of India*. London.

WILLIAMS, G. L. & DOWNIE, C. (1966). Further dinoflagellate cysts from the London clay, in Mesozoic and Cainozoic dinoflagellate cysts by Davey, R. J., Downie, C., Sarjeant, W. A. S. & Williams, G. L. *Bull. Br. Mus. nat. Hist.* (*Geol.*), **3**: 1-248.

WYNNE, A. B. (1872). Memoir on the geology of Kutch, to accompany the map compiled by A. B. Wynne and F. Fedden, during the seasons of 1867-68 and 1869-69. *Mem. geol. Surv. India*, **9** (1-2): 1-289.

EXPLANATION OF PLATES

(*All the photomicrographs are enlarged .ca.* × 500).

PLATE 1

1. *Cyathidites* cf. *C. australis* Couper; Slide no. 5072/2.
2. *Cyathidites* cf. *C. minor* Couper; Slide no. 5073/1.
3. *Intrapunctisporis* sp.; Slide no. 5074/2.

4,5. *Punctatisporites sarangwaraensis* sp. nov.; Slide nos. 5075/2, 5075/6.

6. *Punctatisporites* sp.; Slide no. 5076/3.

7,8. *Toroisporis dulcis* sp. nov.; Slide nos. 5077/4, 5078/3.

9. *Biretisporites convexus* Sah & Kar; Slide no. 5079/2.

10,11. *Leptolepidites chandrae* sp. nov.; Slide nos. 5080/8, 5081/5.

12. *Leptolepidites* sp.; Slide no. 5080/7.

13a,13b. *Striatriletes susannae* van der Hammen; Slide no. 5082/6.

14,15. *Striatriletes* cf. *S. susannae* van der Hammen; Slide nos. 5083/3, 5084/2.

16,17. *Striatriletes* sp.; Slide nos. 5085/1, 5086/3.

PLATE 2

18,19. *Polypodiaceaesporites chatterjii* sp. nov.; Slide nos. 5079/1, 5080/9.

20,21. *Polypodiisporites constrictus* sp. nov.; Slide nos. 5087/4, 5088/8.

22. *Cheilanthoidspora monoleta* Sah & Kar; Slide no. 5089/2.

23. *Spore type* — 1; Slide no. 5090/5.

24,25. *Podocarpidites cognatus* sp. nov.; Slide nos. 5091/2, 5087/3.

26. *Proxapertites scabratus* Jain, Kar & Sah; Slide no. 5092/5.

27,28. *Couperipollis microreticulata* sp. nov.; Slide nos. 5093/1, 5094/11.

29. *Tricolpites* sp. 1; Slide no. 5095/3.

30. *Tricolpites* sp. 2; Slide no. 5096/6.

31,32. *Retitricolpites delicatus* sp. nov.; Slide nos. 5097/4, 5098/6.

33-37. *Trisyncolpites ramanujamii* gen. et sp. nov.; Slide nos. 5099/6, 5094/2, 5099/5, 5092/3, 5100/4.

38. *Araliaceoipollenites* sp.; Slide no. 5080/3.

39. *Retibrevitricolpites* sp.; Slide no. 5089/1.

40,41. *Paleosantalaceaepites minutus* Sah & Kar; Slide nos. 5123/5, 5101/2.

42. *Monoporopollenites* sp.; Slide no. 5102/3.

43. *Triporopollenites exactus* Salujha, Kindra & Rehman; Slide no. 5076/2.

44. *Triporopollenites* sp.; Slide no. 5104/5.

45. *Stephanoporopollenites* sp.; Slide no. 5080/4.

46-47. *Malvacearumpollis rudis* sp. nov.; Slide nos. 5094/4, 5098/1.

PLATE 3

48. *Notothyrites* sp.; Slide no. 5105/1.

49-52. *Kutchiathyrites eccentricus* gen. et sp. nov.; Slide nos. 5106/6, 5106/1, 5107/5, 5108/2.

53. *Pluricellaesporites planus* Trivedi & Verma; Slide no. 5106/7.

54,55. *Dyadosporonites constrictus* sp. nov.; Slide nos. 5109/2, 5110/3.

56. *Lacrimasporonites longus* sp. nov.; Slide no. 5111/1.

57. *Inapertisporites kedvesii* Elsik; Slide no. 5111/2.

58-62. *Aplanosporites robustus* sp. nov.; Slide nos. 5112/3, 5113/1, 5114/3, 5115/4, 5112/2.

PLATE 4

63a-65. *Polysphaeridium microtriainum* (Klumpp) comb. nov.; Slide nos. 5116/2, 5117/1, 5116/5.
66a,67. *Polysphaeridium cephalum* sp. nov.; Slide nos. 5118/1, 5119/2.
68. *Polysphaeridium* sp.; Slide no. 5100/2.
69. *Spiniferites ramosus* cf. var. *multibrevis* (Davey & Williams) Sarjeant; Slide no. 5086/8.
70,71. *Membranilarnacia delicata* sp. nov.; Slide nos. 5120/3, 5121/6.
72. *Membranilarnacia* sp.; Slide no. 5087/2.
73. *Homotryblium* sp.; Slide no. 5122/5.
74. ?Epitractal archaeopyle of *Homotryblium*; Slide no. 5075/1.
75. *Fromea pachyderma* sp. nov.; Slide no. 5077/3.

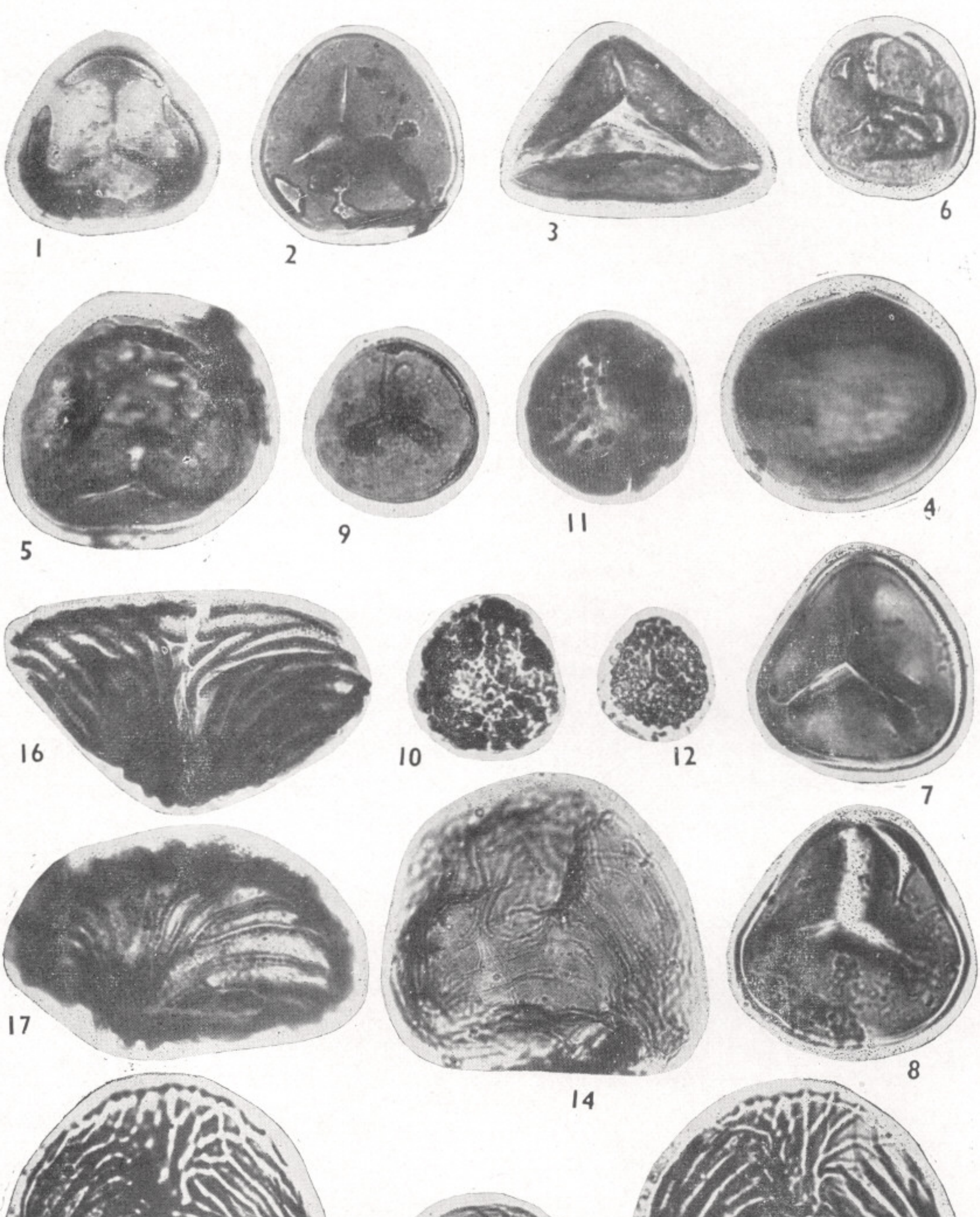


PLATE 1

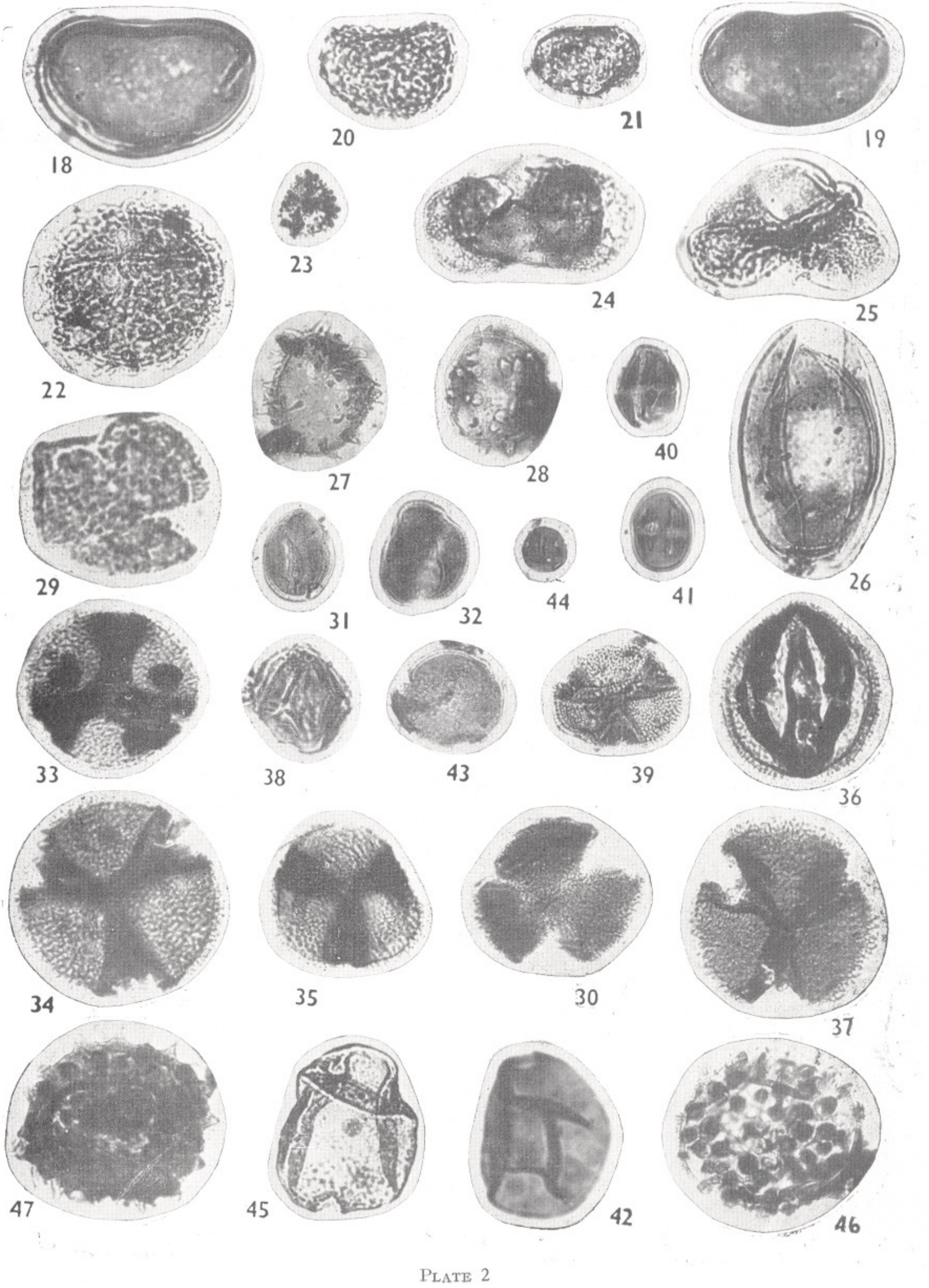

18
20
21
19
22
23
24
25
27
28
40
26
29
31
32
44
41
33
38
43
39
36
34
35
30
37
47
45
42
46

PLATE 2

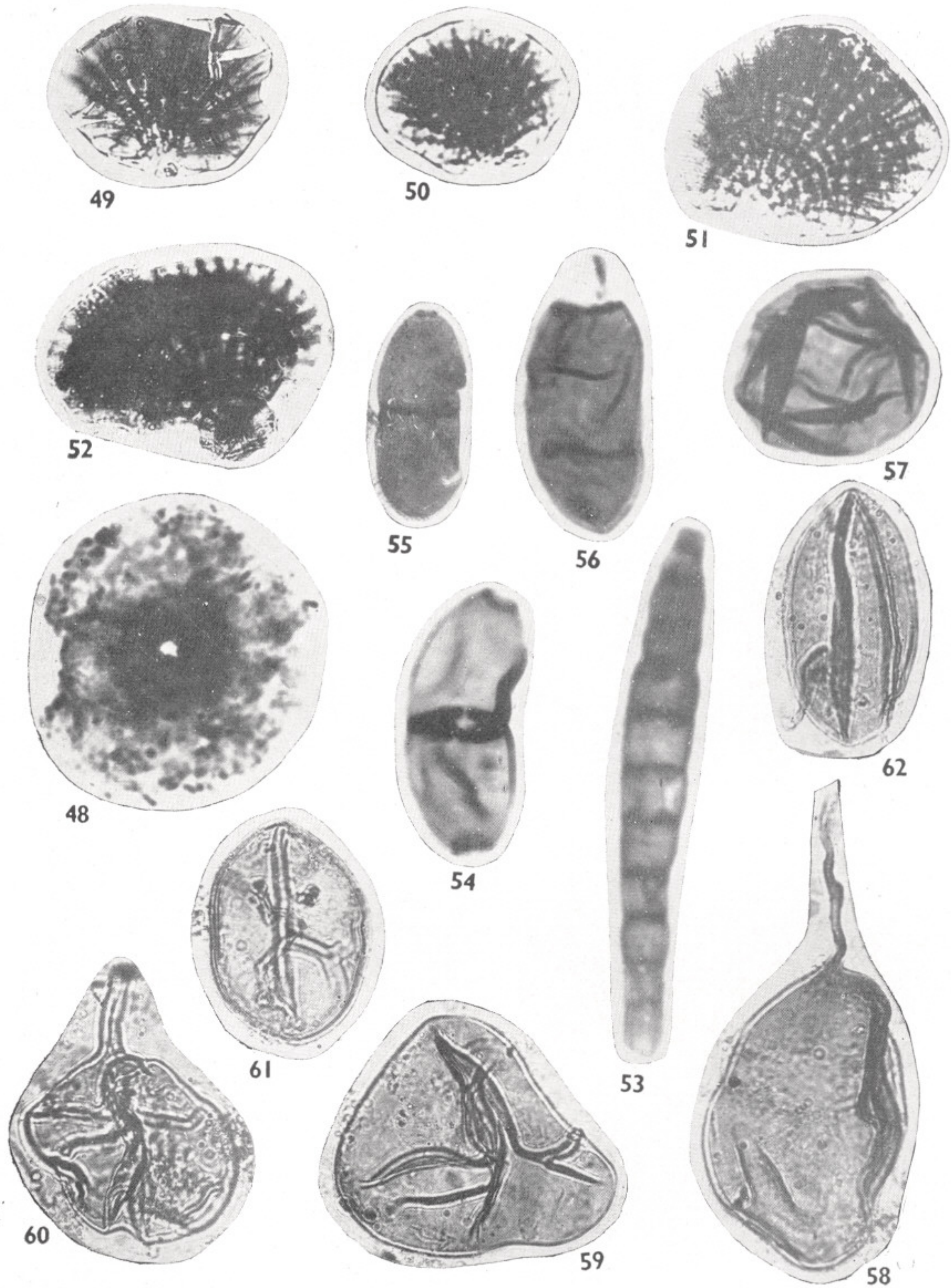


PLATE 3

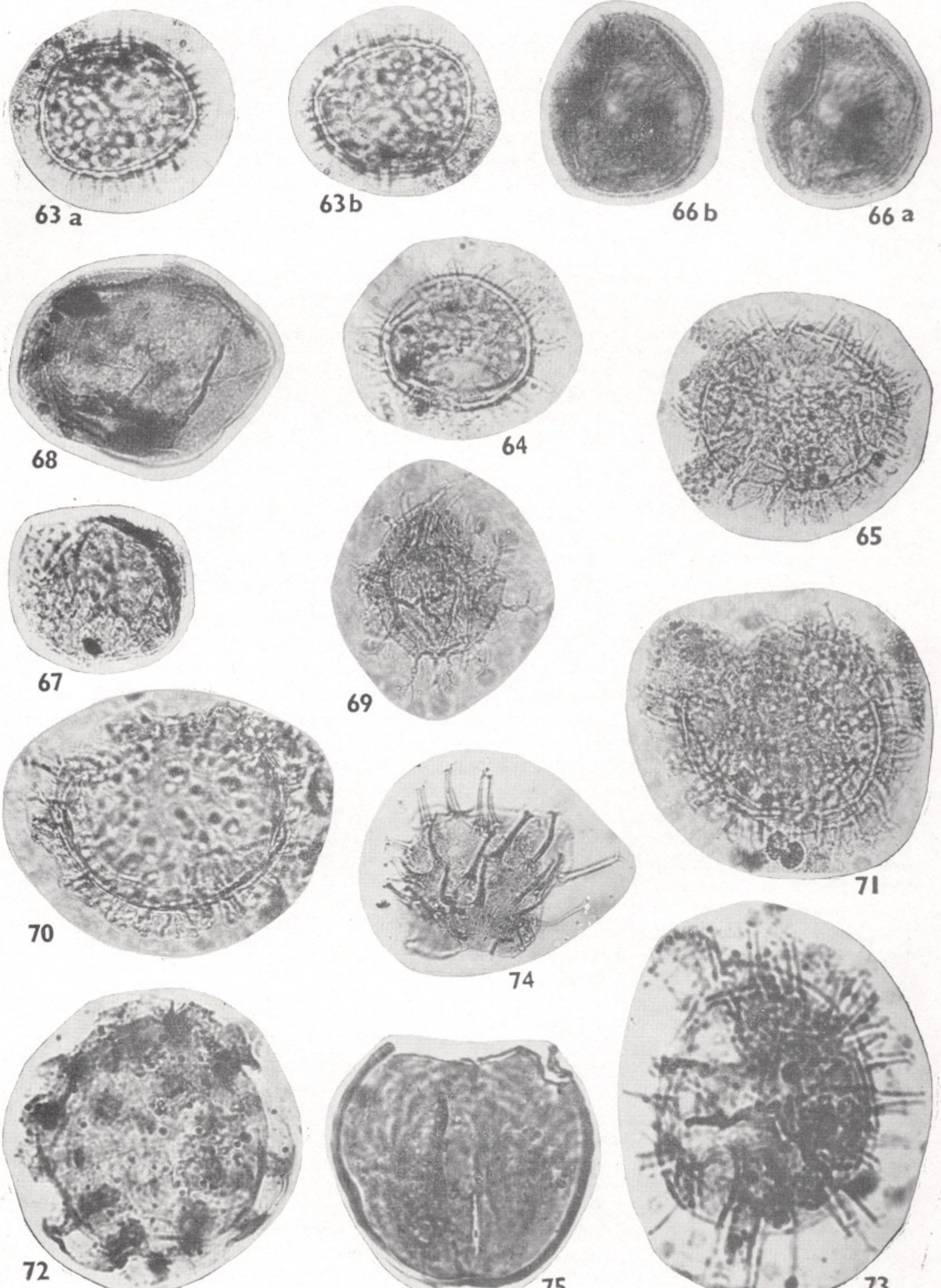


PLATE 4