PALYNOLOGICAL INVESTIGATION OF A BORE CORE NEAR RATARIA, SOUTHERN KUTCH, GUJARAT

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ABSTRACT

Palynological fossils recovered from the bore core no. 27 drilled near Rataria in the district of Kutch, Gujarat have been presented here. The assemblage comprises microplanktons, fungal spores and microthyriaceous bodies, pteridophytic spores and gymnospermous and angiospermous pollen. Of 60 dispersed genera and 66 species, nine genera and seven identifiable species belong to algae and microplanktons, seven genera and seven species to fungi, 17 genera and 20 species to pteridophytes, three genera and two species to gymnosperms and 24 genera and 30 species to angiosperms. The pteridophytic spores (48%) are dominant followed by angiospermous pollen (35%). The following seven species are mostly encountered in the percentage count: *Striatriletes susannae, S. multicostatus, Cheilanthoidspora enigmata, Polypodiaceaesporites strictus, Palmaepollenites kutchensis, Couperipollis kutchensis* and *Oligosphaeridium complex*. The samples studied from this bore core have been dated as early Eocene by the Directorate of Geology & Mining, Gujarat while others have assigned Miocene age to the adjacent sedimentary exposures. The palynological assemblage has been compared with the known Lower Eocene, Middle Eocene, Oligocene and Miocene assemblages of Kutch and it has been concluded that the age of the assemblage should be in between middle Eocene and late Eocene.

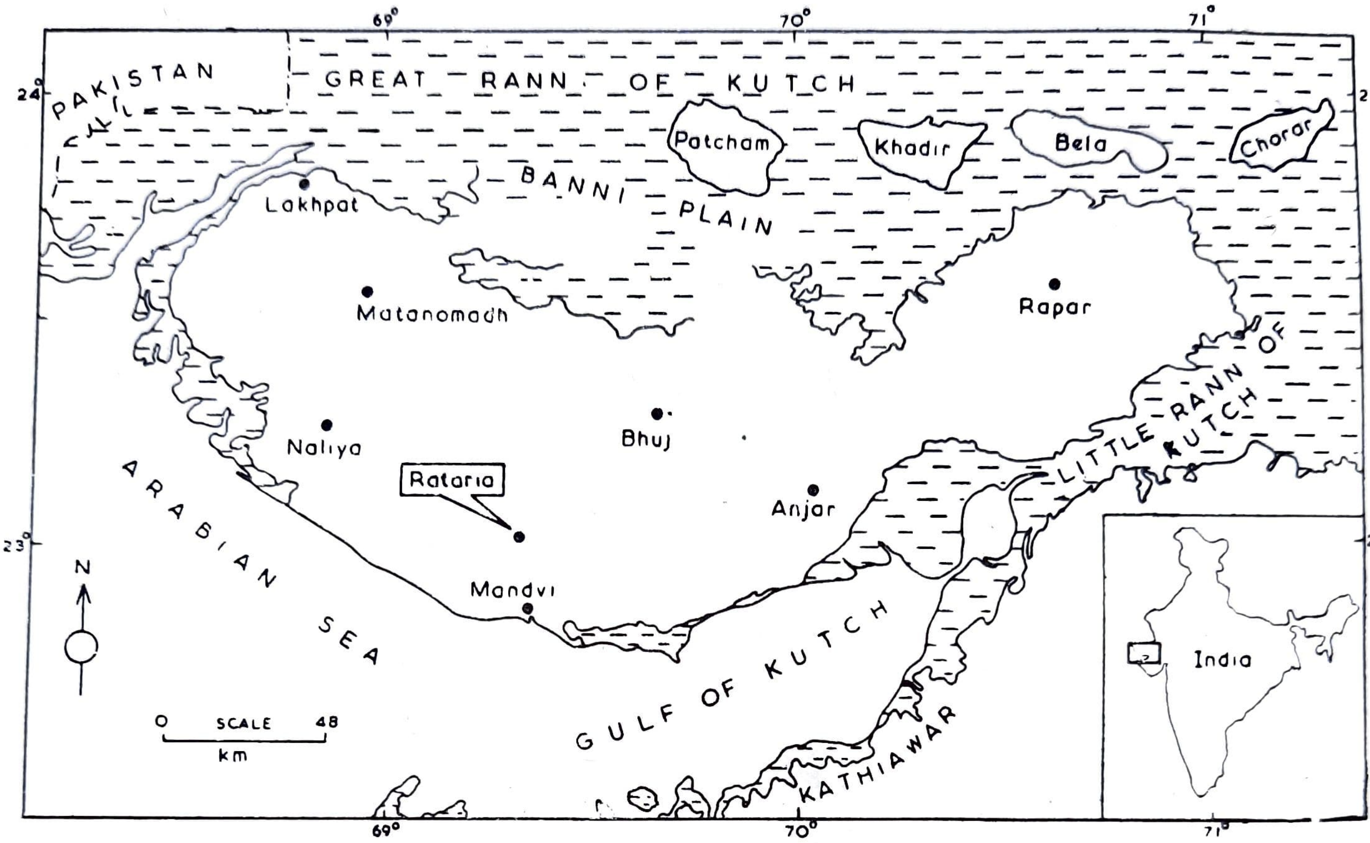
INTRODUCTION

Tertiary sediments occupy a large area of Kutch District of Gujarat, being well exposed in its southern and western parts. The earliest account on the geology of Kutch was published by BARNES (1834) which was followed by the publication of a geological map of Kutch by GRANT (1840). WYNNE (1872) made a detailed study of the geology of Kutch and published a map of this area; he divided the Tertiary succession into six units, viz. (i) Subnummulitic Group, (ii) Gypseous Shale, (iii) Nummulitic Group, (iv) Arenaceous Group, (v) Argillaceous Group and (vi) Upper Tertiary. BLANFORD (1878), NUTTAL (1926), VREDENBURG (1925), TEWARI (1952, 1957), NAGAPPA (1959), PODDAR (1959, 1963) and SEN GUPTA (1964) have also contributed to the Tertiary stratigraphy and palaeontology of Kutch.

BISWAS (1965) instituted a new chronostratigraphic classification for the Tertiary sediments of Kutch and divided them into Madh, Berwali (Kakdi and Babia stages), Lakhpat, Khari (Waior and Khari stages) and Kankawati Series. BISWAS AND DESHPANDE (1970) revised this classification by changing the name and age of some units. They also published geological and tectonic maps of Kutch. BISWAS AND RAJU (1971, 1973) proposed a new lithostratigraphic classification of the Tertiary sequence of Kutch on the basis of the lithological characteristics and mappability of the proposed units.

The palynological studies on the Tertiary of Kutch were started, rather late, when MATHUR (1963) described spores, pollen grains and microplanktons from the Gypseous shale (=Naredi Formation—Lower Eocene). This was followed by another paper by MATHUR (1966) which deals with the palynoflora from the Supratrappeans (=Matanomadh Formation—Palaeocene). Recently, the palynology of this formation has been published by KAR AND SAXENA (1976) and SAXENA (1978, 1979a, 1979b, 1980).

The palynofloral contributions to the Naredi Formation, beside that by MATHUR (1963), are by VENKATACHALA AND KAR (1968, 1969a, 1969b), SAH AND KAR (1969, 1970) and KAR (1978). The Harudi Formation (Middle Eocene) palynoflora has been published by KAR (1978). The Maniyara Fort Formation (Oligocene) has been worked out by CHANDRA AND CHATTERJEE (1973) and KAR (1977, 1979). The Sandhan Formation (Pliocene) has been palynologically investigated by MATHUR AND MATHUR (1969).



Map 1. Location of the bore hole no. 27.

The present paper deals with the palynofloral investigation of the sediments encountered in bore core no. 27 near Rataria (Lat. 23°01′ : Long. 69°19′) in southern Kutch drilled by the Directorate of Geology & Mining, Government of Gujarat (Map-1).

The geology of the area around Rataria (cf. Chota Ruttria) was briefly recorded by WYNNE (1872, pp. 282-283). He described the lithology of traps and overlying sediments exposed in this area without commenting on their age and stratigraphic position. He, however, remarked that the rocks succeeding the laterite (altered traps) are most heterogeneously assembled group of lenticularly and falsely bedded, coarse, white and conglomeratic sandstones with large grains of white quartz and pale, purple, unctuous mottled, aluminous layers and lenticular masses, quite similar in character to the usual volcanic ashy beds associated with the laterites. The Directorate of Geology & Mining assigned an early Eocene age to the bore core sequence. But in the geological map published by BISWAS AND DESHPANDE (1970) the rock exposed around Rataria was shown under Vinjhan Stage (=Vinjhan Shale : Burdigalian).

MATERIAL

The base of the bore core no. 27 is constituted by altered traps (3.06m) and lithomargic clay (4.58m), followed by about 11 metre thick shale comprising carbonaceous shale (3.12m), grey shale (3.59m), carbonaceous shale (4.50m) and a band (0.01m) of siderite. Eleven samples (sample nos. 1-11) were collected from these sediments. Of these, sample no. 1 (36.8m) proved barren while rest yielded palynological fossils. Sample no. 2 was collected at the depth of 36 m, rest of them at the interval of 1m each, from bottom to top. Overlying sediments constitute 24.5 metre thick bed of variegated clay succeeded by 1.2 metre thick soil cover (Fig. 1). The slides and negatives were deposited in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

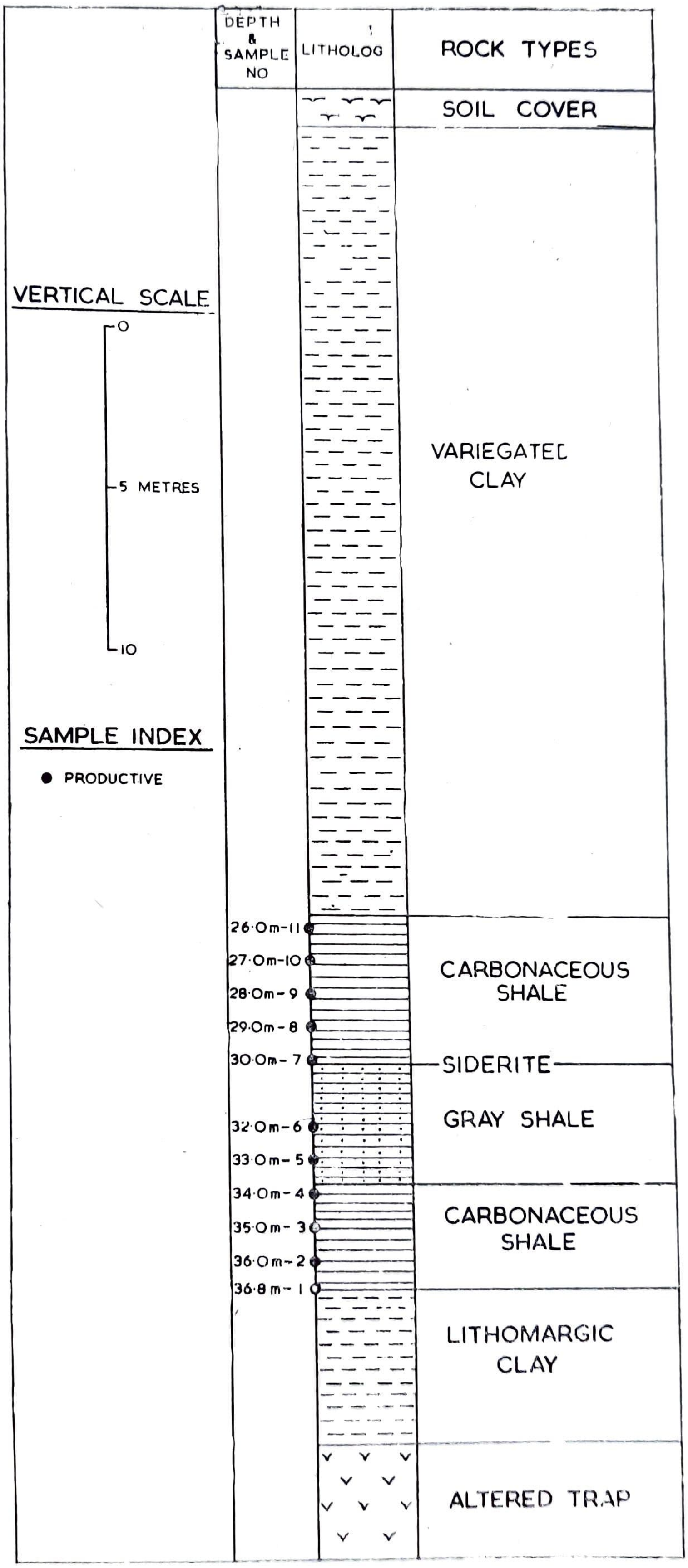


Fig. 1. Lithology of the core in bore hole no. 27 and the position of the samples studied.

PALYNOFLORA

The following spore-pollen species are present in the assemblage :

**Cyathidites australis* Couper, 1953 (Pl. 1, Fig. 1), *Biretisporites convexus* Sah & Kar, 1969 (Pl. 1, Fig. 2), **Todisporites kutchensis* Sah & Kar, 1969 (Pl. 1, Fig. 3), *Intrapunctisporis apunctis* Krutzsch, 1959 (Pl. 1, Fig. 4), **Intrapunctisporis* sp., *Stereisporites assamensis* Dutta & Sah, 1970 (Pl. 1, Fig. 11), *Lygodiumsporites lakiensis* Sah & Kar, 1969 (Pl. 1, Fig. 6), *Dandotiaspora plicata* (Sah & Kar) Sah, Kar & Singh, 1971, **Dandotiaspora verrucata* sp. nov., *cf. *Osmundacidites* sp., **Lophotriletes tertiarus* sp. nov., **Foveosporites splendus* sp. nov., **Foveosporites* sp., *Striatriletes susannae* van der Hammen emend. Kar, 1979, (Pl. 1, Fig. 14), **Striatriletes multicostatus* sp. nov., **Striatriletes microverrucosus* sp. nov., **Striatriletes* sp., *Cheilanthoidspora enigmata* Sah & Kar, 1974 (Pl. 2, Fig. 22), *Cheilanthoidspora monoleta* Sah & Kar, 1974 (Pl. 2, Fig. 23), *Tetrad type-1, *Laevigatosporites lakiensis* Sah & Kar, 1969 (Pl. 2, Fig. 25), **Biswasiaspora baculata* sp. nov., **Biswasiaspora pseudoreticulata* sp. nov., **Polypodiacaesporites strictus* sp. nov., **Polypodiisporites* sp., *Seniasporites verrucosus* Sah & Kar, 1969 (Pl. 2, Fig. 33), **Callialasporites trilobatus* (Balme) Dev, 1961 (Pl. 2, Fig. 34), **Parasaccites* sp., **Podocarpidites khasiensis* Dutta & Sah, 1970 (Pl. 2, Fig. 37), *Palmaepollenites kutchensis* Venkatachala & Kar, 1969a, *Palmaepollenites nadhamunii* Venkatachala & Kar, 1969a, **Liliacidites reticulatus* Sah & Kar, 1974 (Pl. 2, Fig. 36), **Palmidites naviculus* sp. nov., *Arecipites bellus* Sah & Kar, 1970 (Pl. 2, Fig. 40), **Arecipites intrapunctatus* sp. nov., **Arecipites* sp., *Couperipollis kutchensis* Venkatachala & Kar, 1969a (Pl. 3, Fig. 44), **Psiloschizosporis psilata* sp. nov., **Psiloschizosporis punctata* sp. nov., *Proxapertites microreticulatus* Jain, Kar & Sah, 1973 (Pl. 3, Fig. 50), **Assamialetes reticulatus* sp. nov., *Tricolpites reticulatus* Cookson, 1947 (Pl. 3, Fig. 55), *Tricolpites crassireticulatus* Dutta & Sah, 1970 (Pl. 3, Fig. 56), *Tricolpites retibaculatus* Saxena, 1979a, (Pl. 3, Fig. 63), **Retitrescolpites robustus* sp. nov., *Marginipollis kutchensis* (Venkatachala & Kar) Kar, 1979, **Trisyncolpites* sp., *Umbelliferoipollenites ovatus* Venkatachala & Kar, 1969a (Pl. 3 Fig. 47), *Cupuliferoipollenites ovatus* Venkatachala & Kar. 1969a (Pl. 3, Fig. 62), *Paleosantalaceaepites primitiva* Biswas, 1962 (Pl. 3, Fig. 57), *Symplocoipollenites kutchensis* Venkatachala & Kar, 1969a (Pl. 3, Fig. 61), *Araliaceoipollenites matanamadhensis* Venkatachala & Kar, 1969a (Pl. 3, Fig. 51), *Striacolporites ovatus* Sah & Kar, 1970 (Pl. 3, Fig. 64), *Striacolporites cephalus* Sah & Kar, 1970 (Pl. 3, Fig. 65), *Pellicieroipollis langenheimii* Sah & Kar, 1970 (Pl. 3, Fig. 66), *Lakiapollis ovatus* Venkatachala & Kar, 1969a (Pl. 4, Fig. 67), *Lakiapollis matanamadhensis* Venkatachala & Kar, 1969a (Pl. 4, Fig. 68), *cf. *Triorites bellus* Sah & Kar, 1970 (Pl 4, Fig. 69), **Myricipites vulgaris* Dutta & Sah, 1970 (Pl 4, Fig. 70), **Myricipites globatus* sp. nov., **Myricipites* sp., **Semitectotriporites ratariaensis* sp. nov., **Malvacearumpollis rudis* Kar, 1969 (Pl. 4, Fig. 76), *Phragmothyrites eocaenica* Edwards emend. Kar & Saxena, 1976, **Parmathyrites* sp., **Kutchiathyrites eccentricus* Kar, 1979, *Notothyrites amorphus* Kar & Saxena, 1976, *Inapertisporites kedvesii* Elsik, 1968, *Dyadosporonites constrictus* Kar, 1979, *Lacrimasporonites longus* Kar, 1979, **Tetraporina* sp., **Hystrichosphaeridium tubiferum* (Ehrenberg) Davey & Williams, 1966 (Pl. 4, Fig. 78), **Oligosphaeridium complex* (White) Davey & Williams, 1966 (Pl. 4, Fig. 79), *cf. *Perisselasphaeridium pannosum* Davey & Williams, 1966 (Pl. 4, Fig. 80), **Cordosphaeridium gracilis* Eisenack emend. Davey & Williams, 1966 (Pl. 4, Fig. 82), **Cleistosphaeridium heteracanthum* (Deflandre & Cookson) Davey, Downie, Sarjeant & Williams, 1966 (Pl. 4, Fig. 83), **Hystrichokolpoma eisenacki* Williams & Downie, 1966 (Pl. 4, Fig. 84), *Cryptosphaera valvata* Sah & Kar, 1974 (Pl. 4, Fig. 85), *Cornplanktona fracta* Sah & Kar, 1974.

The asterisk marks indicate that the species have either been described or commented upon here. Plate and figure numbers given in the above list in parenthesis denote the illustration of the present paper.

Cyathidites australis Couper, 1953
Pl. 1, Fig. 1

Remarks—The spores studied here are subtriangular with ±convex inter-apical margins while those described by DETTMANN (1963) from the Mesozoic sediments of south-eastern Australia have, on the contrary, concave inter-apical margins.

Todisporites kutchensis Sah & Kar, 1969
Pl. 1, Fig. 3

Remarks—Specimen assigned to this species is bigger (78×70 μm) than those described by SAH AND KAR (1969) from the Eocene sediments of Kutch. The trilete rays are, however, ill-developed, and do not extend more than half the radius ; exine is laevigate and irregularly folded.

Intrapunctisporis sp.
Pl. 1, Fig. 5

Description—Subcircular, 64×60 μm. Trilete rays distinct, extend up to three-fourths radius. Exine 1.5 μm thick, laevigate, intrapunctate.

Comparison—*Intrapunctisporis apunctis* Krutzsch (1959) is distinguished by its triangular shape.

Genus—**Dandotiaspora** Sah, Kar & Singh, 1971
Type species—*Dandotiaspora dilata* (Mathur) Sah, Kar & Singh, 1971

Dandotiaspora verrucata sp. nov.
Pl. 1, Figs. 7, 8

1978—*Dandotiaspora dilata* (Mathur) Sah, Kar & Singh, in Saxena pl. 1, fig. 11

Holotype—Pl. 1, Fig. 7 ; Size 67×60 μm ; Slide no. 6360/11.

Type Locality—Bore core no. 27, depth 36 m, Rataria, Kutch.

Diagnosis—Triangular-subtriangular, 55-70×50-64 μm. Trilete rays distinct, extending three-fourths of the radius to margin, associated with a protuberance on distal side. Exine verrucose, verrucae being sometimes fused.

Comparison—*Dandotiaspora dilata* (Mathur) Sah, Kar & Singh (1971) closely resembles the present species in shape, size and presence of protuberance at ray ends, but the latter is distinguished by its verrucose ornamentation. *D. dilata* has three warts at the ray ends while *D. verrucata* has many verrucae.

cf. **Osmundacidites** sp.
Pl. 1, Fig. 9.

Description—Subcircular, 98×77 μm. Trilete not discernible. Exine about 1.5 μm thick, grana up to 1 μm high, closely placed in middle.

Genus—**Lophotriletes** (Naumova) Potonié & Kremp, 1954
Type species—*Lophotriletes gibbosus* (Ibrahim) Potonié & Kremp, 1954

Lophotriletes tertiarus sp. nov.

Pl. 1, Figs. 16, 17

Holotype—Pl. 1, Fig. 16 ; Size 28×22 μm ; Slide no. 6370/5.

Type Locality—Bore core no. 27, depth 33 m, Rataria, Kutch.

Diagnosis—Spores triangular, 25-30×20-27 μm ; inter-apical margins concave. Trilete rays distinct, extending up to margin. Exine up to 2 μm thick, coni ±1 μm high, closely placed.

Comparison—*Lophotriletes rectus* Bharadwaj & Salujha (1964) described from Permian of India resembles present species in shape and size range but is distinguished by its bigger coni which are about 2 μm long and are sparsely placed. The trilete rays in this species also extend up to the margin.

Genus—**Foveosporites** Balme, 1957

Type species—*Foveosporites canalis* Balme, 1957

Foveosporites splendus sp. nov.

Pl. 1, Figs. 10, 12

Holotype—Pl. 1, Fig. 12 ; Size 77×71 μm ; Slide no. 6351/7.

Type Locality—Bore core no. 27, depth 27 m, Rataria, Kutch.

Diagnosis—Spores triangular—subtriangular, 60-80×50-75 μm. Trilete extending up to three-fourths radius. Exine 1-2 μm thick ; foveolae closely placed.

Comparison—*Foveosporites triangulus* Dutta & Sah (1970) is distinguished from the present species by its smaller size (35-48 μm) and the foveolae are comparatively more distinct. *F. pseudoreticulatus* Dutta & Sah (1970) comes near to the present species in subtriangular shape but is also easily separated by its smaller size range (35-43 μm) and proximal reticulation.

Foveosporites sp.

Pl. 1, Fig. 13

Description—Triangular, 46×43 μm. Trilete not traceable, exine about 2 μm thick ; foveolae closely placed.

Comparison—*Foveosporites triangulus* is bigger and possesses distinct trilete mark.

Genus—**Striatriletes** van der Hammen emend. Kar, 1979

Type species—*Striatriletes susannae* van der Hammen emend. Kar, 1979.

Striatriletes multicostatus sp. nov.

Pl. 1, Figs. 15, 18

Holotype—Pl. 1, Fig. 15 ; Size 78×70 μm ; Slide no. 6358/6.

Type Locality—Bore core no. 20, depth 35m, Rataria, Kutch.

Diagnosis—Spores triangular-subtriangular in polar view, 70-80×68-78 μm, anisopolar, distal side distinctly convex. Apices bluntly rounded, inter-apical margins straight to convex. Trilete rays distinct extending half of radius. Exine laevigate, costate, costae 6-9, arising at ray-ends extending on distal side.

Comparison—From *Striatriletes susannae* the present species is distinguished by its extension of trilete rays up to half of the radius and commencement of costae at ray-ends.

Striatriletes microverrucosus sp. nov.

Pl. 1, Figs. 19, 20

1979—*Striatriletes* sp. Kar, pl. 1, figs. 16-17

Holotype—Pl. 1, Fig. 20 ; Size 80×76 μm ; Slide no. 6352/11.

Type Locality—Bore core no. 27, depth 27m, Rataria, Kutch.

Diagnosis—Spores triangular-subtriangular, 68-82×54-79 μm. Trilete rays distinct-indistinct, extending up to two-thirds radius. Costate, microverrucose, 1-2 sets of costae generally present in inter-radial areas, others originating at ray-ends extending distally in three concentric rings.

Comparison—*S. microverrucosus* is distinguished from *Striatriletes susannae* by its microverrucose costae. *S. multicostatus* is also separated by its laevigate costae. *Striatriletes* cf. *S. susannae* van der Hammen emend. Kar (1979) has flattened, laevigate costae.

Striatriletes sp.

Pl. 2, Fig. 21

Description—Triangular, 52×50 μm, apices rounded, inter-apical margins ± straight. Trilete rays extending half of radius. Exine 1.5 μm thick, costate, costae narrow, arising at ray-ends extending distally in three concentric rings.

Comparison—The specimen is smaller than the species described here.

Tetrad type-1

Pl. 2, Fig. 24

Description—Tetrahedral tetrad, 80×78 μm, three spores present, individual spore up to 60 μm, laevigate.

Remarks—*Droseridites* Cookson (1947), a tetrahedral tetrad, is spinose. *Quadrisporites* (Hennelly) Potonié & Lele (1961) is also sculptured.

Genus—**Biswasiaspora** gen. nov.

Type species—*Biswasiaspora baculata* sp. nov.

Generic Diagnosis—Spores oval-subcircular. Distinct monolete mark absent, but spores generally splitting open along longitudinal axis. Exine baculate, bacula closely or sparsely placed. Incipient inner body may be present.

Generic Description—Spores mostly oval, occasionally a few subcircular spores found, size 60-85×50-60 μm. Well marked haptotypic mark not observed, but exine generally folding longitudinally simulating monolete mark. Sometimes exine also folded to provide a pseudotrilete mark and minutely folded to look wrinkled. Exine thin, not more than 2 μm in most of the specimens. Bacula 2-10 μm long, 1-7 μm broad, mostly juxtaposed, rare on equatorial margin ; tip of bacula straight or slightly lacerated ; a few pila may also be interspersed. In some specimens bacula 2-4 μm high, while in others 6-10 μm. Exine in some specimens (Pl. 2, Figs. 27, 28) splitting open partially in middle region providing an appearance of a colpus.

Comparison—*Polypodiaceaesporites* Thiergart (1938) is characterized by a distinct monolete mark, bean-shaped outline and generally laevigate exine. *Monolites* (Erdtman) Potonié (1956), *Laevigatosporites* Ibrahim (1933) and *Luenites* Bose & Kar (1967) are distinguished from *Biswasiaspora* proposed here by their unsculptured exine. *Polypodiisporites* Potonié (1934) is bean-shaped and verrucose. *Verrucatosporites* Pflug (1952) is also profusely verrucose. *Crassimonoletes* Singh, Srivastava & Roy (1964) is differentiated by its laevigate exine and well-developed, wavy monolete mark. *Foveomonoletes* (van der Hammen) Mathur (1966) is foveclate and the monolete mark is also discernible in most of the specimens. *Verrucososporites* (Knox) Potonié (1970) and *Tuberculatosporites* Imgrund (1952) are verrucose and spinose, respectively. *Biswasiaspora* instituted here is distinguished from all the comparable genera by its oval-subcircular shape and baculate sculptural elements.

Derivation of name—After Dr. S. K. Biswas, Oil & Natural Gas Commission, Dehra Dun, for his outstanding work on the geology of Kutch.

Biswasiaspora baculata sp. nov.

Pl. 2, Figs. 26, 27

Holotype—Pl. 2, Fig. 27 ; Size 78×64 μm ; Slide no. 6363/12.

Type Locality—Bore core no. 27, depth 34 m, Rataria, Kutch.

Diagnosis—Spores oval, 60-84×52-60 μm. Haptotypic mark not discernible but spores generally split open along the longitudinal axis to look like a colpus. Exine up to 2 μm thick, baculate ; bacula 6-10 μm long and 3-7 μm broad, closely placed. Incipient inner body may be present in some spores.

Biswasiaspora pseudoreticulata sp. nov.

Pl. 2, Figs. 28, 29

Holotype—Pl. 2, Fig. 28 ; Size 77×60 μm ; Slide no. 6363/12.

Type Locality—Bore core no. 27, depth 34 m, Rataria, Kutch.

Diagnosis—Spores oval, 60-72×52-60 μm. Distinct monolete absent ; spores sometimes splitting longitudinally. Exine sometimes wrinkled, up to 2 μm thick, baculate; bacula 2-4 μm high, closely placed providing pseudoreticulate appearance in surface view.

Comparison—In *B. baculata*, the bacula are 6-10 μm long whereas in *B. pseudoreticulata*, the bacula are only 2-4 μm long.

Genus—**Polypodiaceaesporites** Thiergart, 1938

Type species—*Polypodiaceaesporites haardti* Thiergart, 1938.

Polypodiaceaesporites strictus sp. nov.

Pl. 2, Figs. 30, 31

Holotype—Pl. 2, Fig. 30 ; Size 70×44 μm ; Slide no. 6366/14.

Type Locality—Bore core no. 27, depth 34 m, Rataria, Kutch.

Diagnosis—Spores oval, 55-70×40-51 μm. Monolete distinct-indistinct, extending up to three-fourths radius. Exine 1-2 μm thick, laevigate ; intrastructure appearing to be intrabaculate.

Comparison—*Polypodiaceaesporites tertiarus* Sah & Dutta (1966) is distinguished by its scabrate exine. *P. levis* Sah (1967) is bean-shaped and *P. chatterjii* Kar (1979) is devoid of any intrastructure.

Polypodiisporites sp.

Pl. 2, Fig. 32

Description—Spore bean-shaped, 59×38 μm, ends unequally broad. Monolete distinct, extending up to three-fourths along longitudinal axis. Verrucae 2-4 μm high, closely placed, giving false reticulate appearance on surface view.

Comparison—Polypodiisporites constrictus Kar (1979) from the Oligocene of Kutch resembles this specimen by its close sculptural elements, but the latter is bigger and is not constricted in middle. *P. repandus* Takahashi (1964) and *P. mawkmaensis* Dutta & Sah (1970) have robustly built, sparsely placed verrucae.

Callialasporites trilobatus (Balme) Dev, 1961

Pl. 2, Fig. 34

Remarks—Callialasporites—a typical Mesozoic genus, is found in abundance in the Mesozoic sediments of Kutch (SINGH, SRIVASTAVA & ROY, 1964 ; VENKATACHALA & KAR 1969c, 1969d, 1972 ; VENKATACHALA, KAR & RAZA 1969a, 1969b). In the material studied here, only a solitary specimen was obtained. It may be mentioned here that SAH AND KAR (1970) also reported this species from the Lower Eocene sediments around Jhulrai, Baranda and Panandhro in the district of Kutch. The pollen grain seems to be reworked as in the adjacent areas there are Mesozoic rocks. It is, however, surprising that only this genus is frequently encountered in the Lower Eocene sediments while the other characteristic Mesozoic genera are absent.

Parasaccites sp.

Pl. 2, Fig. 35

Remarks—Only a single specimen has been recovered. This is a reworked Permian pollen grain. Such monosaccate pollen grains have been earlier reported by VENKATACHALA AND KAR (1969e) and KAR (*pers. obs.*) from the other Tertiary horizons of India.

Podocarpidites khasiensis Dutta & Sah, 1970

Pl. 2, Fig. 37

Remarks—The species is represented by a single specimen in the assemblage. It is 78 ×60 μm and is smaller in size than those described by DUTTA AND SAH (1970) from the Cherra Sandstone of Assam. The diploxylonoid nature is marked and the central body is distinct.

Liliacidites reticulatus Sah & Kar, 1974

Pl. 2, Fig. 36

Remarks—The specimens studied here have more or less same size range and shape, but the mesh-size is more or less uniform.

The extant pollen grains of *Metroxylon salomonense* illustrated by THANIKAIMONI (1970, pl. 21, fig. 423) resemble this species in general organisation and shape but possess thicker exine and coarser reticulation.

Genus—**Palmidites** Chitaley ex Couper, 1953

Type species—Palmidites maximus Couper, 1953

Palmidites naviculus sp. nov.

Pl. 2, Figs. 38, 39

Holotype—Pl. 2, Fig. 38 ; Size 110×56 μm ; Slide no. 6358/11.

Type Locality—Bore core no. 27, depth 35 m, Rataria, Kutch.

Diagnosis—Pollen grains monocolpate, one end broader than other, 80-110× 40-56 μm, colpus well-developed, extending from end to end, broader at one side. Exine 1-2 μm, thick, laevigate.

Comparison—Palmidites plicatus Singh (in SAH & SINGH, 1974) described from the Tura Formation of Assam approximates the present species in size and psilate exine but has associated folds along the colpus.

Genus—**Arecipites** Wodehouse, 1933

Type species—Arecipites punctatus Wodehouse, 1933

Arecipites intrapunctatus sp. nov.

Pl. 3, Figs. 41, 42

Holotype—Pl. 3, Fig. 41 ; Size 70×47 μm ; Slide no. 6369/1.

Type Locality—Bore core no. 27, depth 34 m, Rataria, Kutch.

Diagnosis—Pollen grains oval, 62-75×40-51 μm. Monocolpate, colpus end to end, distinct-indistinct. Exine 1-2 μm thick, intrapunctate.

Comparison—Arecipites bellus Sah & Kar (1970) comes close to this species in shape and size range but the latter is separated by its intrapunctate ornamentation. *A. bellus* is punctate and the puncta are uniformly distributed.

Arecipites sp.

Pl. 3, Fig. 43

Description—Pollen grain monocolpate, 97×60 μm, colpus distinct, extends from one end to other. Exine about 2 μm thick, closely punctate.

Comparison—A. bellus Sah & Kar (1970) is much smaller in size (58-66×48-55 μm) than the present species. *A. intrapunctatus* has intrapunctate structure.

Genus—**Psiloschizosporis** Jain, 1968

Type species—Psiloschizosporis cacheutensis Jain, 1968

Psiloschizosporis psilata sp. nov.

Pl. 3, Figs. 45, 46

Holotype—Pl. 3, Fig. 46 ; Size 87×50 μm ; Slide no. 6369/6.

Type Locality—Bore core no. 27, depth 27 m, Rataria, Kutch.

Diagnosis—Pollen grains oval, 64-100×40-60 μm. Exine 1-2 μm thick, laevigate. Furrow distinct, often splits pollen grains in two equal halves.

Comparison—Psiloschizosporis cacheutensis Jain (1968) is similar to the present species in size range and laevigate exine ; however, the former is distinguished by its circular-subcircular shape. *P. psilata* proposed here is oval in shape.

Psiloschizosporis punctata sp. nov.

Pl. 3, Figs. 48, 49

Holotype—Pl. 3, Fig. 48 ; Size 104×48 μm ; Slide no. 6355/2.

Type Locality—Bore core no. 27, depth 26 m, Rataria, Kutch.

Diagnosis—Pollen grains oval-elliptical, 80-110×45-62 μm. Exine up to 2 μm thick, punctate, puncta closely or sparsely placed. Furrow distinct, pollen grains sometimes divide into two equal parts.

Comparison—Psiloschizosporis cacheutensis Jain (1968) is laevigate whereas the species proposed here has characteristic punctate ornamentation.

Genus—**Assamialetes** Singh, 1975

Type species—Assamialetes emendatus (Sah & Dutta) Singh, 1975

Assamialetes reticulatus sp. nov.

Pl. 3, Figs. 53, 54

Holotype—Pl. 3, Fig. 53 ; Size 48×46 μm ; Slide no. 6364/16.

Type Locality—Bore core no. 27, depth 34 m, Rataria, Kutch.

Diagnosis—Pollen grains subcircular, 40-52×36-50 μm, sometimes split equatorially in two halves, reticulate, meshes may be bigger in size in equatorial and smaller in middle region.

Comparison—*Assamialetes emendatus* (Sah & Dutta) Singh (1975) has bigger and uniform reticulation. In *A. dubius* (Sah & Dutta) Singh (1975), the reticulation is imperfect. The present species is distinguished from all the known species by its two types of meshes.

Genus—**Retitrescolpites** Sah, 1967

Type species—*Retitrescolpites typicus* Sah, 1967

Retitrescolpites robustus sp. nov.

Pl. 3, Figs. 59, 60

Holotype—Pl. 3, Fig. 60 ; Size 62×60 μm ; Slide no. 6364/17.

Type Locality—Bore core no. 27, depth 34 m, Rataria, Kutch.

Diagnosis—Pollen grains subcircular in equatorial view, 53-70×49-68 μm. Tricolpate, colpi narrow, funnel-shaped. Exine baculate-pilate ; sculptural elements robustly built, closely placed forming negative reticulum in surface view.

Comparison—*Retitrescolpites africanus* Sah (1967) is distinguished by circular shape; *R. minor* Dutta & Sah (1970) is smaller in size-range (22-28 μm) ; *R. assamicus* Dutta & Sah (1970) has not so strongly built sculptural elements.

Trisyncolpites sp.

Pl 3, Fig 52

Description—Pollen grain subcircular, 30×28 μm. Trisynmargocolpate ; colpi uniformly broad, joined together to provide the appearance of a triradiate ridge. Exine granulose-pilate.

Comparison—*Trisyncolpites ramanujamii* Kar (1979) is separated by its bigger size-range.

cf. **Triorites bellus** Sah & Kar, 1970

Pl. 4, Fig. 69

Remarks—Only one specimen could be recovered. Two ora are distinct, one seems to be abortive, but these are not placed in the apices as in *T. bellus* Sah & Kar (1970). The exine is granulose.

Genus—**Myricipites** Wodehouse, 1933

Type species—*Myricipites dubius* Wodehouse, 1933

Myricipites vulgaris Dutta & Sah, 1970

Pl. 4, Fig. 70

Remarks—The specimens are bigger in size (40-50 μm) than those described by Dutta and Sah (1970) from the Tertiary sediments of Assam. The pores are strongly built with thickened outer margin. The granulose ornamentation is discernible in some specimens.

Myricipites globatus sp. nov.
Pl. 4, Figs. 71, 72

Holotype—Pl. 4, Fig. 72 ; Size 74×68 μm ; Slide no. 6368/2.

Type Locality—Bore core no. 27, depth 34 m, Rataria, Kutch.

Diagnosis—Pollen grains subcircular, 64-78×56-70 μm. Triorate, margin thickened, interoral margin convex. Exine 1.5-2.5 μm thick, generally granulose, sometimes laevigate.

Comparison—*Myricipites vulgaris* Dutta & Sah (1970) compares with the present species in shape, nature of the ora and psilate exine, but is, smaller in size range (31-36 μm) than the present species.

Remarks—According to Praglowski (1962) the sculptural elements in *Myrica* arise from a suprategillar protrusion and thus they do not stand on crest-like supra-tegillar ridges as in Betulaceae, Casuarinaceae and Corylaceae.

Myricipites sp.
Pl. 4, Fig. 73

Description—Pollen grains triangular, 68-80×60-74 μm. Triorate, ora not protruded. Exine 1-1.5 μm thick, laevigate, irregularly folded.

Comparison—*Myricipits* sp. resembles *M. vulgaris* Dutta & Sah (1970) in size range and shape but the specimen described here has thinner exine and nonprotruding ora. *M. globatus* sp. nov. is subcircular in shape and possesses convex interoral margin.

Genus—**Semitectotriporites** Guzmán, 1967
Type species—*Semitectotriporites gratus* Guzmán, 1967

Semitectotriporites katariaensis sp. nov.
Pl. 4, Figs. 74, 75

Holotype—Pl. 4, Fig. 75 ; Size 60×58 μm ; Slide no. 6352/9.

Type Locality—Bore core no. 27, depth 27m, Rataria, Kutch.

Diagnosis—Pollen grains subcircular, 55-62×50-60 μm, triporate, pore margin thickened. Exine up to 2 μm thick, baculate, interbacular space granulose.

Comparison—*Semitectotriporites gratus* Guzmán (1967) compares well with the present species in shape, but is distinguished by its smaller size and semitectate nature which simulates 'a foveolate or verrucate sculpture. The present species has baculate-granulose ornamentation.

Malvacearumpollis rudis Kar, 1979
Pl. 4, Fig. 76

Remarks—This species is rarely found. The pollen grains are more or less of same size as previously described by Kar (1979) from the Oligocene sediments of Kutch. Panporate nature is discernible and the spines are strongly built with bulbous base and pointed tip.

Parmathyrites sp.
Pl. 4, Fig. 77

Description—Dimidiate ascostroma, with processes 50 μm, pseudoparenchymatous, cells in middle region dark, non-ostiolate. Marginal cells spinose, spines radiating.

Comparison—Parmathyrites robustus Jain & Kar (1979) described from the Neogene sediments of Kerala comes close to the present specimen in general organisation but the former is distinguished by its larger size range and pseudoparenchymatous cells in middle region.

Kutchiathyrites eccentricus Kar, 1979

Remarks—This species was originally described by Kar (1979) from the Oligocene sediments of Kutch. Jain and Kar (1979) reported the same species from the Miocene of Kerala. In Eocene, this species is rare but is bigger in size (90 × 87 μm) than the latter two species.

INCERTAE SEDIS

Tetraporina sp.

Pl. 4, Fig. 81

Description—Spore folded, 44 μm. Tetraporate, pore distinct, exine laevigate.

Remarks—Only one specimen could be recovered. Naumova (1950) first described this genus from the Carboniferous of USSR and since then it has been reported in different geological horizons.

MICROPLANKTON

Hystrichosphaeridium tubiferum (Ehrenberg) Davey & Williams, 1966

Pl. 4, Fig. 78

Description—Body subcircular, 41 × 38 μm, composed of two layers, the periphragm bearing the processes ; processes tubiform, more or less of equal length with serrated tips, more than twenty ; reflected tabulation not very clear ; apical archaeopyle not discernible.

Oligosphaeridium complex (White) Davey & Williams, 1966

Pl. 4, Fig. 79

Description—Central body subcircular-circular, 30-40 μm. Wall two-layered, inner endophragm and outer periphragm which bears processes. Processes hollow, cylindrical, branched at tips, 20-30 μm long, more or less of same length ; cingular processes absent ; number of processes not more than 18 in intact specimens.

cf. **Perisselasphaeridium pannosum** Davey & Williams, 1966

Pl. 4, Fig. 80

Remarks—Only a single specimen could be recovered. The central body is subcircular, 50 × 48 μm, made up of two layers ; the inner endophragm and the outer periphragm, the latter bears the processes. The processes are of two kinds—one is broad open and tubular and the other is slender, closed processes. The reflected tabulation is not distinct and the apical archaeopyle not detectable.

Cordosphaeridium gracilis Eisenack emend. Davey & Williams, 1966

Pl. 4, Fig. 82

Description—Central body subcircular, 54 × 45 μm, two layered, the outer layer bearing processes ; processes few, more or less of same size, cylindrical, hollow, branching at tips with characteristic Y-shaped pattern. Archaeopyle apical, made up of one plate; partially ruptured plate seen in the figured specimen.

Remarks—According to DAVEY AND WILLIAMS (1966), the specimens assignable to this species from the London Clay have the size range of the central body 50-71 μm. The specimen figured here is 54 μm in size.

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

Pl. 4, Fig. 83

Remarks—The central body is subcircular, folded, 50 μm. The periphragm bears many, slender, small processes of various shapes. Besides, one large, broadly rectangular process is also clearly visible. DAVEY *et al.* (1966) think that this big process is apical in position and the archaeopyle, when developed, is also apical in position. By the nature of the processes, it seems that there are more than one process per plate.

Hystrichokolpoma eisenacki Williams & Downie, 1966

Pl. 4, Fig. 84

Description—Central body not clearly distinguishable due to robustly built processes. Periphragm thin bearing two kinds of processes—the larger ones with very broad bases and slightly tapering ends and the other slender and small. Antapical process slightly bigger than the rest.

DISCUSSION

The palynological fossils reported here belong to algal cysts and other bodies, fungal spores, hyphae and microthyriaceous ascostromata, pteridophytic spores, gymnospermous and angiospermous pollen grains. In total, 60 dispersed genera comprising 66 species have been recovered. Of them nine genera and seven species belong to algae and seven genera and seven species to fungi. Pteridophytes are represented by 17 genera and 20 species, of which 12 genera and 15 species are of triletes and five genera and five species are of monoletes. Only three genera and two identifiable species of gymnosperms could be recognized. Out of them two genera, viz. *Callialasporites* and *Parasaccites* are supposed to be reworked. Twenty-four genera and 30 species of angiospermic pollen are found in the assemblage. This is the highest generic representation amongst all the groups present in the assemblage.

Of the yielding samples, sample nos. 2, 3, 4, 5 and 10 are rich in palynological fossils, and were counted to find out the percentage of different species. The other samples, i.e. nos. 6, 7, 8, 9 and 11, are poor and hence not counted. The following 41 species have been found in the percentage count ; *Cyathidites australis*, *Biretisporites convexus*, *Todisporites kutchensis*, *Intrapunctisporis apunctis*, *Stereisporites assamensis*, *Lygodiumsporites lakiensis*, *Dandotiaspora plicata*, *Striatriletes susannae*, *S. multicostatus*, *Cheilanthoidspora enigmata*, *S. monoleta*, *Laevigatosporites lakiensis*, *Biswasiaspora baculata*, *Polypodiaceaesporites strictus*, *Seniasporites verrucosus*, *Palmaepollenites kutchensis*, *P. nadhamunii*, *Liliacidites reticulatus*, *Palmidites naviculus*, *Arecipites intrapunctatus*, *Couperipollis kutchensis*, *Proxapertites microreticulatus*, *Tricolpites reticulatus*, *T. crassireticulatus*, *Cupuliferoipollenites ovatus*, *Araliaceoipollenites matanamadhensis*, *Pellicieroipollis langenheimii* , *Lakiapollis ovatus*, *L. matanamadhensis*, *Myricipites vulgaris*, *M. globatus*, *Malvacearumpollis rudis*, *Phragmothyrites eocaenica*, *Notothyrites setiferus*, *Inapertisporites kedvesii*, *Dyadosporonites constrictus*, *Lacrimasporonites longus*, *Hystrichosphaeridium* *tubiferum*, *Oligosphaeridium complex*, *Cleistosphaeridium heteracanthum* and *Cryptosphaera valvata* (Table 1).

Table 1. Showing the percentage of the species in samples studied.

Name of the species	Samp. no. 2	Samp. no. 3	Samp. no. 4	Samp. no. 5	Samp. no. 6 (few spores)	Samp. no. 7 (few spores)	Samp. no. 8 (few spores)	Samp. no. 9 (few spores)	Samp. no. 10	Samp. no. 11 (few spores)	Average
Cyathidites australis	3			1							1
Biretisporites convexus				2							0.5
Todisporites kutchensis	2			4					5		2
Intrapunctisporis apunctis	1			1							0.5
Stereisporites assamensis	1			2							0.5
Lygodiumsporites lakiensis	8	2		4					2		3
Dandotiaspora plicata	5	1	1	3							2
Striatriletes susannae		18							40		12
Striatriletes multicostatus									33		7
Cheilanthoidspora enigmata	6	1	41	3							10
Cheilanthoidspora monoleta			4								1
Laevigatosporites lakiensis	2			3							1
Biswasiaspora baculata			1								+
Polypodiaceaesporites strictus	12	1	1	11							5
Seniasporites verrucosus	2										0.5
Palmaepollenites kutchensis	3			21							5
Palmaepollenites nadhamunii	1			3							1
Liliacidites reticulatus	3										0.5
Palmidites naviculus		4	1						2		1
Arecipites intrapunctatus									1		+
Couperipollis kutchensis	8	2	28	9							9.5
Proxapertites microreticulatus	3		3	8							3
Tricolpites reticulatus	12	1		7							4
Tricolpites crassireticulatus									15		3
Cupuliferoipollenites ovatus	1										+
Pellicieroipollis langenheimii				1							+
Lakiapollis ovatus	2	6		8							3
Lakiapollis matanamadhensis	3		1	1							1
Myricipites vulgaris	1		2	1							1
Myricipites globatus	1		1	3							1
Malvacearumpollis rudis		1									+
Notothyrites setiferus	1										+
Inapertisporites kedvesii	15	2	16								7

Table 1—(*Contd.*)

Dyadosporonites constrictus		1			+
Lacrimasporonites longus		1			+
Hystrichosphaeridium tubiferum		11			2
Oligosphaeridium complex		45			9
Cleistosphaeridium heteracanthum		2	3	1	1
Cryptosphaera valvata	2				0.5

Of the 41 species which appeared in the percentage count, none of them is consistently represented in all the samples. In sample no. 2, *Lygodiumsporites lakiensis* (8%), *Cheilanthoidspora enigmata* (6%), *Polypodiaceaesporites strictus* (12%), *Couperipollis kutchensis* (8%), *Tricolpites reticulatus* (12%) and *Inapertisporites kedvesii* (15%) are found as major taxa. But in sample no. 3, *Striatriletes susannae* (18%), *Lakiapollis ovatus* (6%), *Hystrichosphaeridium tubiferum* (11%) and *Oligosphaeridium complex* (45%) are the dominant species. *Cheilanthoidspora enigmata* (41%), *Couperipollis kutchensis* (28%) and *Inapertisporites kedvesii* (16%) are mostly found in sample no. 4. In sample no. 5, *Polypodiaceaesporites strictus* (11%), *Palmaepollenites kutchensis* (21%), *Couperipollis kutchensis* (9%), *Proxapertites microreticulatus* (8%), *Tricolpites reticulatus* (7%) and *Lakiapollis ovatus* (8%) are commonly met with. The sample no. 10 is rich in *Striatriletes susannae* (40%), *S. multicostatus* (33%) and *Tricolpites crassireticulatus* (15%). However, taking the average of all the samples the following seven species are found in good percentage. *Striatriletes susannae* (12%), *S. multicostatus* (7%), *Cheilanthoidspora enigmata* (10%), *Polypodiaceaesporites strictus* (5%), *Palmaepollenites kutchensis* (5%), *Couperipollis kutchensis* (9.5%) and *Oligosphaeridium complex* (9%).

The pteridophytic spores are the dominant elements in the assemblage as they contribute 48 per cent to the assemblage. Of them, triletes (41%) are more common than monoletes (7%). Angiospermous pollen grains come second (35%) in spite of the fact that they have better generic and specific representation. The fungal elements are rare (4%) but the microplanktons (13%) are common.

Comparison with other Tertiary assemblages in Kutch

Naredi Formation—The Naredi Formation is represented by *Triorites triangulus* Cenozone with the characteristic species of *Cupuliferoipollenites ovatus*, *Lakiapollis ovatus*, *Cyathidites minor*, *Tricolpites reticulatus*, *T. levis*, *T. brevis*, *Rhoipites kutchensis*, *Symplocoipollenites constrictus*, *Meliapollis ramanujamii* and *Pseudonothofagidites kutchensis*.

The following species are common in both the assemblages : *Dandotiaspora plicata*, *Palmaepollenites kutchensis*, *Proxapertites microreticulatus*, *Tricolpites reticulatus*, *Araliaceoipollenites matanamadhensis*, *Cupuliferoipollenites ovatus* and *Lakiapollis ovatus*.

The present assemblage differs considerably from the Naredi Formation by its dominance of pteridophytic spores. The genus *Striatriletes* which is found in significant percentage is conspicuous by its absence in the Naredi Formation. Moreover, *Triorites triangulus* which is most common in Naredi Formation is not at all found in the Rataria bore core. Besides, the present material has also good percentage of microplankton.

Harudi Formation—This formation in Kutch has been dated as Middle Eocene (Lutetian) on the basis of *Nummulites* by Biswas and Raju (1971, 1973) and planktonic foraminifera by MOHAN AND SOODAN (1970). The miospore assemblage worked out by KAR (1979) is dominated by *Proxapertites microreticulatus* together with *Palmaepollenites kutchensis*, *P. ovatus*, *Cyathidites minor*, *Couperipollis kutchensis*, *Scantigranulites sparsus*, *Seniasporites verrucosus*, *Laevigatosporites cognatus* and *Tricolpites levis*.

The assemblage recovered from the present bore core has very insignificant percentage of *Proxapertites microreticulatus*. In fact, except *Palmaepollenites kutchensis* and *Couperipollis kutchensis* the other important taxa of both the assemblages are not common to each other. *Striatriletes* which is abundant in the present bore core is totally absent in the Harudi Formation.

Maniyara Fort Formation—This formation has been dated as Oligocene by BISWAS (1965), BISWAS AND DESHPANDE (1970) and BISWAS AND RAJU (1971). KAR (1977, 1979) recorded *Polysphaeridium microtriainum* Cenozone, *Trisyncolpites ramanujamii* Cenozone and *Aplanosporites robustus* Cenozone from this formation.

In sample no. 3 of the present bore core microplanktons are dominant and mostly represented by *Oligosphaeridium complex* and *Hystrichosphaeridium tubiferum*. It may be mentioned here that the small spiny varieties which are abundant in the Maniyara Fort Formation are rare in the present assemblage. On the contrary, dinoflagellate cysts with open, tubular processes are found in abundance. *Trisyncolpites ramanujamii* is also not found in the present assemblage and only one pollen grain, assignable to this genus, has been described as *Trisyncolpites* sp. The next dominant element of the Maniyara Fort Formation, viz. *Aplanosporites robustus*, is also absent in this assemblage. However, *Striatriletes susannae*, the parkeriaceous spore, is found as one of the dominant elements in both the assemblages. Besides, *Inapertisporites kedvesii*, *Phargmothyrites eocaenica*, *Kutchiathyrites eccentricus*, *Laevigatosporites lakiensis*, *Dyadosporonites constrictus* and *Lacrimasporonites longus* are also found as common species in the two assemblages.

Khari Nadi Formation—BISWAS AND RAJU (1971) assigned Aquitanian age for this formation on the basis of fauna. No published palynological information is available. However, work done by KAR (unpublished data) shows that this formation is characterized by the dominance of pteridophytic spores, gymnospermous pollen grains and microplanktons. The pteridophytic spores are mostly represented by *Striatriletes*, *Cyathidites* and *Lycopodiumsporites*. The gymnospermous pollen have been provisionally identified as *Podocarpidites* and *Tsugaepollenites*. Amongst angiosperms, *Malvacearumpollis* is common. The microplanktons are represented by dinoflagellate cysts and the small spiny types are prolifically represented than the cysts with open, tubular processes.

The present assemblage resembles that of the Khari Nadi by its representation of *Striatriletes*, but the rarity of gymnospermous pollen distinguishes the Rataria assemblage from the previous one. In addition, the microplanktons of the two assemblages are also distinct from one another.

AGE OF THE PRESENT ASSEMBLAGE

The Directorate of Geology and Mining has assigned early Eocene age to the bore core because the carbonaceous shale rests on the lithomargic clay and laterites. BISWAS AND DESHPANDE (1970), however, thought that in the neighbourhood there is no Eocene exposure and marked the local exposures as Vinjhan Shale, dating them Burdigalian in age.

The Lower Eocene rocks represented by Naredi Formation have been thoroughly worked out and it has already been pointed out that the present assemblage differs considerably from the former. The palynological assemblage from Harudi Formation (middle Eocene) is also quite distinct. The Maniyara Fort Formation (Oligocene) resembles the present assemblage by the presence of *Striatriletes*. It may be mentioned here that the genus *Striatriletes*, according to the present state of knowledge, does not appear in India before Upper Eocene (Kopili Formation) and finds its maximum development during Oligocene and Miocene.

On the basis of *Striatriletes*, the assemblage may be put anywhere between Upper Eocene to Miocene. But the presence of *Cheilanthoidspora enigmata* and *C. monoleta* in the assemblage indicates a Lower Eocene affinity as both of them are characteristic species of Palana lignites, Rajasthan which are of early Eocene in age. Taking all these data into consideration, it seems that the assemblage described here may be of middle Eocene —late Eocene in age. The presence of *Oligosphaeridium complex* and *Hystrichosphaeridium tubiferum* in good percentage in one sample also points towards Eocene as both these specimens have been recorded from the London Clay by Davey and Williams (1966).

The palynological assemblage from the Quilon and Warkalli beds (Miocene) of Kerala worked out by Rao and Ramanjuam (1978) and Jain and Kar (1979) differs from the present one by the presence of *Crassoretitriletes*, *Margocclporites*, *Ctenolophonidites*, *Verrutriporites* and *Chenopodipollis*.

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EXPLANATION OF PLATES

(All figures are ca ×500)

Plate 1

1. *Cyathidites australis* Couper, Slide no. 6351/13.
2. *Biretisporites convexus* Sah & Kar, Slide no. 6361/5.
3. *Todisporites kutchensis* Sah & Kar, Slide no. 6351/4.
4. *Intrapunctisporis apunctis* Krutzsch, Slide no. 6365/5.
5. *Intrapunctisporis* sp., Slide no. 6352/10.
6. *Lygodiumsporites lakiensis* Sah & Kar, Slide no. 6352/4.

7, 8. *Dandotiaspora verrucata* sp. nov., Slide nos. 6360/11, 6364/1.

9. cf. *Osmundacidites* sp., Slide no. 6364/6.

10, 12. *Foveosporites splendus* sp. nov., Slide nos. 6370/3, 6351/7.

11. *Stereisporites assamensis* Dutta & Sah, Slide no. 6371/6.

13. *Foveosporites* sp., Slide no. 6365/1.

14. *Striatriletes susannae* van der Hammen emend. Kar, Slide no. 6356/2.

15, 18. *Striatriletes multicostatus* sp. nov., Slide nos. 6358/6, 6357/11.

16, 17. *Lophotriletes tertiarus* sp. nov., Slide no. 6370/5.

19, 20. *Striatriletes microverrucosus* sp. nov., Slide nos. 6351/11, 6352/11.

Plate 2

21. *Striatriletes* sp., Slide no. 6357/11.
22. *Cheilanthoidspora enigmata* Sah & Kar, Slide no. 6367/7.
23. *Cheilanthoidspora monoleta* Sah & Kar, Slide no. 6366/3.
24. Tetrad type-1, Slide no. 6353/2.
25. *Laevigatosporites lakiensis* Sah & Kar, Slide no. 6368/22.

26, 27. *Biswasiaspora baculata* sp. nov., Slide nos. 6364/17, 6363/12.

28, 29. *Biswasiaspora pseudoreticulata* sp. nov., Slide nos. 6363/12, 6354/1.

30, 31. *Polypodiaceaesporites strictus* sp. nov., Slide nos. 6366/14, 6359/11.

32. *Polypodiisporites* sp., Slide no. 6364/10.
33. *Seniasporites verrucosus* Sah & Kar, Slide no. 6367/6.
34. *Callialasporites trilobatus* (Balme) Dev, Slide no. 6371/2.
35. *Parasaccites* sp., Slide no. 6368/18.
36. *Liliacidites reticulatus* Sah & Kar, Slide no. 6368/4.
37. *Podocarpidites khasiensis* Dutta & Sah, Slide no. 6368/16.

38, 39. *Palmidites naviculus* sp. nov., Slide nos. 6358/11, 6366/9.

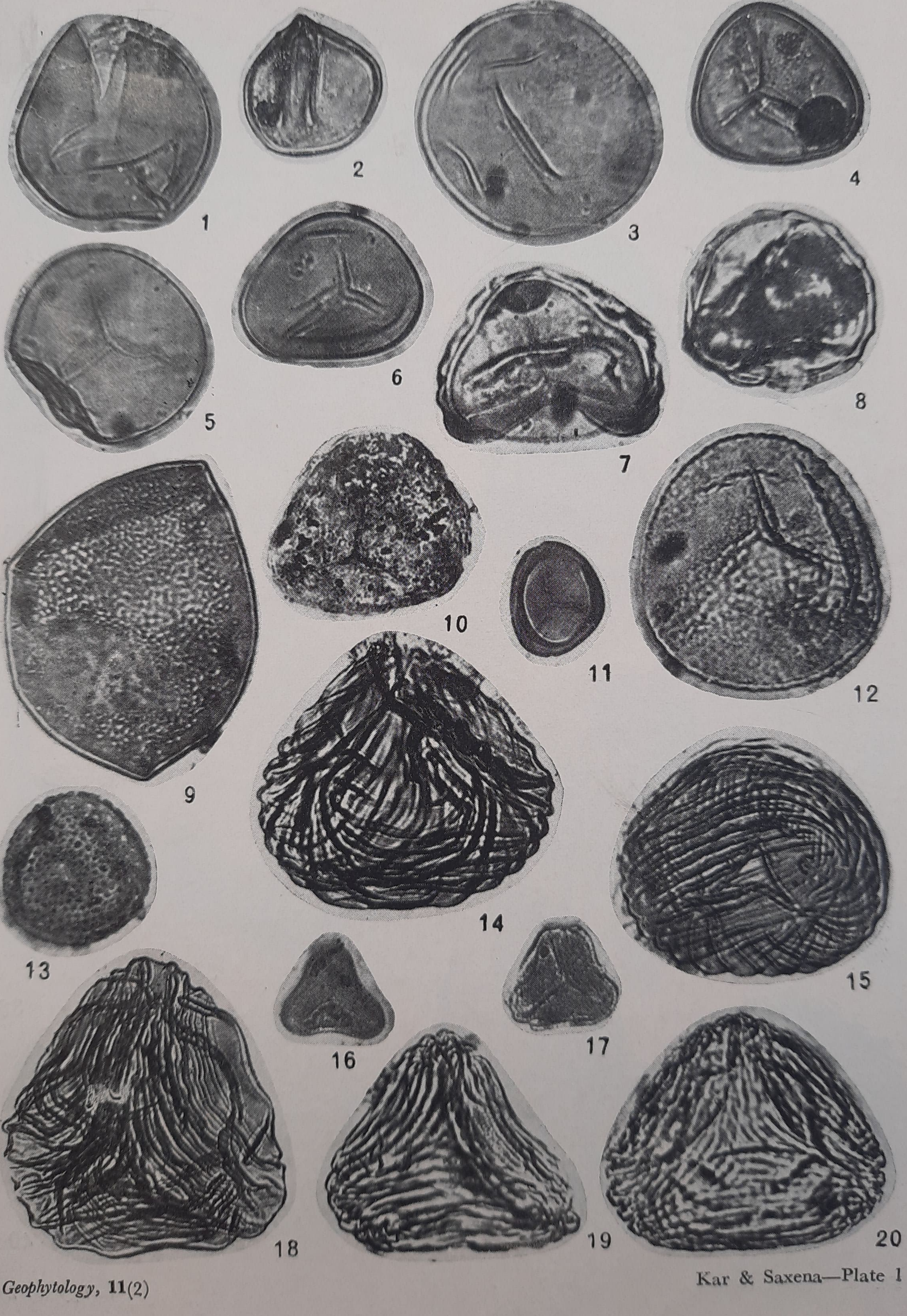
40. *Arecipites bellus* Sah & Kar, Slide no. 6364/19.

PLATE 3

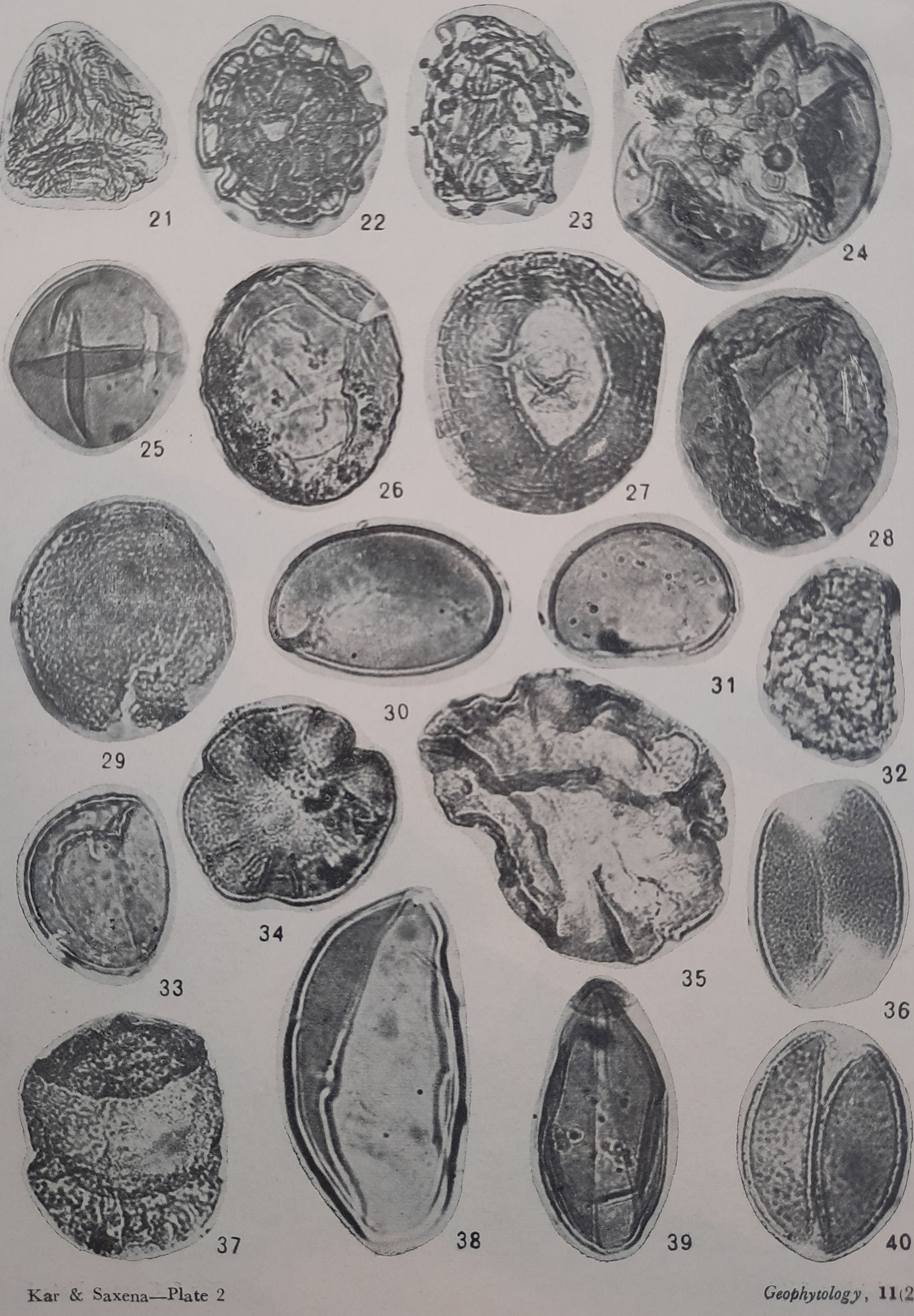
41, 42. *Arecipites intrapunctatus* sp. nov., Slide nos. 6369/1, 6361/6.
43. *Arecipites* sp., Slide no. 6367/15.
44. *Couperipollis kutchensis* Venkatachala & Kar, Slide no. 6367/8.
45, 46. *Psiloschizosporis psilata* sp. nov., Slide nos. 6370/2, 6369/6.
47. *Umbelliferoipollenites ovatus* Venkatachala & Kar, Slide no. 6370/2.
48, 49. *Psiloschizosporis punctata* sp. nov., Slide nos. 6355/2, 6363/9.
50. *Proxapertites microreticulatus* Jain, Kar & Sah, Slide no. 6368/20.
51. *Araliaceoipollenites matanamadhensis* Venkatachala & Kar, Slide no. 6373/5.
52. *Tisyncolpites* sp., Slide no. 6370/7.
53, 54. *Assamialetes reticulatus* sp. nov., Slide nos. 6364/16, 6364/13.
55. *Tricolpites reticulatus*, Cookson, Slide no. 6371/11.
56. *Tricolpites crassireticulatus* Dutta & Sah, Slide no. 6351/7.
57. *Paleosantalaceaepites primitiva* Biswas, Slide no. 6362/9.
58. *Marginipollis kutchensis* (Venkatachala & Kar) Kar, Slide no. 6372/9.
59, 60. *Retitrescolpites robustus* sp. nov., Slide nos. 6364/12, 6364/17.
61. *Symplocoipollenites kutchensis* Venkatachala & Kar, Slide no. 6367/8.
62. *Cupuliferoipollenites ovatus* Venkatachala & Kar, Slide no 6372/2.
63. *Tricolpites retibaculatus* Saxena, Slide no. 6351/5.
64. *Striacolporites ovatus* Sah & Kar, Slide no. 6367/13.
65. *Striacolporites cephalus* Sah & Kar, Slide no. 6366/2.
66. *Pellicieroipollis langenheimii* Sah & Kar, Slide no. 6372/3.

PLATE 4

67. *Lakiapollis ovatus* Venkatachala & Kar, Slide no. 6367/14.
68. *Lakiapollis matanamadhensis* Venkatachala & Kar, Slide no. 6372/5.
69. cf. *Triorites bellus* Sah & Kar, Slide no. 6373/2.
70. *Myricipites vulgaris* Dutta & Sah, Slide no. 6360/5.
71, 72. *Myricipites globatus* sp. nov., Slide nos. 6370/4, 6368/2.
73. *Myricipites* sp., Slide no. 6368/19.
74, 75. *Semitectotriporites ratariaensis* sp. nov., Slide no. 6352/8, 6352/9.
76. *Malvacearumpollis rudis* Kar, Slide no. 6351/10.
77. *Parmathyrites* sp., Slide no. 6359/9.
78. *Hystrichosphaeridium tubiferum* (Ehrenberg) Davey & Williams, Slide no. 6357/2.
79. *Oligosphaeridium complex* (White) Davey & Williams, Slide no. 6369/8.
80. cf. *Perisselasphaeridium pannosum* Davey & Williams, Slide no. 6351/14.
81. *Tetraporina* sp., Slide no. 6359/12.
82. *Cordosphaeridium gracilis* Eisenack emend. Davey & Williams, Slide no. 6366/1.
83. *Cleistosphaeridium heteracanthum* (Deflandre & Cookson) Davey, Downie, Sarjeant & Williams, Slide no. 6370/6.
84. *Hystrichokolpoma eisenacki* Williams & Davey, Slide no. 6356/6.
85. *Cryptosphaera valvata* Sah & Kar, Slide no. 6359/5.



Kar & Saxena—Plate 1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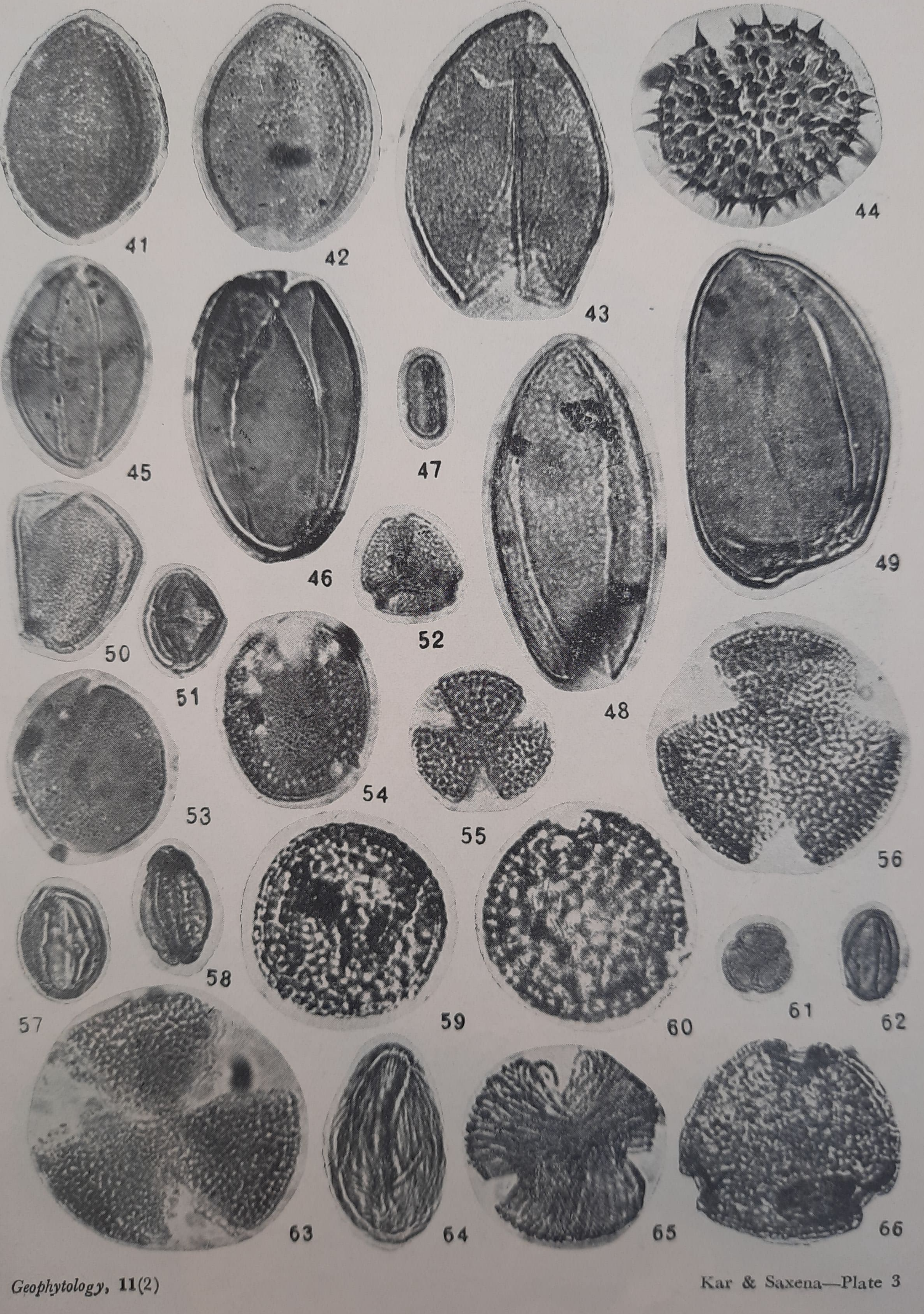
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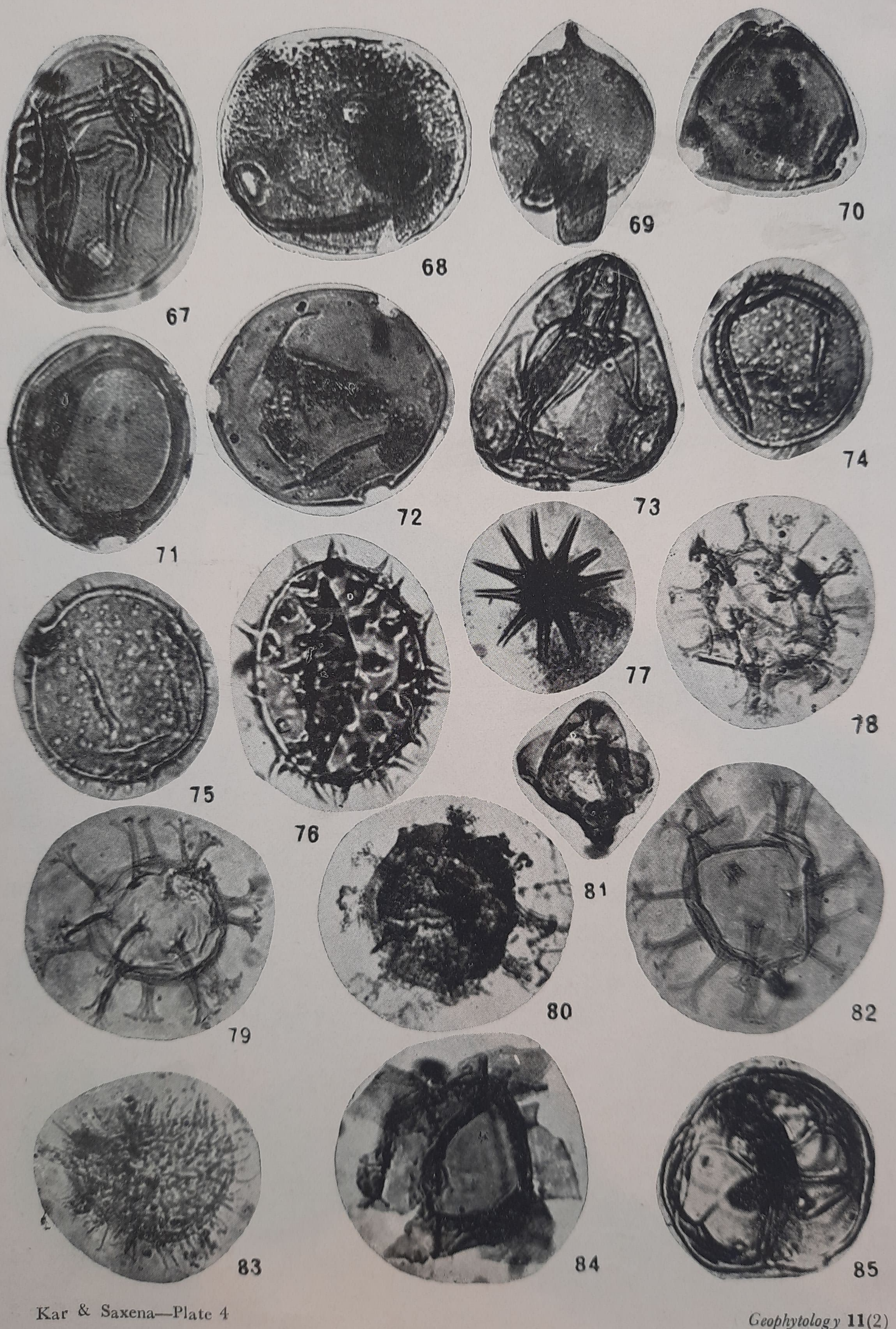

Kar & Saxena—Plate 4