PALYNOLOGY OF THE TERTIARY SEDIMENTS IN THE CAUVERY BASIN. 2. OLIGOCENE-MIOCENE PALYNOFLORA FROM THE SUBSURFACE[1, 2]

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ABSTRACT

Subsurface sediments occurring in Karaikal, Madanam and Mannargudi wells drilled by the Oil & Natural Gas Commission are studied. Oligocene-Miocene palynological assemblages recorded from the subcrop sequences of Karaikal and Madanam wells are discussed in the present paper. 68 genera and 96 species of spore and pollen and microplankton are recognised in this study, of which 7 genera and 42 species are newly proposed. Detailed descriptive analysis and differential diagnosis are given to exemplify the new taxa.

The following three main palynological zones are recognised.

1. *Magnastriatites cauveriensis* zone.
2. *Lacrimapollis pilosus* zone
3. *Tricollareporites echinatus* zone.

Zone 3, designated as *Tricollareporites echinatus* zone is further subdivided into two subzones as follows:

1. *Verrucatosporites bullatus* subzone.
2. *Malavacearumpollis paucibaculatus* subzone.

The abundant angiosperm pollen assemblages recovered in the wells studied, point out that the vegetation that provided material to the Oligocene-Miocene deposits in this basin were chiefly angiospermous. Marine phyto-plankton are recorded only in Oligocene-Lower Miocene sediments. Pteridophytic representatives form a sub-dominant group of plants. Fungal remains show a uniform distribution and form 5-10% of the total assemblage.

Pollen of arborescent angiosperm families are more in number as compared to the herbaceous ones. Mangrove elements, such as pollen of Rhizophoraceae, Araliaceae, Lecythidaceae as well as Schizaeaceous spores are present in good number. The overall representation of plant families in general point to swampy tropical warm humid climate, deposited under neritic environment. Marine phytoplankton are confined to hystrichosphaerid remains and recorded only in Oligocene and Lower Miocene sediments.

INTRODUCTION

THIS paper deals with the palynology of the Oligocene & Miocene sediments occurring in Karaikal deep wells E and F and Madanam deep well in the Cauvery basin, drilled by the Oil & Natural Gas Commission. The geology of the area is discussed in detail in an earlier paper (Venkatachala & Rawat, 1972). The nomenclature and methodology followed in this communication is also the same as adopted by Venkatachala & Rawat (1972).

68 genera and 96 species of spores, pollen and allied fossils are recognized in this study, of which 7 genera and 42 species are newly proposed.

SYSTEMATIC PALYNOLOGY

PTERIDOPHYTIC SPORES

Divisisporites (Thomson in Thoms. and Pf. 1952) Potonié, 1956.

Type species *Divisisporites euskirchensis* Thoms. in Thoms. and Pf. 1952; 48 μ.

Divisisporites enormis Pf. 1953

Pl. 1, Fig. 1

Remarks — Pflug (1952) gave the size range of *Divisisporites enormis* as 40-70 μ. The Cauvery specimen measures 74 μ and resembles closely with the specimens recorded from Palaeocene lignite of Texas by Elsik (1968, Pl. 9, Fig. 2). The type species of the genus is distinctly smaller in size.

Botanical affinity — Unknown.

***Apiculatisporis* Potonié and Kremp, 1956**

Type species — *Apiculatisporis oculeatus* (Ibrahim in Pot. & Kr.) Pot. 1956.

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Apiculatisporis sp.
Pl. 1, Fig. 2

Description — Miospore ± circular; 92·2 ×85·8 μ; trilete; y-mark distinct, open, reaching ± 3/4 of spore radius. Exine about 3·5 μ thick, apiculate; sculptural elements flat, do not protrude at the equatorial margin.

Botanical affinity — Unknown.

Crassoretitriletes Germ., Hopp. & Mull. 1968

Type species — *Crassoretitriletes vanraadshooveni* Germ., Hopp. & Mull. 1968.

Crassoretitriletes cauverensis sp. nov.
Pl. 1, Fig. 3

Holotype — Pl. 1, Fig. 3; 89·7 ×92·5 μ.

Description — Spore almost circular, 89·7 ×92·5 μ, trilete; laesura indistinct; exine about 1·3 μ thick, coarsely reticulate; meshes ± polygonal to oval, lumina wide, 10-16 μ wide, muri narrower, 5-7 μ thick, projecting at the equatorial exteremity. Exine in the lumina-area, scabrate.

Comparison — *Crassoretitriletes cauverensis* is closely comparable to the type species *C. vanraadshooveni* reported from the Miocene of Nigeria in shape and size range, but the cauvery species is distinguished by its thicker muri, wider lumina and scabrate luminar areas.

Botanical affinity — *Lygodium*.

Magnastriatites Germ., Hopp., & Mull. 1968

Type species — *Magnastriatites howardi* Germ., Hopp. & Mull. 1968.

Magnastriatites cauveriensis sp. nov.
Pl. 1, Fig. 5

Holotype — Pl. 1, Fig. 5.

Description — Microspore laterally compressed, originally ± spheroidal; trilete; 82·5×66 μ. Y-mark not visible. Exine about 2·5 μ thick, contact area of proximal face punctate, surrounded by ridges, remaining surface of spore coarsely striate; striae thick, about 4·6 μ wide, grooves thin, about 1·0 μ wide.

Comparison — *Magnastriatites cauveriensis* described here is comparable to the type species in disposition of striations and shape, but the former differs in the ornamentation of contact area, which is finely punctate; while *M. howardi* has smooth proximal contact area and is comparatively larger in size.

Botanical affinity — Parkeriaceae (*Ceratopteris*).

Lygodiumsporites (Pot., Thoms. & Thierg.) Pot. 1956

Type species — *Lygodiumsporites adriensis* (Pot. & Gell.) Pot. Thoms. & Thierg. 1950.

Lygodiumsporites sp.
Pl. 3, Fig. 1

Description — Microspore roundly triangular, 56·8×59·4 μ; trilete. Y-mark distinct, lasurae slightly opened, Y-rays extending up to ± half spore radius. Exine about 1·5 μ thick, smooth.

Botanical affinity — Schizaeaceae (*Lygodium*).

Lygodiumsporites sp.
Pl. 3, Fig. 2

Description — Microspore roundly triangular, 49·5×46·2 μ; trilete; Y-mark distinct, Y-rays narrow, extending ½ or slightly more of spore radius. Exine 1·5-2 μ thick, smooth.

Botanical affinity — Schizaeaceae (*Lygodium*).

Cibotiidites Ross, 1949

Type species — *Cibotiidites zonatus* Ross, 1942.

Cibotiidites kundavaensis Sah, 1967
Pl. 3, Fig. 3

Holotype — Sah, 1967; Pl. 2, Fig. 14.

Remarks — The illustrated specimen measures 43·5 μ.

Botanical affinity — ? Gleicheniaceae — ? Cyatheaceae.

***Auriculiretisporites* gen. nov.**

Type species — *Auriculiretisporites cauvariensis* sp. nov.

Diagnosis and Description — Microspore with triangular amb, sides ± straight, apices rounded; 35·6×36·5 μ; trilete. Y-mark distinct, Y-rays reaching up to the margin, apex raised, labra thin, slightly raised. Exine about 2·0 μ thick, auriculate thickening about 3·5 μ at angular apices. Proximally smooth, distally reticulate, muri low, about 1·0 μ thick not forming the prominent peaks at the equatorial margin; lumina polygonal, wide, 2-3·5 μ.

Auriculiretisporites cauveriensis sp. nov.

Pl. 3, Fig. 4

Holotype — Pl. 3, Fig. 4.
Description — Same as for the genus.
Botanical affinity — Unknown.

***Biretisporites* (Delc. & Sprum.) emend. Delc. Dett. & Hugh. 1963**

Type species — *Biretisporites potoniaei* Delc. & Sprum., 1955.

Biretisporites crassisexinus sp. nov.

Pl. 3, Fig. 5

Holotype — Pl. 3, Fig. 5.
Description — Microspore roundly triangular in polar view with broadly rounded angles and convex sides; 82·5×81·2 μ; trilete. Y-mark distinct, laesura straight, Y-rays extending up to ¾ of the spore radius, labra thick, raised, apex and vertex high, ending in a raised thickened area simulating bifurcate ray-ends. Exine 4·5 to 5·2 μ thick; surface finely irregularly granulose, appearing reticulate in surface view.

Comparison — *Biretisporites crassisexinus* compares well with *B. triglobosus* Sah & Dutta (1966) from lower Eocene of Assam in size range and general features of the spore but differs in having a thick exine and different surface ornamentation. Comparable spores have been described by Vimal (1952) from Tertiary lignites from Dandot, W. Punjab (Pakistan), but they differ in size and exine characters. *B. spectabilis* Dettmann (1963) has globular thickening at the ray ends.
Botanical affinity — ? *Matoniaceae.*

***Cicatricosiporites* Pot. & Gell. 1933**

Type species — *Cicatricosiporites dorogensis* Pot. & Gell. 1933.

Cicatricosisporites (*Ceratopteris*) *Macrocostatus* (Baks.) Sah & Dutta, 1967

Pl. 3, Fig. 6

Lectotype — Biswas, 1962; Pl. 4, Fig. 53.
Remarks — The illustrated specimen measures 79·0×95·5 μ.
Botanical affinity — Schizaeaceae

***Polypodiaceoisporites* Potonié, 1951**

Type species — *Polypodiaceoisporites speciosus* (Pot.) Pot. 1951.

Polypodiaceoisporites sp.

Pl. 3, Fig. 7

Description — Microspores with triangular amb, angles rounded, sides straight to slightly concave, cingulate, trilete; 28·0 ×27·0 μ; Y-mark distinct, rays thin, reaching up to periphery. Exine up to 1·5 μ thick, irregularly verrucate; cingulum smooth up to 3·5 μ thick.

Remarks — The specimen recorded here is distinguished by its smaller size from other known species of the genus (Sah, 1967).
Botanical affinity — Polypodiaceae.

***Rugulatisporites* Pf. (in Thom. & Pf. 1953)**

Type species — *Rugulatisporites quintus* Thoms. & Pf. 1953.

Rugulatisporites striatus Sah, 1967

Pl. 3, Fig. 8

Holotype — Sah, 1967; Pl. 2, Fig. 7.
Remarks — The Cauvery specimen measures 43×47·5 μ.
Botanical affinity — Lycopodiaceae.

Ceratosporites Cooks. & Dettm. 1958

Type species— *Ceratosporites equalis* Cooks. & Dettm. 1958.

Ceratosporites conatus sp. nov.

Pl. 3, Fig. 10

Holotype — Pl. 3, Fig. 10.

Description — Microspore roundly triangular with convex sides and rounded angles. Trilete; 33-30 μ; Y-mark distinct, laesura open, reaching more than ¾ of spore radius. Exine about 1·5 μ thick, spinose, spines conate with broad base and pointed distal ends, sparsely distributed; exine granulate in between spines.

Comparison — *C. conatus* described here resembles the type species, *C. equalis* in shape and size but differs in the overall exine ornamentation. The spines are blunt and baculate in the type species while they are angular and conate in *C. conatus*.

Botanical affinity — *Selaginella.*

Spore type

Pl 3, Fig. 9

Description — Microspore roundly triangular in polar view, 26·4×28·4 μ (excluding the outer perine); trilete. Trilete mark thin, extending up to the equatorial margin of the body. Exine thin, less than 1·0 μ, smooth to finely ornamented. The body is covered by a transparent perine like structure, about 10·0 μ wide in flattened position.

Botanical affinity — Unknown.

Polypodiaceaesporites Thier. 1940

Type species — *Polypodiaceaesporites hardti* (Pot. & Ven.) Thier. 1938.

Polypodiaceaesporites levis Sah, 1967

Pl. 3, Fig. 12

Holotype — Sah, 1967; Pl. 3, Fig. 13.

Remarks — The illustrated specimen measures 29·6×23·0 μ.

Botanical affinity — Polypodiaceae.

Polypodiisporites Pot. 1934

Type species — *Polypodiisporites favus* (Pot.) Pot. 1934.

Polypodiisporites ornatus Sah, 1967

Pl. 3, Fig. 13

Holotype — Sah, 1967; Pl. 3, Fig. 19.

Remarks — The illustrated specimen measures 52·8×36·3 μ.

Botanical affinity — Polypodiaceae.

Verrucatosporites (Pf. in Pf. & Thom. 1953) Pot. 1956

Type species — *Verrucatosporites alienus* (Pot.) Thom. & Pf. 1953.

Verrucatosporites sparsus sp. nov.

Pl. 3, Fig. 14

Holotype — Pl. 3, Fig. 14.

Description — Microspore, plano-convex in outline, bilaterally symmetrical with convex distal outline and ± straight proximal amb; 43×30·5 μ; monolete. Laesura thin, extending about ¾ of length. Exine up to 1·5 μ thick, verrucate; verrucae low, 2·5-3·0 μ wide at the base, sparsely distributed.

Comparison — *Verrucatosporites sparsus* is differentiated from all other known species of the genus by its low and sparsely arranged verrucae.

Botanical affinity — Polypodiaceae.

Verrucatosporites bullatus sp. nov.

Pl. 3, Fig. 16

Holotype — Pl. 3, Fig. 16.

Description — Microspore bilaterally symmetrical; biconvex; 47·6×31·8 μ; monolete. Laesura straight, 30 μ long with thin margo. Exine ± 1·5 μ thick, verrucate; verrucae low, 2-3 μ high, 4·0 μ broad at the base, sparsely distributed with rounded tips.

Comparison — *Verrucatosporites bullatus* is distinguished from *V. sparsus* in the nature of verrucae. The former possesses comparatively high and broad ornamentation and margo on either side of the laesura.

Botanical affinity — Polypodiaceae.

Verrucatosporites sp.

Pl. 3, Fig. 11

Description — Microspore bilaterally symmetrical; monolete; 47·5×26·4 μ. Monolete mark up to ¾ length; exine ±2·0 μ thick,

verrucate; verrucae closely spaced, 4 μ broad and as high.

Botanical affinity — Polypodiaceae.

Verrucatosporites sp.

Pl. 3, Fig. 15

Description — Microspore ± spheroidal in polar view, bilaterally symmetrical; 31·7 × 32·5 μ; monolete. Laesura open, straight about 20·0 μ long. Exine about 1·5 μ thick, verrucate; verrucae about 3·5 μ long, 4-4·5 μ wide, irregularly distributed.

Botanical affinity — Polypodiaceae.

GYMNOSPERMOUS POLLEN

Abietineaepollenites Pot. 1951

Type species — *Abietineaepollenites microalatus* (Pot.) Pot. 1951.

Abietineaepollenites sp.

Pl. 1, Figs. 6, 12

Description— Pollen grain bisaccate; overall length 55·8-66 μ; overall width 46·5-59 μ; central body elliptical in polar view, 44·5-55·8 × 34·5-39·6 μ; exine thin, about 1·0 μ, foveolate. Bladders large, outline semicircular, 38·5-55·8 × 28·8-39·6 μ, infra-reticulate, lumina very irregular; distal sulcus narrow to wide; 2·0-9·0 μ.

Botanical affinity — Pinaceae.

ANGIOSPERMOUS POLLEN

Inaperturites V. d. Ham. 1956

Inaperturites sp.

Pl. 3, Fig. 18

Description — Pollen grain ± oval-shaped in folded condition; 46·0 × 33·0 μ; without any aperture. Exine 2·0 μ thick, sexine as thick as nexine, baculate, baculae forming pseudoreticulum.

Botanical affinity — Unknown.

Spinainaperturites Pier. 1961

Type species — *Spinainaperturites recurvatus* Pier. 1961.

Spinainaperturites densispinus Venkat. & Raw. 1971

Pl. 4, Fig. 1

Holotype — Venkat. & Raw. 1971; Pl. 1, Fig. 16.

Description — Pollen grain spheroidal; Inaperturate; 30 × 30·5 μ; with few folds. Exine up to 1·5 μ thick, sexine thicker than nexine, studded with densely spaced prominent sharply pointed spines, spines 3·5 to 4·5 μ long; basal part broad but not bulbous, interspersed with 0·5 μ wide grana.

Comparison — *Spinainaperturites densispinus* resembles *S. recurvatus* (Pierce, 1961) in size, but the Cauvery species is distinguished by its non-recurved, comparatively longer spines and granulose surface in between spines. *Spinainaperturites magnificus* Ramanujam (1966) is distinctly a larger form and is characterized by smooth exine between spines.

Botanical affinity — Unknown.

Couperipollis Venkat. & Kar, 1968

Type species— *Couperipollis* (*Monosulcites*) *perspinosus* (Coup.) Venkat. & Kar, 1968.

Couperipollis rarispinosus (Sah & Dutta) Venkat. & Kar, 1968

Pl. 2, Fig. 4 & Pl. 4, Fig. 2

Holotype — Sah & Dutta, 1966; Pl. 1, Fig. 28.

Remarks — The illustrated specimens measure 30 × 40-47 μ (excluding spines).

Botanical affinity — Palmae.

Couperipollis perspinosus (Coup.) Venkat. & Kar, 1968

Pl. 4, Fig. 3

Holotype — Couper, 1953; Pl. 8, Fig. 133.

Remarks — The illustrated specimen measures 48·2 × 23·0 μ.

Botanical affinity — Palmae.

Liliacidites Coup. 1953

Type species — *Liliacidites kaitangaensis* Coup., 1953.

Liliacidites densireticulatus sp. nov.

Pl. 4, Fig. 4

Holotype — Pl. 4, Fig. 4.

Description — Pollen grains elongate to sub-spherical; 43·5×33·0 μ. Monosulcate; colpus obscured by ornamentation. Exine up to 2·5 μ thick, sexine thicker than nexine, tectate, clavate, pila heads forming reticulum.

Comparison — *Liliacidites kaitangaensis* Coup. (1953) is distinguished by its larger size than the present species. *L. variegatus* Coup. (1953) is smaller in size. *L. intermedius* Coup. (1953) approximates the present species in size but is distinguished by its nature of reticulum, which is about 5·0 μ in the centre and 1 μ at periphery. *L. sphericus* Coup. (1960) approximates the present species in surface reticulum but is distinguished by its smaller size. *L. ellipticus* Venkatachala and Kar (1968) from Tertiary sediments of Kutch is distinguished by its finely intramicroreticulate exine. *L. baculatus* Venkatachala & Kar (1968) is larger in size. *L. foveoreticulatus* Venkat. & Rawat (1972) recorded in this basin is distinguished by its finely foveoreticulate surface.

Botanical affinity — Liliaceae.

Liliacidites foveoreticulatus Venkat. & Raw. 1971

Pl. 4, Fig. 6

Holotype — Venkatachala & Rawat, 1971; Pl. 2, Fig. 3.

Description — Pollen grains oval in shape, monocolpate, 29·7×19·8 μ, colpus wide, running along the entire length of the pollen. Exine about 2·0 μ thick, sexnie thicker than nexine, tectate, foveolate, foveolae less than 1·0 μ forming fine uniform reticulum.

Comparison — Pollen grains belonging to *Liliacidites* recorded by Couper (1953, 1960) from Australian sediments are distinguished by their baculate-clavate sculptural elements. *L. ellipticus* Venkatachala & Kar (1968) approximates the present species in shape but is distinguished by its wide sulcus and bigger size. *L. densireticulatus* sp. nov. also recorded in the present study can be distinguished by its larger size and nature of clavate structural elements forming a distinct surface reticulum.

Botanical affinity — Liliaceae.

Genus — *Nymphaeacidites* Sah, 1967

Type species — *Nymphaeacidites typicus* Sah, 1967.

Nymphaeacidites decoratus sp. nov.

Pl. 4, Fig. 5

Holotype — Pl. 4, Fig. 5.

Description — Pollen grain ± spherical in shape, 32·5×31·7 μ, aperturate, aperture obscured by ornamentation; operculum not distinct, exine up to 3·0 μ thick, sexine thicker than nexine, baculate, baculae tips accuminate, measuring about 2·0 μ, evenly distributed interspersed with fine granulations.

Comparison — The pollen grains of *Nymphaeacidites typicus* Sah (1967) resemble the present species in sexinous baculate processes but can be distinguished by its larger size.

Botanical affinity — Nymphaeaceae.

***Monoporopollenites* (Meyer) Pot. 1960**

Type species — *Monoporopollenites gramineoides* Meyer, 1956; ca 23 μ.

Monoporopollenites gramineoides Meyer, 1956

Pl. 6, Figs. 8, 9, 10, 11

Holotype — Meyer, 1956; Pl. 4, Fig. 29.

Remarks — The specimens illustrated here measure 23-29·7×26·5-36 μ. Body variously folded.

Botanical affinity — Graminae.

***Tricolpites* (Erdtma. Cooks. & Ross) Coup. 1953**

Type species — *Tricolpites reticulatus* Cooks. 1947.

Tricolpites margocolpites Venkat. & Raw. 1971

Pl. 2, Figs. 5, 7

Holotype — Venkata. & Raw. 1971; Pl. 3, Fig. 27.

Remarks — The illustrated specimens measure 33×31·7 μ.

Botanical affinity — Unknown.

Tricolpites longicolpatus Venkat. & Raw. 1971

Pl. 2, Fig. 6

Holotype — Venkat. & Raw. 1971; Pl. 2, Fig. 16.

Description — Pollen grain roundly triangular, 19·8×20 μ; tricolpate, colpi long, almost reaching the poles, up to 9·0 μ deep in polar view, wedged shaped. Exine up to 1·2 μ thick, tectate; sexine thicker than nexine, retipilate.

Remarks— Detailed comparisons are made by Venkatachala & Rawat, 1972.

Botanical affinity — Unknown.

Tricolpites crassisexinus sp. nov.

Pl. 4, Fig. 9

Holotype — Pl. 4, Fig. 9.

Description — Pollen grains spheroidal, tricolpate; 30·0×28 μ; colpi long, 26·5 μ and widely open into three distinct lobes. Exine 1·9 μ thick, well stratified, sexine twice as thick as nexine, tectate, finely reticulate in surface view.

Comparison — *T. fissilis* Couper (1960) is distinguished from *T. crassisexinus* by its non-crassisexinus, scabrate to finely clavate, exine giving a finely pitted appearance. *T. reticulatus* Cookson (1947) is differentiated by its larger size and exine stratification.

Botanical affinity — Unknown.

Tricolpites cf. *T. fissilis* Coup. 1960

Pl. 4, Fig. 10

Description — Pollen grain sub-triangular; tricolpate, 26·5×26·5 μ. Colpi long, up to 10 μ deep in polar view and widely open into distinct 3-lobes. Exine up to 1·3 μ thick, stratification obscure, scabrate to finely clavate giving finely reticulate appearance in surface view.

Remarks — The specimen referred here to cf. *T. fissilis* Couper (1960) is smaller in size, possesses thinner exine than those originally described by Couper (1960) from New Zealand sediments.

Botanical affinity — Unknown.

Striatopollis Krutz. 1959

Striatopollis bellus, Sah, 1967

Pl. 4, Fig. 13

Holotype — Sah, 1967; Pl. 5, Fig. 16.

Remarks — The specimen referred here to *Striatopollis bellus* Sah (1967) is smaller in size and measures 37×23·2 μ. Specimen described under *Striatricolpites* by Gonzalez (1967) from Columbian Tertiaries is closely comparable to this genus. The genus *Striatopollis* (Krutzsch, 1959) is here considered valid on grounds of priority. *Striatricolpites* is also recorded from the Tertiary of Nigeria and Borneo (Germeraad *et al.*, 1968).

Botanical affinity — Solanaceae and Fabaceae (*Anthonotha* and *Isoberlinia*).

Foveotricolpites Pier, 1961

Type species — *Foveotricolpites sphaeroides* Pier. 1961.

Foveotricolpites perforatus V. d. Ham. & Garcia, 1965

Pl. 4, Figs. 7k 8

Holotype — V. d. Ham. & Garcia, 1965; Fig. 18.

Remarks — The illustrated specimen measures 47·5×50·5 μ.

Botanical affinity — Unknown.

Beaupreaidites (Cooks. 1950) Coup. 1953

Type species — *Beaupreaidites elegansiformis* Cooks. 1950.

Beaupreaidites tegillatus sp. nov.

Pl. 4, Fig. 32

Holotype — Pl. 4, Fig. 32.

Description — Pollen grain roundly triangular with slightly convex sides and rounded angles, 23·2×23·7 μ in polar view; tricolpate, angulaperturate. Colpi very short,slit like. Exine about 1·5 μ, sexine thicker than nexine except at aperture region where nexinous thickenings are prominent, puncti-tegillate, punctae 0·5 to 1·0 μ in diameter forming a reticulate surface.

Comparison — *B. tegillatus* differs from the type species *B. elegansiformis* Cookson and *B. verrucosus* Cookson, in its smaller size, thinner exine and surface sculpturing.

Botanical affinity — Proteaceae.

Bombacacidites Coup. 1960

Type species — *Bombacacidites bombaxoides* Coup. 1960.

Bombacacidites inausus sp. nov.

Pl. 4, Fig. 14

Holotype — Pl. 4, Fig. 14.

Description — Pollen grain triangular with rounded angles in polar view, sides convex; 36·5×39·6 μ; tricolpate. Colpi midway between sides (Planaperturate), short, about 5·3 μ deep in polar view. Exine 2·0 μ thick, sexine ± twice as thick as nexine, tectate, coarsely reticulate in surface view, muri thinner than lumina; lumina about 2·0 μ in diameter at poles clearly demarcated from the smaller brochi at the apices less than 1·0 μ.

Comparison — *Bombacacidites inacusus* appears similar to *B. bombaxoides* Couper (1960) from the Tertiary of New Zealand, but differs in the sculpturing of the exine. *Bombacacidites africanus* (Sah, 1967) from Neogene of Africa is larger in size. *B. clarus* (Sah, 1967) is distinguished by its triporate condition. *B. annae* (Van. der Hammen, 1959) has coarser polar ornamentation as compared to the species described new.

Botanical affinity — Bombacaceae.

Lacrimapollis Gen. nov.

Type species — *Lacrimapollis pilosus* sp. nov. (Pl. 4, Fig. 16).

Diagnosis and Description — Pollen grain spheroidal, tricolpate; 20·4-21·2×20·4-22·5 μ. Colpi short, teardrop-shaped, 4·7 μ deep in polar view, surrounded by up to 2·0 μ wide 'margo'. Exine ± 2·0 μ thick, sexine thicker than nexine, tectate, pilate, surface finely reticulate, reticulations less than 1·0 μ in diameter.

Derivations of name — Latin, Lacrima = tear drop, the characteristic shape of the colpi.

Lacrimapollis pilosus sp. nov.

Pl. 4, Figs. 16-20

Holotype — Pl. 4, Fig. 16.

Description — Pollen grain spheroidal, tricolpate, 20·4-21·2×20·4-22·5 μ. Colpi short, tear drop shaped, 4·7 μ deep in polar view, surrounded by a upto 2·0 μ wide margo. Exine ± 2·0 μ thick, sexine thicker than nexine, tectate, pilate, surface finely reticulate; reticulations less than 1·0 μ in diameter.

Botanical affinity — Unknown.

Margocolporites Raman. 1966

Type species — *Margocolporites tsukadai* Raman. 1966.

Margocolporites sahnii Raman. 1966

Pl. 2, Fig. 1

Holotype — Raman. 1966; Pl. 4, Fig. 70.

Remarks — The specimen illustrated and referred here as *M. sahnii* Ramanujam (1966) has more or less the same size (50×47·5 μ) as Neyveli lignite fossil, but in the present specimen, ora quite distinct, which is circular to lalongate.

Botanical affinity — Caesalpiniaceae.

Margocolporites sitholeyi Raman. 1966

Pl. 5, Fig. 2

Holotype — Raman. 1966; Pl. 4, 68.

Remarks — The illustrated specimen measures 35 μ.

Botanical affinity — Caesalpiniaceae.

Araliaceoipollenites Pot. 1951

Araliaceoipollenites descretus sp. nov.

Pl. 4, Figs. 15, 21

Holotype — Pl. 4, Fig. 21.

Description — Pollen grain ± oval in equatorial view, 36·4-39·5×28·5 μ. Tricolporate; colpi long, extending almost the whole length of the grain, ± uniformly broad with tapering ends; ora conspicuously lalongate, 7·2×4·0 μ. Exine 2·0 to 2·5 μ thick, tectate, sexine thicker than nexine, reticulate.

Comparison — *Araliaceoipollenites potoniei* Ramanujam (1966) recorded from the south Arcot lignite, is comparable to the present species in size and apertural organization, but the latter is distinguished by its punctitegillate ornamentation. *A. euphorii* (Pot.) Potonié (1951) resembles the Cauvery specimen in oval shape, but the former is

characterized by its thicker exine at the poles and less conspicuous lalongate ora.

A. matanamadhensis Venkatachala & Kar (1968) recorded from Tertiary of Kutch is smaller in size. Araliaceous pollen described under the name *Palaeoaraliaceaepites indica* from Tertiary of Assam (Biswas 1962), & (Baksi 1962) differ in possessing a thin continuous oral zone.

Botanical affinity — Araliaceae.

Araliaceoipollenites mannargudii sp. nov.

Pl. 4, Fig. 22

Holotype — Pl. 4, Fig. 22.

Description — Pollen grain oval in equatorial view; 39·6 × 29·7 μ, tricolporate. Colpi long, uniformly broad except in the equatorial region slightly broader and tapering ends; ora distinct and conspicuously lalongate. Exine about 2·0 μ thick, sexine as thick as nexine or slightly thicker, tegillate, sexine surface granulose.

Comparison — Araliaceoipollenites potoniei Ramanujam (1966) is differentiated from the present species by its smooth surface. *A. matanamadhensis* Venkatachala & Kar (1968) is smaller in size and has laevigate-intramicroreticulate exine. *A. euphorii* Potonié (1951) resembles in shape but is distinguished by its smaller size and unequal thickening of the exine. *A. descretus* sp. nov. recorded in Madanam distinguishes in possessing a reticulate exine.

Botanical affinity — Araliaceae.

Sapotaceoidaepollenites Pot., Thom. & Thierg. 1950

Type species—Sapotaceoidaepollenites manifestus (Pot.) Pot., Thoms. & Thierg. 1950.

Sapotaceoidaepollenites obscurus (Pf. & Thoms.) Comb. nov.

Pl. 4, Figs. 23, 24

Syn. Tetracolporopolleniets obscurus Pf. & Thoms. 1953.

Hololype — Pf. & Thoms. 1953.

Descrip ion — Pollen grain sub-prolate, tetracolporate, 23·2 × 16·5 μ; colpi long reaching ± to the poles, ora distinct, lalongate. Exine about 2·0 μ thick, sexine thicker than nexine, surface ornamentation obscure, ± smooth.

Remarks — *S. obscurus* described by Sah (1967) as a new species is larger than the specimens presently included in *S. obscurus* (Pf. & Thoms.) comb. nov. The holotype of *S. obscurus* (Sah) is to be examined before synonomy can be suggested.

Botanical affinity — Sapotaceae.

Sapotaceoidaepollenites dakshinii sp. nov.

Pl. 4, Figs. 12, 25, 26

Holotype — Pl. 4, Fig. 25; 13·2 × 9·0 μ (Polar view).

Description — Pollen grains prolate oval in equatorial view, 13·2 × 9·0 μ and roundly triangular in polar view, 13·8 × 13·2 μ. Tricolporate, colpi long, narrow, almost reaching the poles, ora circular to slightly lolongate. Exine up to 1·5 μ thick, sexine thicker than nexine, nexine thicker at pore-region, smooth to slightly scabrate.

Comparison — Sapotaceoidaepollenites dakshinii is distinguished from *S. manifestus* Pot., Thoms. & Thierg. (1950) by its smaller size. Sah (1967) also described a number of species of the genus which are larger than the species described here. *S. neyvelii* Ramanujam (1966) is distinctly tetracolporate pollen and larger in size. *S. obscurus* another species recorded in this study is tetracolporate and has conspicuous lalongate ora and obscure surface ornamentation.

Botanical affinity — Sapotaceae.

***Favitricolporites* Sah, 1967**

Type species — Favitricolporites eminens Sah, 1967.

Favitricolporites crassisexinus sp. nov.

Pl. 4, Fig. 27

Holotype — Pl. 4, Fig. 27.

Description— Pollen grains spheroidal-oval in equatorial view, tricolporate; 29 × 21·2 μ. Colpi long about 16·5 μ, tapering on either ends, ora lolongate. Exine very thick, 3·3 μ at equator, thickening towards poles reaching up to 4·8 μ; sexine thicker than nexine, tectate, tectum supported by pila, exine surface foveolate, foveolae less than 1·0 μ in diameter.

Comparison — Sah (1967) instituted the genus *Favitricolporites* and described six species under the genus from the Neogene sediments of Burundi, Rusizi Valley of

Central Africa. *F. crassisexinus* recorded in the present study can be differentiated from these by its smaller size and foveolate sculpturing.

Botanical affinity — Unknown.

Rhoipites Wodeh. 1933

Type species — *Rhoipites bradleyi* Wodeh. 1933.

Rhoipites conatus Venkat. & Raw. 1972

Pl. 2, Fig. 12; Pl. 4, Fig. 31

Holotype — Venkat. & Raw. 1971, Pl. 3, Fig. 18; 24×18·5 μ.

Remarks — The species is compared in detail by (Venkatachala & Rawat 1972). The illustrated specimens measures 24-29·7 ×18·5-20·5 μ.

Botanical affinity — Unknown.

Rhoipites cauveriensis sp. nov.

Pl. 4, Figs. 33-35

Holotype — Pl. 4, Fig. 33.

Description — Pollen grain ± oval-shaped in equaotial view, 23·7-29·7×18·5-20·0 μ; tricolporate. Colpi long, almost reaching upto the poles, uniformly wide, ora ± circular to conspicuously lalongate. Exine about 1·5 μ thick, sexine thicker than nexine, tegillate, surface sculpturing apparently finely punctate-reticulate.

Comparison — *Rhoipites cauveriensis* resembles very much in size and shape the pollen grains referred to as *Rhoipites conatus* Venkatachala & Rawat (1972) but can be distinguished by not possessing conate sculpturing.

R. psilatus and *R. dubius* recorded by Sah (1967) from Neogene of Central Africa are comparable to the present species in size but can be distinguished by their exine sculpture. *R. nitidus* Sah & Dutta (1967) described from the Miocene sediments of Assam is comparable in shape and size but differs in possessing thinner exine and in its sculpturing.

Botanical affinity — Unknown.

Rhoipites sp.

Pl. 5, Fig. 3

Description — Pollen grain broadly oval in equatorial view; 41×29·7 μ; tricolporate. Colpi long but not reaching the poles, pores simple, lalongate. Exine about 1·3 μ thick, sexine ± as thick as nexine, reticulate, lumina less than 1·0 μ, sometimes aligned to form the pseudostriation on the surface.

Botanical affinity — Unknown.

Costatipollenites Gen. nov.

Type species — *Costatipollenites pauciornatus* sp. nov.

Diagnosis and Description — Pollen grains spheroidal, circular to roundly triangular in polar view; tricolporate, brevicolpate; ora more distinct than colpi, with thick margo. Sexine equal or thicker than nexine, variously ornamented.

Comparison — *Symplocoipollenites* is more triangular in equatorial outline with prominent sunken pores and a distinct margo and hence not comparable to the present genus. Comparable pollen are described under *Porocolpopollenites* (Pflug) Thomson & Pflug (1953). This name is not a valid name and subsequently transferred to *Symplocoipollenites* by Potonié (1960).

Costatipollenites is here differentiated from other tricolporate pollen generally included under *Porocolpopollenites* (see Elsik, 1968) by brevicolpate apertures. Symplocaceae is an eurypalynous family consisting of more than one type of pollen. *Symplocos coccinea* and *S. phanerophlebia* (Erdtman, 1952) possess pollen grains comparable to the present species in shape and exine characters. However, *S. coccinea* is a larger form. *S. phanerophlebia* resembles in size, but can be distinguished by its betuloid pores.

Costatipollenites pauciornatus sp. nov.

Pl. 5. Figs. 8 & 9

Holotype — Pl. 5, Fig. 9.

Description — Pollen grain with rounded amb, tricolporate, 17·2-17·8×18·5 μ; colpi very short, about 4·0 μ deep in polar view; margo present, pores lalongate, encircled by a annulas, about 2·0 μ wide. Exine about 1·3 μ thick, sexine as thick as nexine or thicker, scabrate with vermiculate-pseudoreticulate ornamentation.

Botanical affinity — Symplocaceae.

***Palaeocoprosmadites* Raman. 1966**

Type species — *Palaeocoprosmadites arcotense* Raman. 1966.

Palaeocoprosmadites acrotense Raman. 1966

Pl. 5, Fig. 13

Holotype — Raman., 1966; Pl. 3, Fig. 61.
Remarks — The illustrated specimen measures 20·5×21·2 μ.
Botanical affinity— Rubiaceae (*Coprosma.*)

***Zonocostites* Germ., Hopp. & Mull. 1968**

Type species — *Zonocostites ramonae* Germ., Hopp. & Mull. 1968.

Zonocostites ramonae Germ., Hopp. & Mull. 1968

Pl. 5, Fig. 26

Remarks — The illustrated specimen is broadly oval in equatorial view and measures 16·5×13·2 μ.
Botanical affinity — Rhizophoraceae.

***Ericipites* Wodeh. 1933**

Type species — *Ericipites longisulcatus* Wodeh. 1933.

Ericipites sp.

Pl. 6, Fig. 7

Description— Pollen grains united in tetrahedral tetrad, 28·4×33·0 μ. Individual grain ± spheroidal, 16·5×19·0 μ, tricolporate; colpi long, ora ± rounded. Exine about 2·0 μ thick, tectate, sexine thicker than nexine, pila distinct; surface punctate, punctae about 0·5 μ in diameter forming fine-reticulations.
Remarks — Pollen grains referable to the genus *Ericipites* are known from the Miocene sediments of Garo Hills, Assam (Banerjee, 1964) and S. Arcot lignite (Ramanujam, 1966).
Botanical affinity — Ericaceae.

***Cauveripollis* Gen. nov.**

Type species — *Cauveripollis* (*Caprifoliipites*) *superbus* (Sah) comb. nov.

Diagnosis and description — Pollen grain roundly triangular, triporate (3-colporoidate), 26·4×27 μ. Pores distinct, 6·6 μ in diameter, colpi ± of the same width as ora. Exine about 2·0 μ thick, tectate, sexine as thick as nexine or slightly thicker, sexine composed of pilate processes with rounded heads, pila evenly spaced and distinct, surface appearing closely reticulate.

Cauveripollis superbus (Sah) comb. nov.

Pl. 4, Fig. 11

Holotype — Sah, 1967; Pl. 7, Fig. 11.
Diagnosis and description — Pollen grain roundly triangular, triporate (3-colporoidate), 26·5×27·0 μ. Pores distinct, 6·6 μ in diameter; colpi short, ± of the same width as ora. Exine about 2·0 μ thick, tectate, sexine as thick as nexine or slightly thicker, composed of pilate processes with rounded heads; pila evenly spaced and distinct, surface appearing closely reticulate, muri about 1·0 μ thick, lumina wide, irregular to polygonal in shape, becoming smaller in the aperture region.
Remarks — Wodehouse (1933) included distinctly tricolpate ovoid pollen in the genus *Caprifoliipites*. The type species is characterized by a long colpi (see Potonié, 1960, p. 97). The specimens included in *Caprifoliipites superbus* show a brevicolporoid nature and hence are precluded from *Caprifoliipites* and included in a new genus. The Cauvery specimens are closely comparable to those described by Sah (1967) and as such are here considered as the same as those described here.
Botanical affinity — ? Caprifoliaceae.

***Caprifoliipites* Wodeh. 1933**

Type species— *Caprifoliipites viridifluminis* Wode. 1933.

Caprifoliipites sp.

Pl. 2, Fig. 9

Description — Pollen grain roundly triangular, 26·4×25 μ; tricolporate. Colpi moderately long but not reaching the poles, about 9 μ deep in polar view; ora circular to lalongate. Exine 1-1·3 μ thick, tectate, slightly thickening towards pore-region; nexinous thickening around the ora; sexine

thicker than nexine, granulate; surface very finely reticulate, body folded.

Remarks — Specimen referred here as *Caprifoliipites* sp., compares closely to *C. descretus* recorded from the Eocene of Mannargudi well, in general shape and 3-colporate condition, but differs in having comparatively longer colpi, less ornamented wall and slightly bigger size. The type species is differentiated by its better ornamented exine.

Botanical affinity — Caprifoliaceae.

Tricolporate pollen type

Pl. 2, Fig. 10

Description — Pollen grain spheroidal, 23 $\times$ 26·4 μ; tricolporate, colpi short, brevicolpate; ora not distinct, probably lalongate. Exine about 2·5 μ thick, tectate, sexine thicker than nexine, tectum pila not very distinct; echinate suprategillar ornamentation; spinules coni like, small, sparsely placed.

Botanical affinity — Unknown.

Marginipollis Clark. & Fred. 1968

Type species — *Marginipollis concinnus* Clark. & Fred. 1968.

Marginipollis concinnus Clark. & Fred. 1968

Pl. 4, Fig. 28

Holotype — Clark. & Fred. 1968; Pl. 2, Fig. 10.

Remarks — The specimen illustrated is smaller (19·8 $\times$ 36·5 μ) than the type species.

Botanical affinity — Lecythidaceae; *Planchonia*-type.

Tiliaepollenites (Pot.) Pot. & Ven. 1934

Type species — *Tiliaepollenites instructus* (Pot.) Pot. & Ven. 1934.

Tiliaepollenites foveolatus sp. nov.

Pl. 5, Fig. 1

Holotype — Pl. 5, Fig. 1.

Description — Pollen grain spheroidal, subtriangular in polar view, 3-aperturate, ? brevicolpoidate; 36·5 $\times$ 39·0 μ. Pores circular to slightly lolongate, annulate, colpi very short opening only up to the poral area. Exine about 3·5 μ; sexine thicker than nexine, tegillate, closely packed with columellae, surface foveolate, foveolae uniformly distributed, about 1·0 μ in diameter, nexinous thickening present underneath each pore.

Comparison — *Tiliaepollenites instructus* Potonié and Venitz (1934) compares in general shape and size and poral organization but *T. foveolatus* described here differs possessing distinctly foveo-reticulate exine. *T. paucus* Sah (1967) described from Burundi, Central Africa is large in size and differs in possessing reticulate sexine consisting of thin muri, while the present species is characterized by a foveolate-foveoreticulate ornamentation.

Pollen grains of living genera *Diplosiscus* (Tiliaceae) and *Fremontia* (Sterculiaceae) are comparable to those described here under *Tiliaepollenites*.

Tiliaepollenites rotundus sp. nov.

Pl. 5, Fig. 15

Holotype — Pl. 5, Fig. 15.

Description — Pollen grains spheroidal, amb circular; triporate, 17 $\times$ 16·5 μ. Pores sub-sunken, $\pm$ circular, about 2·0 μ, encircled by an unsculptured annulus of about 1·5 μ width. Exine $\pm$ 1·5 μ thick, sexine as thick as nexine or slightly thicker, tectate, intrapunctate.

Comparison — *Tiliaepollenites instructus* (Pot.) Pot. & Ven. (1934) is larger in size and prominently ornamented. *T. paucus* Sah (1967) is again a larger form and subtriangular and sexine is densely crowded with pila or bacula, forming a distinct reticulum. *T. foveolatus* is distinguished by its larger size and has foveo-reticulate surface.

Botanical affinity — Tiliaceae.

Myricipites Wodehouse, 1933

Type species — *Myricipites dubius* Wode. 1933.

Myricipites harrisii (Coup. 1953) comb. nov.

Pl. 4, Figs. 36, 39

1953 — Couper, *Triorites harrisii*, Pl. 7, Fig. 111.

1954 — Cookson & Pike, *Triorites harrisii*, Pl. 2, Figs. 95-99.
1964 — Harris, *Triorites harrisii*, Pl. 27, Fig. 37.

Description — Pollen grain sub-triangular, sides slightly convex between ora in polar view, 19·8-23·1×19·8-21·2 μ. Pores approximately circular, 2·0 to 3·3 μ in diameter, slightly aspidate with a definite thickening (annulus) around, ± 3·3 μ wide. Exine about 1·5 μ thick, scabrate; granulations prominent at the apertural region giving the characteristics feature to the pollen.

Remarks — *Triorites magnificus* Cookson (1950) is a triangular form with broad apertural cavity and a very distinct sculpture composed of baculae, reticuloid ornamentation. The same diagnosis is taken for the genus as amplified by Couper, 1953 (see also Potonié, 1960). Cookson meant to include mainly Proteaceous types of pollen under this genus.

The pollen under consideration here as well as those listed in synonym do not answer to the generic diagnosis of *Triorites*. *Myricipites* as designated by Wodehouse (1933) to accommodate spheroidal pollen of the type described here with aspidate poral thickenings and a smooth exine and hence are described under *Myricipites*.

Pollen of *Canacomyrica* Guill., a southern representative of Myricaceae, known only from New Caledonia are closely comparable to pollen of *Myricipites harrisii*, as suggested by Cookson & Pike (1954). A superficial resemblance to *Casuarina* can be ruled out as the latter has very prominent aspidate pore terminals (see Chanda, 1969).

Botanical affinity — Myriaceae.

Triatriopollenites (Pflug) Thomson & Pflug, 1953

Type species — *Triatriopollenites rurensis* Thoms. & Pf. 1953.

Triatriopollenites sp.

Pl. 5, Fig. 4

Description — Pollen grain spheroidal, circular in polar view, 37×37 μ. Triporate. Pores circular, 2·5-3 μ in diameter, slightly protruding with an unsculptured thickening around it. Exine up to 2·0 μ thick, sexine thicker than nexine, sexinous thickening absent in pore-area, laevigate to finely pitted.

Remarks — This type is rare and represented by a few specimens, and so detailed comparisons are not made.

Botanical affinity — Unknown.

Proteacidites Cooks. ex Coup. 1953

Type species — *Proteacidites adenanthoides* Cooks. 1950.

Proteacidites terrazus Rouse, 1962

Pl. 5, Figs. 5

Holotype — Rouse, 1962; Pl. 2, Fig. 22.

Remarks — The specimen referred here to *P. terrazus* Rouse (1962) is smaller in size (23×21·7 μ) than the holotype. The latter is also differentiated by its long protruding porate region. Closely comparable specimens have been included under *Retitriporites* Van der Hammen (1956) by Ramanujam (1966). The pollen of *Erythrina* which has been compared with similar pollen by Ramanujam is a distinct type and is not comparable.

Botanical affinity — Proteaceae.

Proteacidites granulatus sp. nov.

Pl. 5, Fig. 6, 7

Holotype — Pl. 5, Fig. 6.

Description — Pollen triangular with convex sides, corners rounded, angulaperturate; triporate, 20·5-22·5×19·8 μ in polar view. Ora aspidate, circular to slightly lalongate about 3·5 μ, protruding due to nexinous thickening (collar) about 2·0 μ wide. Exine less than 1·0 μ thick, being thicker towards poral region. Sexine thicker than nexine, granulose, grana less than 1·0 μ, sparsely spaced.

Comparison — *Proteacidites tuberculatus* Cookson (1950) is distinct in possessing large tubercles for ornamentation. *P. symphyonemoides* Cookson (1950) is larger in size with a broad ora. *P. adenanthoides* Cookson (1950), is distinguished by long protruding porate region. *P. reticuloscabratus* Harris (1965) has a very close ornamentation and thick orate aperture. *P. tuberculiformis* Harris (1965) has broad tubercles for its ornamentation and broad triangular amb. *P. terrazus* Rouse (1962) is distinctly a reticulate form. The other species of *Protea-*

cidites are highly ornate and as such not comparable.

Botanical affinity — Proteaceae.

Myricaceoipollenites Pot. 1951

Type species — *Myricaceoipollenites megagranifer* Pot., 1951.

Myricaceoipollenites punctitegellatus sp. nov.

Pl. 5, Fig. 12

Holotype — Pl. 5, Fig. 12.

Description — Pollen grain with almost circular amb, angulaperturate, triporate; 16·5×16·5 μ. Pores circular to slightly lalongate, about 2·0 μ, annulus not well developed. Exine about 1·5 μ, increasing in thickness at pore regions; sexine thicker than nexine, punctitegillate.

Comparison — Pollen grains of *Corylus tripollenites* Rouse (1962) are similar to the present species in three pored condition and nature of pore, but the latter is more spheroidal and possesses better ornamented wall and smaller in size. *Myricaceoipollenites megagranifer* Potonié (1951) is larger in size and has sparse grana as its ornamentation.

Botanical affinity — Myricaceae.

Coneopollis gen. nov.

Type species — *Coneopollis decorus* sp. nov.

Diagnosis and description — Pollen grains spherical in polar outline; tricolporate; 25·5 ×25·5 μ, brevicolpate. Pores broadly oval with thickened margin. Colpi small, wedged shaped. Exine thick, sexine thicker than nexine, tegillate, coarsely reticulate with broader lumina, muri narrow, polygonal; nexine thickened along the pores forming a broad collar.

Comparison — *Coneopollis* is comparable to *Thomsonipollis* (Krutzsch) Elsik (1968), but is distinguished by its tectate-coarsely reticulate surface ornamentation and thicker exine while the latter has tectate-psilate to intectate granulose thinner exine and has only pores for their apperture.

Tricolporopollenites baculoferus Pflug (1953) and those referred to as *Tricolporopollenites* spp. by Elsik (1968) are also closely comparable but differ in possessing a longer colpi as seen in equatorially flattened position.

Coneopollis decorus sp. nov.

Pl. 5, Fig. 14

Holotype — Pl. 5, Fig. 14.

Description — Pollen grains spheroidal in polar view, tricolporate; 25·5×25·5 μ; brevicolpate. Pores broadly oval with thickened margin, up to 3·0 μ thick, colpi wedged-shape. Exine up to 2·5 μ thick; sexine thicker than nexine, tegillate, coarsely reticulate with broader polygonal lumina and narrow muri. Nexine thicker along the pores forming a broad collar.

Botanica' affinity — Unknown.

Caryapollenites Raatz, 1937

Type Species — *Caryapollenites simplex* (Pot.) Raatz.

Caryapollenites cauveriensis sp. nov.

Pl. 5, Figs. 16, 20, 21

Holotype — Pl. 5, Fig. 21.

Description — Pollen grain spheroidal, amb circular, 12-16·5×13·8 μ. Triporate; pores subequatorial, simple, circular to slightly oval about 3·0 μ wide. Exine thin, 1·0 μ or less, sexine thicker than nexine, scabrate.

Comparison — *Caryapollenites simplex* (Pot.) Raatz (1937) is larger in size, roundly triangular. *C. anulatus* (described as *Subtriporopollenites anulatus* Pflug and Thomson (in Thomson and Pflug. 1953) is also larger in size with a pronounced papillose ornamentation. *Carya juxtaporipites* (Wodehouse) Rouse (1962) is closely comparable but it is slightly larger.

Botanical Affinity — Juglandaceae.

Caryapollenites tetraporoides sp. nov.

Pl. 5, Fig. 22

Holotype — Pl. 5, Fig. 22.

Description — Pollen grain spheroidal; tetraporate; 19·8×19·8 μ; pores subequatorially placed, circular to slightly oval-shaped, about 2·7 μ in diameter with slightly thickened rim. Exine thin, about 1·0 μ, sexine thicker than nexine, granulose.

Comparison — *Caryapollenites simplex* (Pot.) Raatz (1937) and *C. anulatus* are larger in size and also differ in shape and ornamentation. *C. juxtaporipites* (Wodehouse) Rouse (1962) differs in triporate

condition. *C. cauveriensis* sp. nov., another species described in this study is a triporate pollen and smaller in average dimentions.

Botanical Affinity — Juglandaceae.

Scabratriporites v. d. Ham. 1956

Type Species — *Scabratriporites simpliformis* H. Klink. 1966.

Remarks — *Scabratriporites* van der Hammen (1956) is here validated to include angulaperturate, scabrate triporate pollen with pores not subtended by thickenings. *Triporopollenites* (Pflug) Thomson and Pflug (1953) which is validly published includes pollen with aspidate apertures.

Scabratriporites was published by van der Hammen with a modern equivalent as the type. Hence, was not considered valid by Potonié. Hoeken-klinkenberg (1966) described similar pollen under *Scabratriporites simpliformis* recorded from Palaeocene of Nigeria. This species is here considered as the type species in validating this genus.

Scabratriporites triangularis sp. nov.

Pl. 5, Fig. 18

Holotype — Pl. 5, Fig. 18.

Description — Pollen grain with triangular amb, sides convex; triporate, 23·7×24·4 μ in polar view. Pores circular to slightly oval in shape, 3·3 μ wide. Exine about 1·2 μ thick, sexine thicker than nexine, nexine thickening at the pore region, surface scabrate.

Comparison — *Scabratriporites triangularis* described here is closely comparable to *S. simpliformis* Hoeken Klinkenberg (1966), but differs in its smaller size and bigger pores.

Botanical affinity — Unknown.

Subtriporopollis Sah, 1967

Type species — *Subtriporopollis tenuis* Sah, 1967.

Subtriporopollis scabratus sp. nov.

Pl. 5, Figs. 17 , 19

Holotype — Pl. 5, Fig. 19.

Description — Pollen grains spheroidal, amb ± circular, triporate; 25 × 26·4 μ. Pores distinct, circular, placed very near the equator, intragranular, 6·6×2·6 μ in diameter. Exine 1·5 to 2·0 μ thick, sexine slightly thicker than nexine, tectate, scabrate. Prominent nexinous thickening around the ora.

Comparison — *Subtriporopollis tenius* Sah (1967) is distinguished by its larger size, reticulate ornamentation and tenuiexinous nature. *S. rotundis* Sah (1967) is also reticulate and larger with closely comparable pores as that of the species described here

Botanical affinity —? Ulmaceae or Rubiaceae

Striatriporites H. Klink. 19566

Type species — *Striatriporites nigeriensis* H. Klink. 1966.

Striatriporites cf. *S. nigeriensis* H. Klink, 1966

Pl. 5, Fig. 23

Description — Pollen grain with triangular amb with slightly convex sides and rounded angles, angulaperturate; triporate; 32× 23·7 μ in polar view. Pores ± circular about 2·0 μ in diam., encircled by an unsculptured annulus about 2 μ in width, pore-borders slightly protruding Exine 1 μ or less, stratification indistinct, striate; striations less than 1 μ thick, circumambient to the angles in polar view, meeting at the poles, undulating.

Comparison — The specimen described here compares very closely with the Nigerian species described by Hoeken-Klinkenberg (1966) from the Maestrichtian sediments.

Botanical affinity — Unknown.

Striatriporites cauveriensis sp. nov.

Pl. 5, Fig. 25

Holotype — Pl. 5, Fig. 25.

Description — Pollen grain roundly triangular with straight to convex sides, 17·8×19·8 μ. Triporate; angulaperturate. Pores equatorial, protruding, ± circular about 2·0 μ in diameter encircled by an unsculptured 1·5-2 μ wide annulus. Exine thin, less than 1·0 μ, stratification obscure, ornamented with striations. Ridges following the contour of the pore and meeting at the poles.

Comparison — *Striatriporites cauveriensis* compares well with the *S. nigeriensis* in its general morphological features, but is distinguished by its smaller size and prominently protruding pores.

Botanical affinity — Unknown.

Thomsonipollis (Krutz.) Els. 1966

Type species — *Thomsonipollis magnificus* Pf. & Thom. 1953.

Thomsonipollis submarginatus sp. nov.

Pl. 5, Fig. 24

Holotype — Pl. 5, Fig. 24.

Description — Pollen grains spheroidal-circular in polar view; triporate, 26·4×33 μ. Pores submarginal, circular to slightly oval, 2·6 to 3·3 μ in diam. with a distinct annulus. Exine about 3·0 μ thick; sexine thicker than nexine, ornamented with fine closely spaced pila and bacula, often coalescing to form a vermiculate-reticulate pattern.

Comparison — *Thomsonipollis palaeocenicus* Elsik (1968) is larger in size, roundly triangular with prominently invaginated larger pores. *T. magnificus* Pflug and Thomson, 1953 ex Krutzsch (1960) is highly ornamented with distinct processes, variously covered over the sexine.

Botanical affinity — Rubiaceae.

Thomsonipollis variornatus sp. nov.

Pl. 5, Fig. 27

Holotype — Pl. 5, Fig. 27.

Description — Pollen grain spheroidal, amb circular, variously folded; triporate, 34·5×39·6 μ. Pores submarginal, circular, about 4·0 μ wide with a distinct annulus, 2·5-3·0 μ around pores. Exine about 3·0 μ thick, stratification not distinct, sexine ornamented with irregularly distributed grana of varying sizes with laevigate exine in between.

Comparison — *Thomsonipollis palaeocenicus* Eslik (1968) is roundly triangular with prominently envaginated pores. *T. magnificus* Pflug and Thomson ex Krutzsch (1960) is highly ornamented.

T. submarginatus sp. nov. is distinguished by its closely set pila for ornamentation.

Botanical affinity — Unknown.

Maculoporites Gen. nov.

Type species — *Maculoporites reticulatus* sp. nov.

Diagnosis and description — Pollen grains spheroidal, circular to roundly triangular in polar view. Triporate, pore margin thickened by nexinous thickenings, sexine tactate, thicker than nexine, reticulate with closely set meshes. Pore margins not covered by sexine.

Comparison — *Triorites* (Erdtman, Cookson) Couper (1953) distinctly triangular without any elaborate sexinous ornamentation. *Thomsonipollis* (Krutzsch) Elsik (1968) is comparable in the type of pore construction, but differs in the ornamentation of the sexine, tectate-psilate to intectate-granulose and aperture number which also varies from one to eight or more in number.

Maculoporites reticulatus sp. nov.

Pl. 5, Fig. 28

Holotype — Pl. 5, Fig. 28.

Description — Pollen grain spheroidal, amb ± circular, triporate; 33·66×34·4 μ. Pores equatorially placed, circular to oval in shape, about 3·3 μ wide, bordered by 1·3 μ wide nexinous thickenings. Exine about 2 μ thick, sexine thicker than nexine, tectate, columella distinct with rounded distal ends, surface reticulate.

Botanical affinity — Unknown.

Tricollareporites Gen. nov.

Type species — *Tricollareporites echinatus* sp. nov.

Diagnosis and description — Pollen grain spheroidal, amb circular in polar view; triporate, pores surrounded by a thick collar. Exine thick, sexine pilate, baculate, granulose or echinate.

Derivation of Name — The generic name is derived from the conspicuous thick collard aperture. Triporate pollen with thick collar and heavy ornamented sexine are included under the genus.

Comparison — *Tiliaepollenites* Pot. & Ven. (1934) are also vestibulate but have a pore cavity and sometimes colporate and apertures are intrangular. Comparable pollen are known in the family Stertculiaceae (*Pterospermum*).

Tricollareporites echinatus sp. nov.

Pl. 5, Figs. 29, 30; Pl. 6, Fig. 5

Holotype — Pl. 5, Fig. 29.

Description — Pollen spheroidal, amb circular; triporate, 46·2-47·5×46·2-52·8 μ. Pores circular to elliptical, about 3·5 μ in diameter, surrounded by a thick collar, 4·6-6·0 μ wide making the poral region prominent. Exine about 3·3 μ thick, sexine thicker than nexine, tectate; surface granulose, echinate; spines about 3·3 μ long, conical with ± blunt tips, evenly spaced and sparsely distributed.

Remark — The present fossil species compares very closely to the pollen grains of the extant genus, *Pterospermum* of Sterculiaceae in its morphological features, however fossil pollen are smaller in size.

Botanical affinity — Sterculiaceae.

Symplocospollenites Pot. Thoms. & Thierg. 1950

Type species — *Symplocospollenites rotundus* (Pot.) Pot., Thoms. & Thierg. 1950.

Symplocospollenites sp.

Pl. 2, Fig. 8

Description — Pollen grain ± spheroidal in polar view; 19·8×18·5 μ; tetraporate. Pore simple, small, ± circular to slightly lolongate, slightly aspidate, 1·5-2·0 μ in diameter. Exine about 1·5 μ thick, thicker at pore-region; sexine as thick as nexine, smooth to faintly ornamented.

Remarks — The specimen referred here to the genus *Symplocospollenites* is comparatively smaller than the type species. The latter is further differentiated by comparatively more aspidate pores.

Botanical affinity — Symplocaceae.

Myrtaceidites (Cooks. & Pike) Pot. 1960

Type species — *Myrtaceidites mesonesus* Cooks. & Pike, 1954.

Myrtaceidites mesonesus Cooks. and Pike, 1954

Pl. 4, Fig. 30

Holotype — Cookson & Pike; Pl. 1, Fig. 36.

Remarks — The illustrated specimen measures 12·5-12·5 μ.

Botanical affinity — Myrtaceae.

Myrtaceidites eucalyptoides Cooks. & Pike, 1954

Pl. 4, Fig. 29

Holotype — Cookson & Pike.

Remarks — The present specimen is smaller than the type species and the holotype and measures 11·8×12·5 μ in equatorial diameter.

Botanical affinity — Myrtaceae.

Cupanieidites Cooks. & Pike, 1954

Type species — *Cupanieidites orthoteichus* Cooks. & Pike, 1954.

Cupanieidites decoratus sp. nov.

Pl. 4, Figs. 37, 38

Holotype — Pl. 4, Fig. 38.

Description — Pollen grain roundly triangular with convex sides in polar view, 19·8×21·2 μ; trisyncolpate, arci prominent, colpi joining, forming a distinct polar island. Exine about 1·0 μ or less, stratification obscure due to well-built ornamentation, nexinous thickening distinct at the poral region, prominently reticulate, reticulations uniform and formed due to punctae.

Comparison — *Cupanieidites decoratus* resembles *C. orthoteichus* (Cookson & Pike, 1954) in size and syncolpate condition, but the latter is distinguished by its fine reticulation.

Cupanieidites major Cookson and Pike (1954) is distinctly larger in size and possesses a very small polar island. *C. reticulatus* Cookson & Pike (1954) resembles the Cauvery species in size and sexine reticulations but is distinguished by a less developed polar island which sometime is completely absent.

Botanical affimity — Sapindaceae.

Stephanocolpites (V. d. Ham.) Pot. 1960

Type species — *Stephanocolpites costatus* V. d. Ham. 1954.

Stephanocolpites aggerus sp. nov.

Pl. 2, Fig. 3

Holotype — Pl. 2, Fig. 3.

Description — Pollen grain spheroidal, 26·4×25·7 μ; Pentacolpate. Colpi thin,

silt like, short, 7-8 μ deep in polar view. Exine about 4·0 μ thick, sexine nearly 3-times as thick as nexine, verrucate; verrucae low, 2·0 μ broad and 1·5 μ high.

Comparison — *Stephanocolpites nadhamunii* Venkatachala and Kar (1968) resembles the present species in size, shape and nature of colpi, but the latter can easily be distinguished by its verrucate ornamentation.

Retistephanocolpites coromandeliensis Venkatachala & Rawat, 1971 recorded in the Eocene sediments of the basin is comparable in shape and colpi number to the present species, but the former can be distinguished by its foveo-reticulate exine ornamentation.

S. aggerus is differentiated from *S. costatus* (V. d. Hammen) Potonié, 1960 by its verrucate exine. The latter has reticulate-foveolate exine.

Botanical affinity — Unknown

Stephanocolpites flavatus Venkat. & Kar, 1968

Pl. 5, Fig. 10

Holotype — Venkat. & Kar, 1968; Pl. 3, Fig. 76.

Remarks — The specimen illustrated here resembles the specimen described by Venkatachala and Kar (1968) from Kutch in size and shape, but in the present specimen, granulations are less developed and colpi are longer (9·3 μ) than the Kutch specimens.

Botanical affinity — Unknown.

Tetracolporites Coup. 1953

Type species — *Tetracolporites camaruensis* Coup. 1953.

Tetracolporites insignatus sp. nov.

Pl. 5, Fig. 11

Holotype — Pl. 5, Fig. 11.

Description — Pollen grain with quadrangular amb; tetracolporate; 23·7×25 μ, colpi small ± 8·0 μ deep in polar view, tenuimarginate; ora slightly lalongate with slightly thickened rim. Exine about 1·5 μ thick, sexine thicker than nexine, finely intragranulate to psilate.

Comparison — *Tetracolporites insignatus* described here resembles in shape, colpi and exine characters with *T. quadrangularis* Ramanujam (1966) but the former is distinguished by its smaller size and less developed appertures.

Tetracolporites paucus Sah and Dutta (1967) described from Barail series in Upper Assam is distinctly a larger form and is further distinguished by its ornamentation which is pitted-reticulate, polybrochate, simplibaculate. *Tetracolporites onagraceoides* Sah & Dutta (1967) differs in having characteristic bulge-like apertural parts and is distinctly larger in size. *T. longicolpus* Sah and Dutta (1967) resembles the present species in shape and size but can be distinguished by its longer colpi, almost extending up to the poles and possesses thicker exine.

T. camaruensis Couper (1953, 1960) and *T. ixerboides* Couper (1960) are larger in size and differ in exine ornamentation and aperture characters. The other species of *Tetracolporites* described by Sah (1967) from the Neogene of Congo also differ in size and exine ornamentation.

Botanical affinity — Unknown.

***Malvacearumpollis* Nagy, 1962**

Syn. *Echiperiporites* V. d. Ham. and Wijms. 1964.

Type species — *Malvacearumpollis bakonyensis* Nagy, 1962.

Malvacearumpollis paucibaculatus sp. nov.

Pl. 6, Figs. 1, 2

Holotype — Pl. 6, Fig. 1.

Description — Pollen grain spheroidal, panaperturate, polyporate; 49·0×46·2 μ (excluding spines). Pores annulate, 8-10 in number, sparsely distributed, about 4·5 μ in diameter; sexine as thick as nexine or thinner, 1·0 μ or less, thickened at roots of spines up to 3·3 μ, tectate; spines few sparsely distributed, about 6·0 μ long, about 2·0 μ thick at the base, tapering distally, with conical to blunt tips. Exine between the spines prominently granulate, grana closely placed and 1 μ or more than 1 μ in diameter.

Comparison — *Echiperiporites estelae* van der Hammen and Wijmstra (1964) is a closely comparable but differs in possessing the larger number of pores and bigger size. *Malvacearumpollis grandis* Sah (1967) and *M. africana* Sah (1967) described from Neogene of Congo are distinctly larger in

size and also differ in pore number and of spines. *M. bakonyensis* Nagy (1962) differs from the present species in possessing non-tegillate sexinous layer at the base of spines and possesses more suprategillar spines.

Botanical affinity — *Thespesia* (Malvaceae)

Polyporina (Naumova) Potonié, 1960

Type species — *Polyporina multistigmosa* (Pot.) Pot. 1960.

Polyporina excavatus sp. nov.

Pl. 6, Figs. 3, 4, 6

Holotype — Pl. 6, Fig. 4.

Description — Pollen grains spheroidal, amb ± circular, Panporate, polyporate; 39·6-44×39·6-47·5 μ. Pores large, circular to ellipsoidal, 3·5-6·6 μ in diam., 25-30 in numbers, 4 to 5 μ apart. Exine about 4·0 μ thick, sexine thicker than nexine, tegillate, pilate, pila distinct, less than 1·0 μ thick, small coni form the suprategillar ornamentation, coni very small, about 1 μ high, sparsely spaced.

Comparison — *Polyporina multistigmosa* (Pot.) Potonié (1960) is small in size. *P. globosa* Sah (1967) is distinctly a smaller form and also differs in not having suprategillar ornamentation. *P. magna* Sah (1967) is distinguished by its bigger size and annulate pores. *Buttinia*, a genus described by Boltenhagen (1967) from the Upp. Cretaceous sediments of Gabon and later also recorded from the Upp. cretaceous by Germaraad *et al.* (1968) is comparable in as much as the polyporate nature. The specimens included here under *Polyporina excavatus* distinguish in possessing an elaborate sculptural pattern. A detailed study may necessiate separating them under a new genus.

Botanical affinity — Caryophyllaceae.

Polyporina ornata sp. nov.

Pl. 2, Fig. 2

Holotype — Pl. 2, Fig. 2.

Description — Pollen grain spheroidal, 59·4×57·5 μ; panaperturate; Polyporate, Pores about 40-50 in number, circular to ellipsoidal, small, 2-2·6 μ in diam., annulate, annulus about 2·0 μ wide. Exine 6·5 to 7·0 μ thick, tectate; sexine much thicker than nexine; highly ornamented; positive ornamentation appears to be radiating from the pore-margins outwardly on the surface; fine echinate structures form the superategillar ornamentation.

Comparison — *Polyporina ornata* is distinguished from all known fossils of the genus (Potonié, 1934, 1960; Sah, 1967) by its characteristic exine ornamentation.

Botanical affinity — ? Caryophyllaceae.

Polyporina sp.

Pl. 6, Fig. 12

Description — Pollen grain ± spheroidal, 26·5×28 μ; polyporate, Pores ± circular, 4-5 μ in diameter, 10-15 in number. Exine about 2 μ thick, sexine thicker than nexine, punctitegillate.

Botanical affinity — Unknown.

Pollen type

Pl. 2, Fig. 11

Description — Pollen oval to subspheroidal, 41×35 μ; nonaperturate. Exine about 1·3 μ thick, tectate; sexine thicker than nexine, with faintly reticulate ornamentation.

Botanical affinity — Lauraceae or Annonacea.

Algae

Oudhkusumites Sriv. 1967

Type species — *Oudhkusumites ankleshvarensis* Sriv 1967.

Oudhkusumites ankleshvarensis Sriv. 1967

Pl. 3, Figs. 17, 19

Holotype — Sriv., 1967; Pl. 1, Fig. 1.

Remarks — The present Miocene specimens measures 45-46·2×49-62 μ.

Heliospermopsis Nagy (1965) is closely comparable, as the authors have no access to the type material of *Heliospermopsis*, the Cauvery forms have been placed with the genus *Oudhkusumites sensu* Srivastava (1967).

Botanical affinity — Algae.

? *Algal sphaeromorph*

Pl. 6, Fig. 17

Description — Specimen with spherical amb; 77·2×79·2 μ. Central body not distinguishable from the wings except being lighter in colour, appears to be spherical, 29·5×26·5 μ in diameter; wall smooth and very thin. Wing well developed, 23-26·5 μ wide, radially folded and smooth.

Botanical affinity — Algae.

Hystrichosphaeridium Defl. 1937

Type species — *Hystrichosphaeridium tubiferum* Ehr. 1938.

Hystrichosphaeridium complex (white) Defl. 1946

Pl. 2, Figs. 15, 16

Description — Body spheroidal to broadly oval shaped, 46×36·5 μ. Body wall thin, less than 1·0 μ, finely granulate. Processes arising all over the body, slender, sparsely distributed, probably hollow, long, 16·5-20 μ, moderately thick, almost uniform in width, about 2 to 2·6 μ, except the proximal broader portion; tips furcating, furcations usually laterally extended, and sometimes curved.

Botanical affinity — Algae.

Hystrichosphaeridium sp. 1

Pl. 1, Fig. 10

Description — Body spheroidal, 72×83·2 μ; body wall thin, 1 to 1·2 μ thick, finely punctate, punctae very small, less than 1·0 μ; in diameter. Processes long, 20-26·4 μ, arising from all over the body, almost uniformly distributed, hollow, slender to slightly supple, with wider proximal base, about 3·5 μ wide and gradually thinning distally, distal tips bifurcate to multifurcate. Body folded.

Botanical affinity — Algae.

Hystrichosphaeridium sp. 2

Pl. 1, Fig. 13

Description — Specimen broken, body presumably spherical, 49·5 μ. Body wall thin, less than 1·0 μ, finely granulate. Processes long, about 23·5 μ; 4·6 to 7·3 μ thick almost uniformly broad, slightly thicker proximally, sparsely distributed, 9-13 μ apart; multifurcate distal ends form a fan like structure; furcations of very small magnitude. Apparently it is make up of either 2-3 number of processes or it may be a single thick process.

Botanical affinity — Algae.

Genus — _Cooksonella_ Nagy, 1965

Type species — *Cooksonella circularis* Nagy, 1965.

Cooksonella circularis Nagy, 1965

Pl. 2, Fig. 13

Holotype — Nagy, 1965; Pl. 4, Fig. 16.

Remarks — The specimen recorded here in this study is quite identical to the specimen described from the Neogene sediments of Hungary (Nagy, 1965), in all morphological features, except for its smaller size measuring only 100×97 μ, while the type species measures 140 μ.

Botanical affinity — Leiosphaeridae.

Incertae sedis

Pl. 2, Fig. 14

Description — Colonial type of algae, ± spherical, measuring 25-64 μ. A thick up to 15 μ wide well stratified mucillaginous envelope present in all the colonies, aggregation of up to 20 cells common.

Botanical affinity — Algae. ? Crytophyceae (*Phaecococcus*).

Fungal Remains

Fusiformisporites (Rouse, 1962) Elsik, 1968

Type species — *Fusiformisporites crabii* Rouse, 1962.

Fusiformisporites pseudocrabii Els. 1968

Pl. 1, Fig. 4

Holotype — Els., 1968, Pl. 2, Fig. 14.

Remarks — The Cauvery specimen is closely identical to the form described by Elsik, 1968 (Pl. 2, Figs. 13 & 14) from Paleocene sediments of Rockdale lignite,

Taxas, in all its morphological features and measures 59·4×26·4 μ. The type of the genus is comparatively smaller.

Botanical affinity — Spores of *Cookeina* as illustrated by Wolf and Cavaliere, 1966 (see Elsike, 1968) are closely comparable.

Diporisporites (v. d. Hamm.) Els. 1969

Diporisporites piercei (Var. and Raw.) Els. 1968

Pl. 1, Fig. 7

Syn. Granodiporites piercei Var. and Raw. 1963.

Description ... Spore, 2-porate, bilateral, isopolar, barrel-shaped, 38·5×23·5 μ. Pores slightly bulging, provided with a thickened collar, presumably circular, about 7·5 μ in diameter. Exine less than 1·0 μ; sexine thicker than nexine, finely granulate.

Botanical affinity — Fungal.

Diporisporites anklesvarensis (Var. & Raw. 1963) Els. 1968

Pl. 1, Fig. 8

Syn. Foveodiporites anklesvarensis Var. & Raw. 1963.

Description — Spore 2-porate, bilateral, isopolar, oval somewhat elongated; 52·8 ×26·4 μ. Pores at the lateral ends about 8·5 μ in diameter at the base, elevated from the general body by a collar about 4·5 μ high. Pore opening comparatively small, ± 4·0 μ in diameter. Exine about 1·0 μ, foveolate, foveolae mixing, giving an irregular pseudoreticulum on the surface.

Remarks — *Foveodiporites anklesvarensis* Varma and Rawat (1963) a common species recorded from Eocene to oligocene sediments of western region of India, has also been transferred to *Diporisporites anklesvarensis* by Elsik (1968) who also assigned fungal affinity (for detail comments see Venkatachala & Rawat, 1972.)

Botanical affinity — Fungal.

Phragmothyrites Edw. 1922

Type species — *Phragmothyrites eocaenicus* Edw. 1922.

Pragmothyrites sp. 1

Pl. 1, Fig. 9

Description — Perithecium subcircular, 38·5×39.6 μ. Hyphae are radially arranged, interconnected forming pseudoparenchymatous tissue; cells squarish to rectangular, outer cells slightly conical and elongated giving rise to undulating margin. Marginal cells possess pore like structure, about 1·3 μ in diameter.

Botanical affinity — Microthyriaceae.

Phragmothyrites sp. 2

Pl. 6, Fig. 13

Description — Specimen circular, 29·7× 28·0 μ. Hyphae radially arranged, interconnected forming pseudoparenchymatous tissue. Cells rectangular to squarish.

Botanical affinity — Microthyriaceae.

Fungal spore type

Pl. 6, Fig. 14

Description — Specimen ± spheroidal with distinctly weavy or indented wall; 14·5× 16·0 μ. Wall about 1·5 μ thick, smooth. Minute equatorial pore like structure present all-around.

Remarks — Such spores are virtually identical with those of the extant fungal genus *Desmidiospora*.

Botanical affinity — Fungal spore (*Desmidiospora*).

Fungal spore

Pl. 1, Fig. 11

Description — Spores unicellular, spindle-shaped, with rounded ends; 33×13·2 μ. A central longitudinal furrow extending from pole to pole, uniformly broad. Exine about 1·0 μ thick; esxine thicker than nexine, psilate.

Remarks — Sah (1967, Pl. 12, Figs. 8, 9) has described such comparable spores from the Neogene sediments of Congo which are classed under Fungi Imperfecti.

Botanical affinity — Fungi Imperfecti.

Fungi Type 1

Pl. 6, Fig. 15

Description — Specimen broken, composed of a single layer of systematically arranged

cells, Each cell elongated, ± oval-shaped, 19·8×9·0 μ with pointed distal end and short stalk; cell wall 1·0 μ or less, two layered, smooth, irregularly distributed few perforation observed.

Fungal type 2
Pl. 6, Fig. 16

Description — Specimen elongated, ± oval-shaped; 79·3×53·0 μ. Hyphae radially arranged inter-connected; cells rectangular. At one end the cells are more crowded.

Bryophytic spore type
Pl. 6, Fig. 18

Description — Spore sphercidal, probably inaperturate; 76·5×73·5 μ. Spore-amb with a well-developed flange like structure, about 4·0 μ wide alround. Exine about 3·5 μ thick, coarsely reticulate, meshes polygonal, about 9·5 μ wide, muri thin, 1·5 μ thick, equatorially projecting over the flange; muri area well punctate.

Botanical affinity — ? Bryophytic.

DISCUSSION

Three palynological zones, viz., *Magnastriatites cauveriensis, Lacrimapollis pilosus* and *Tricollareporites echinatus* are proposed on the basis of qualitative and quantitative distribution of spore-pollen taxa in the Oligocene-Miocene sediments of the Cauvery basin (Venkatachala & Rawat, 1970). The present paper deals with a detailed account of the palynology of oligo-miocene sediments met within Madanam and Karaikal wells studied by the authors.

Zone 1 — *Magnastriatites Cauveriensis* zone (Oligocene)

This zone is recognized in Madanam and Karaikal wells E & F. The zone is characterized by the appearance of *Cicatricosisporites macrocostatus, Monoporopollenites gramineoides, Abietineaepollenites* sp., *Foveotricolpites perforatus, Proteacidites granulatus, Polyporina* spp., *Magnastriatites cauveriensis.* These taxa are considered important in marking Eocene-Oligocene boundary in the present study (see also Venkatachala & Rawat, 1972).

An abundance of *Verrucatosporites sparsus, Verrucatosporites* spp., *Polypodiisporites ornatus, Costatipollenites pauciornatus, Favitricolporites* sp., *Myricaceoipollenites* spp., *Myricipites harrissi* is well represented in the sub-surface of Madanam, while they decrease in percentage in Karaikal wells. *Margocolporites* which is well represented in the underlying *Margocolporites sahnii* zone (see Venkatachala & Rawat, 1972) is rare in this zone. *Caprifoliipites* and *Sapotaceoidaepollenites* are well represented in this zone as compared with the underlying zone.

The continuance of the Upper Eocene taxa, such as *Cupanieidites flaccidiformis, Proteacidites terrazus, Favitricolporites* spp., *Talisiipites retipilatus, Polypodiaceaesporites levis,* and *Caprifollipites obscurus* also distinguish this zone (Venkatachala & Rawat, 1971).

Magnastriatites cauveriensis is restricted to this zone in the Karaikal wells.

Important fossil taxa, such as *Psilodiporites hammenii, Proxapertites hammenii, Spinizonocolpites echinatus, Polycolpites pedaliaceoides, Stephanocolpites octacolpites, Retistephanocolpites coromendeliensis, Symplocoipollenites punctatus, S. gracilis* of the underlying Palaeocene-Eocene sequence (Venkatachala & Rawat, 1971) are not recorded in this zone.

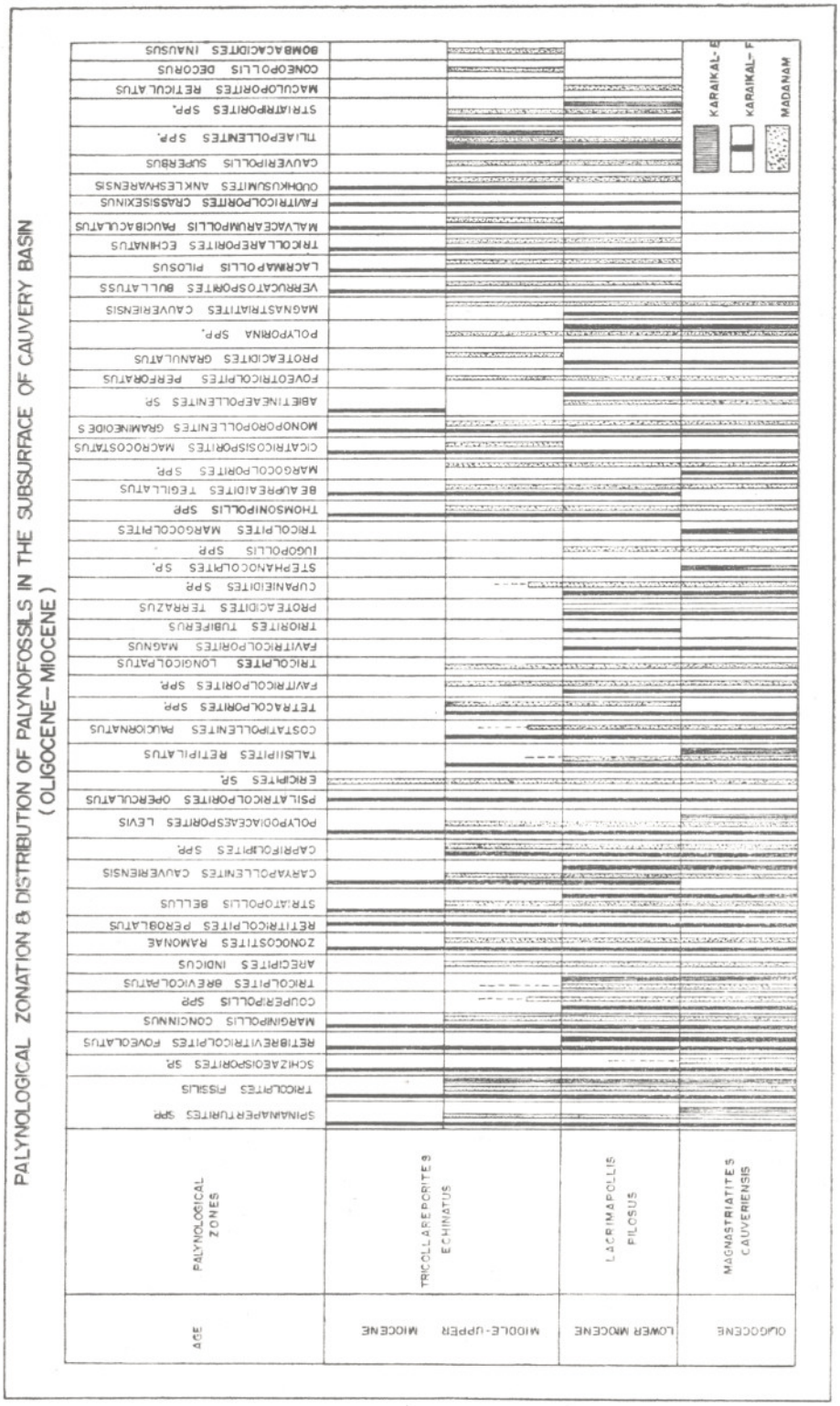
Sonneratiaceous pollen referred here to *Iugopollis* are recorded only in the Madanam well.

Marine phytoplankton represented only by hystrichosphaerids, are well represented in the Madanam well, and show a meagre percentage in the Karaikal wells.

Zone 2 — *Lacrimapollis Pilosus* zone (Lower Mioceue)

This zone is recognized in both Madanam and Karaikal wells. The first appearance of *Verrucatosporites bullatus, Lacrimapollis pilosus, Tricollareporites echinatus, Malvacearumpollis paucibaculatus, Oudhkusumites ankleshvariensis, Cauveripollis superbus, Tiliaepollenites* sp., *Stritriporites cauveriensis, S. nigeriensis* and *Maculoporites reticulatus* mark this zone.

An abundance of mixed pteridophytic and angiospermic representatives is well marked in this zone. Fungal remains constitute 10-20% of the total assemblage. Hystrichosphaerids show a gradual improverishment in number in this zone and are absent


PALYNOLOGICAL ZONATION & DISTRIBUTION OF PALYNOFOSSILS IN THE SUBSURFACE OF CAUVERY BASIN
(OLIGOCENE– MIOCENE)
AGE
PALYNOLOGICAL ZONES
OLIGOCENE
LOWER MIOCENE
MIDDLE-UPPER MIOCENE
MIOCENE
MAGNASTRIATITES CAUVERIENSIS
LACRIMAPOLLIS PILOSUS
TRICOLLAREPORITES ECHINATUS
KARAIKAL- E
KARAIKAL- F
MADANAM
SPINAMAPERTURITES SPP
TRICOLPITES FISSILIS
SCHIZAEOISPORITES SP.
RETIBREVITRICOLPITES FOVEOLATUS
MARGINIPOLLIS CONCINNUS
COUPERIPOLLIS SPP.
TRICOLPITES BREVICOLPATUS
ARECIPITES INDICUS
ZONOCOSTITES RAMONAE
RETITRICOLPITES PERGOLATUS
STRIATOPOLLIS BELLUS
CARYAPOLLENITES CAUVERIENSIS
CAPRIFOLIPITES SPP.
POLYPODIACEAESPORITES LEVIS
PSILATRICOLPORITES OPERCULATUS
ERICIPITES SP.
TALISIIPITES RETIPILATUS
COSTATIPOLLENITES PAUCIORNATUS
TETRACOLPORITES SPP.
FAVITRICOLPORITES SPP.
TRICOLPITES LONGICOLPATUS
FAVITRICOLPORITES MAGNUS
TRIORITES TUBIFERUS
PROTEACIDITES TERRAZUS
CUPANIEIDITES SPP.
STEPHANOCOLPITES SP.
LUGOPOLLIS SPP.
TRICOLPITES MARGOCOLPITES
THOMSONIPOLLIS SPP.
BEAUPREAIDITES TEGILLATUS
MARGOCOLPORITES SPP.
CICATRICOSISPORITES MACROCOSTATUS
MONOPOROPOLLENITES GRAMINEOIDES
ABIETINEAEPOLLENITES SP.
FOVEOTRICOLPITES PERFORATUS
PROTEACIDITES GRANULATUS
POLYPORINA SPP.
MAGNASTRIATITES CAUVERIENSIS
VERRUCATOSPORITES BULLATUSS
LACRIMAPOLLIS PILOSUS
TRICOLLAREPORITES ECHINATUS
MALVACEARUMPOLLIS PAUCIBACULATUS
FAVITRICOLPORITES CRASSISEXINUS
OUDHKUSUMITES ANKLESHWARENSIS
CAUVERIPOLLIS SUPERBUS
TILIAEPOLLENITES SPP.
STRIATRIPORITES SPP.
MACULOPORITES RETICULATUS
CONEOPOLLIS DECORUS
BOMBACACIDITES INAUSUS

in the overlying *Tricollareporites echinatus* (Mid.-Up. Miocene) zone.

A high incidence of polypodiaceous ferns, such as *Polypodiisporites ornatus, Verrucatosporites bullatus, V. sparsus,* along with angiospermous pollen, viz., *Psilatricolporites operculatus, Costatipollenites pauciornatus, Favitricolporites* spp., *Caryapollenites cauveriensis, Sapotaceoidaepollenites* spp. is observed in this zone. *Maculoporites reticulatus* is only recorded in the Madanam well.

Older Taxa, such as *Magnastriatites cauveriensis, Polyporina* spp., *Proteacidites granulatus, Foveotricolpites perforatus, Monoporopollenites gramineoides, Cicatricosisporites macrocostatus* and *Abietineaepollenites* sp. recorded in the underlying (*Magnastriatites cauveriensis*) zone also continue to occur in this zone.

Favitricolporites magnus, Triorites tubiferus, Proteacidites terrazus mark the top of this zone.

Zone 3 — *Tricollareporites echinatus* zone (Mid-UP. Miocene)

Two subzones are marked in the *Tricollareporites echinatus* zone.

Verrucatosporites bullatus subzone — This subzone is recognized in Madanam and Karaikal wells and is marked by the occurrence of *Coneopollis decorus, Bombacacidites inausus.* The earlier recorded Mid. Miocene (*Lacrimapollis pilosus* zone) taxa, such as *Verrucatosporites bullatus, Lacrimapollis pilosus, Tricollareporites echinatus, Malvaceatumpollis paucibaculatus, Oudhkusumites ankleshwariensis, Cauveripollis superbus, Tiliaepollenites* spp. and *Striatriporites cauveriensis* also distinguish this zone

The dominance of *Verrueatosporites bullatus, Verrucatoporites* spp., *Foveotricolpites perforatus, Monoporopollenites graminoides, Sapotaceoidaepollenites* spp. and *Paleocoprosmadites arcotense* is pronounced.

Talisiipites retipilatus, Costatipollenites pauciornatus, Favitricolporites spp., *Tricolpites longicolpatus, Foveotricolpites perforatus, Proteacidites granulatus, Cauveripollis superbus, Tiliaepollenites* spp. and *Striatriporites* spp. are restricted up to this zone and their stratigraphic range is Eocene-Middle Miocene in this basin.

Bombacacidites inausus and *Coneopollis decorus* are only recorded in this zone.

Malvacearumpollis paucibaculatus subzone — This zone is only recognized in Karaikal well-F. The absence of the above taxa characterising the underlying *Verrucatosporites bullatus* subzone, mark this zone. *Monoporopollenites gramineoides,* a grass pollen (Ppaceae) which records a maximum distribution in the Middle Miocene times, gradually declines in its representation in this zone.

This zone is further characterized by the abundance of spore-pollen taxa viz., *Verrucatosporites bullatus, Verrucatosporites* spp., *Polypodiisporites ornatus, Divisisporites enormis, Rugulatisporites striatus, Cicatricosisporites macrocostatus, Lygodiumsporites* sp., *Polypodiaceaesporites levis, Lacrimapollis pilosus, Sapotaceoidaepollenites* spp., *Psilatricolporites operculatus, Striatopollis bellus, Malvacearumpollis paucibaculatus* and *Oudhkusumites ankleshwariensis.*

Marine phytoplankton are not recorded in this zone. The vegetation consists of pteridophytic and angiospermic representatives.

Loranthaceous pollen referable to *Cranwellia* are frequent pollen taxa in the Upper Cretaceous sediments of Virdhachalam and Pondicherry areas of Cauvery basin studied by Venkatachala and Sharma (1971). The occurrence of *Cranwellia* in Miocene subsurface sediments of Karaikal-F. is interesting. A solitary specimen of *Cranwellia* is only recorded in a cutting sample and its absence in the Paleogene sediments of this basin is important. The range of this fossil needs confirmation.

The pollen of arborescent plants are abundant than that of herbaceous plants.

Many of the pteridophytic spores can be confidently assigned to extant plant families such as, Schizaeaceae, Parkeriaceae, Lycopodiaceae, Gleichiniaceae, Cyatheaceae, Matoniaceae, Polypodiaceae, selaginellaceae. Spores of leptosporangiate ferns, e.g. Schizaeaceae and Polypodiaceae constitute the bulk of pteridophytic assemblage.

The abundant angiospermous pollen assemblage recovered in the sub-surface point out that it was chiefly angiospermous vegetation that contributed to the assemblage of the Oligo-Miocene sediments in Cauvery basin.

Fossil pollen grains identifiable with the following modern angiospermous families are recorded. The families are — Symplocaceae, Caryophyllaceae, Lauraceae, Anonaceae, Palmae, Poaceae, Liliaceae, Nymphaeaceae, Solanaceae, Fabaceae, Malvaceae,

Bombacaceae, Sterculiaceae, Araliaceae, Sapotaceae, Rhizophoraceae, Lecythidaceae, Caesalpiniaceae, Rubiaceae, Ericaceae, Caprifoliaceae, Tiliaceae, Myricaceae, Proteaceae, Juglandaceae, Myrtaceae, Sapindaceae, Santalaceae, Onagraceae.

Mangrove elements, such as pollen of Rhizophoraceae, Lecythidaceae, Araliaceae, Palmae are abundently present.

The first appearance of grass pollen (*Monoporopollenites gramineoides*) in low percentage in Oligo-Low. Miocene sediments and its abundance in the Middle and Upper Miocene is well marked which reflects towards less dominent swampy vegetation during Mid.-Upp. Miocene times in the basin.

The flora recorded as a whole in Oligo-Miocene sediments in Cauvery basin represents a coastal swampy tropical vegetation and the sediments were deposited in a neritic environment with marine influence during Oligocene-Lower Miocene times. Marine phytoplankton are confined to hystrichosphaerid remains only.

The constant occurrence of mycrothyriaceous discs and other fungal remnants in the assemblage also point out towards a warm humid climate. Temperate fossil elements such as, Caryophyllaceae, Juglandaceae and Pinaceae are perhaps derived from the near by upland vegetation.

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A complete list of references is given in the first part of this paper (Venkatachala & Rawat, 1972).

EXPLANATION OF PLATES

PLATE 1

1. *Divisisporites enormis* Pflug (× 500).
2. *Apiculatisporis* sp. (× 500).
3. *Crassoretitriletes cauveriensis* sp. nov. (× 500).
4. *Fusiformisporites pseudocrabbii* Elaik (× 500).
5. *Magnastriatites cauveriensis* sp. nov. (× 500).
6, 12. *Abietineaepollenites* sp. (× 500).
7. *Diporisporites piercei* (Verma & Rawat) Elsik (× 500).
8. *Diporisporites anklesvariensis* (Verma & Rawat) Elsik (× 500).
9. *Phragmothyrites* sp. (× 500).
10. *Hystrichosphaeridium* sp. 1 (× 500).
11. *Fungal* spore (× 500).
13. *Hystrichosphaeridium* sp. 2 (× 500).

PLATE 2

1. *Margocolporites sahnii* Ramanujam (× 500).
2. *Polyporine ornata* sp. nov. (× 500).
3. *Stephanocolpites aggerus* sp. nov. (× 500).
4. *Couperipollis rarispinosus* (Sah & Dutta) Venkatachala & Kar (× 500).
5, 7. *Tricolpites margocolpites* sp. nov. (× 500).
6. *Tricolpites longicolpatus* sp. nov. (× 500).
8. *Symplocospollenites* sp. (× 500).
9. *Caprifoliipites* sp. (× 500).
10. Tricolporate pollen type (× 500).
11. Pollen type (× 500).
12. *Rhoipites conatus* Venkatachala & Rawat (× 500).
13. *Cooksonella circularis* Nagy (× 500).
14. Algal colony (× 80).
15, 16. *Hystrichosphaeridium complex* (white) Deflandre (× 500).

PLATE 3

1. *Lygodiumsporites* sp. (× 500).
2. *Lygodiumsporites* sp. (× 500).
3. *Cibotiidites kundavaensis* Sah (× 300).
4. *Auricu'iretisporites cauveriensis* Gen. et sp. nov. (× 750).
5. *Biretisporites crassisexinus* sp. nov. (× 500).
6. *Cicatricosisporites macrocostatus* (Bakshi) Sah & Dutta (× 500).
7. *Polypodiaceoisporites* sp. (× 750).


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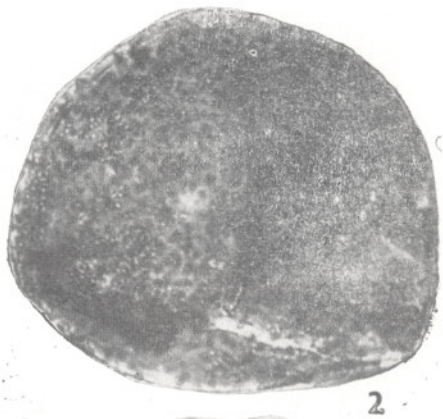
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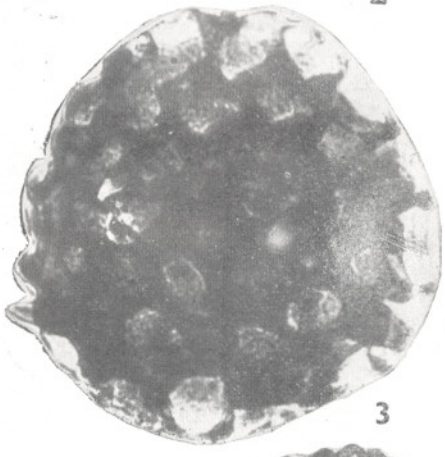
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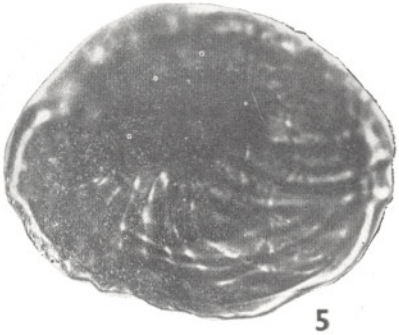
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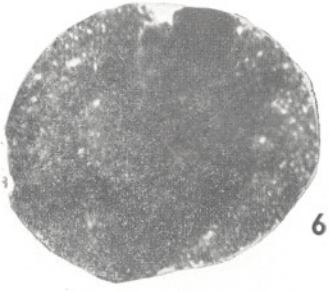
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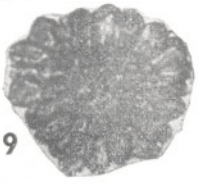
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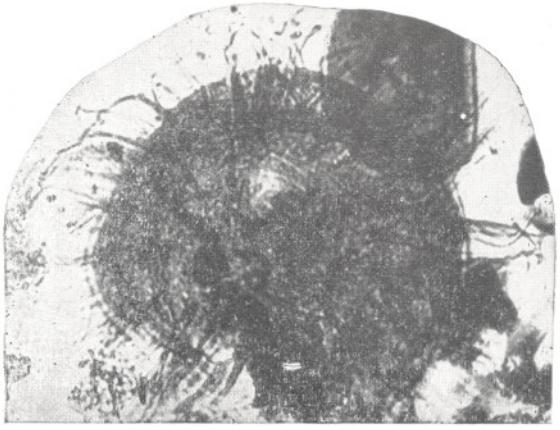
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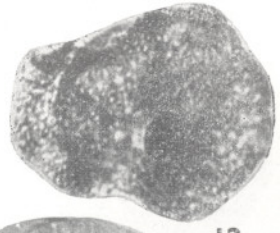
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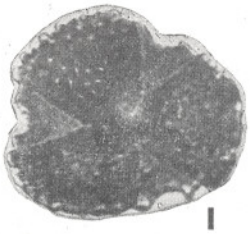
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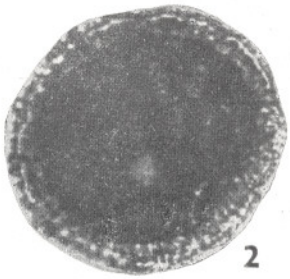
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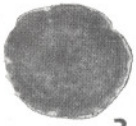
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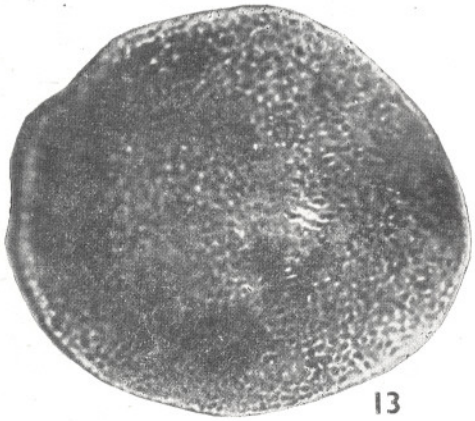
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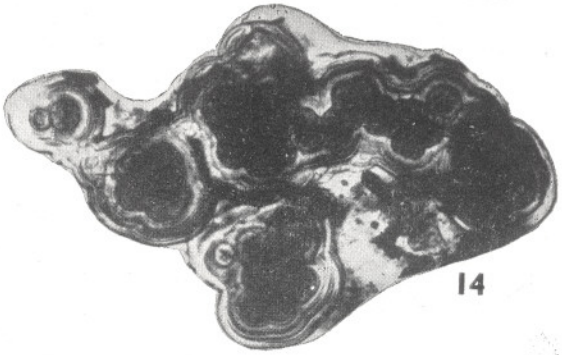
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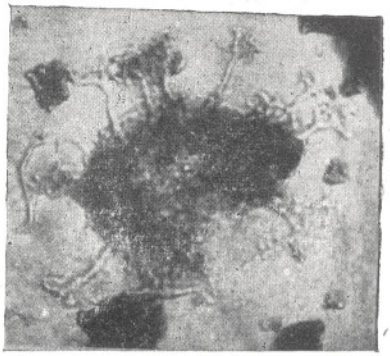
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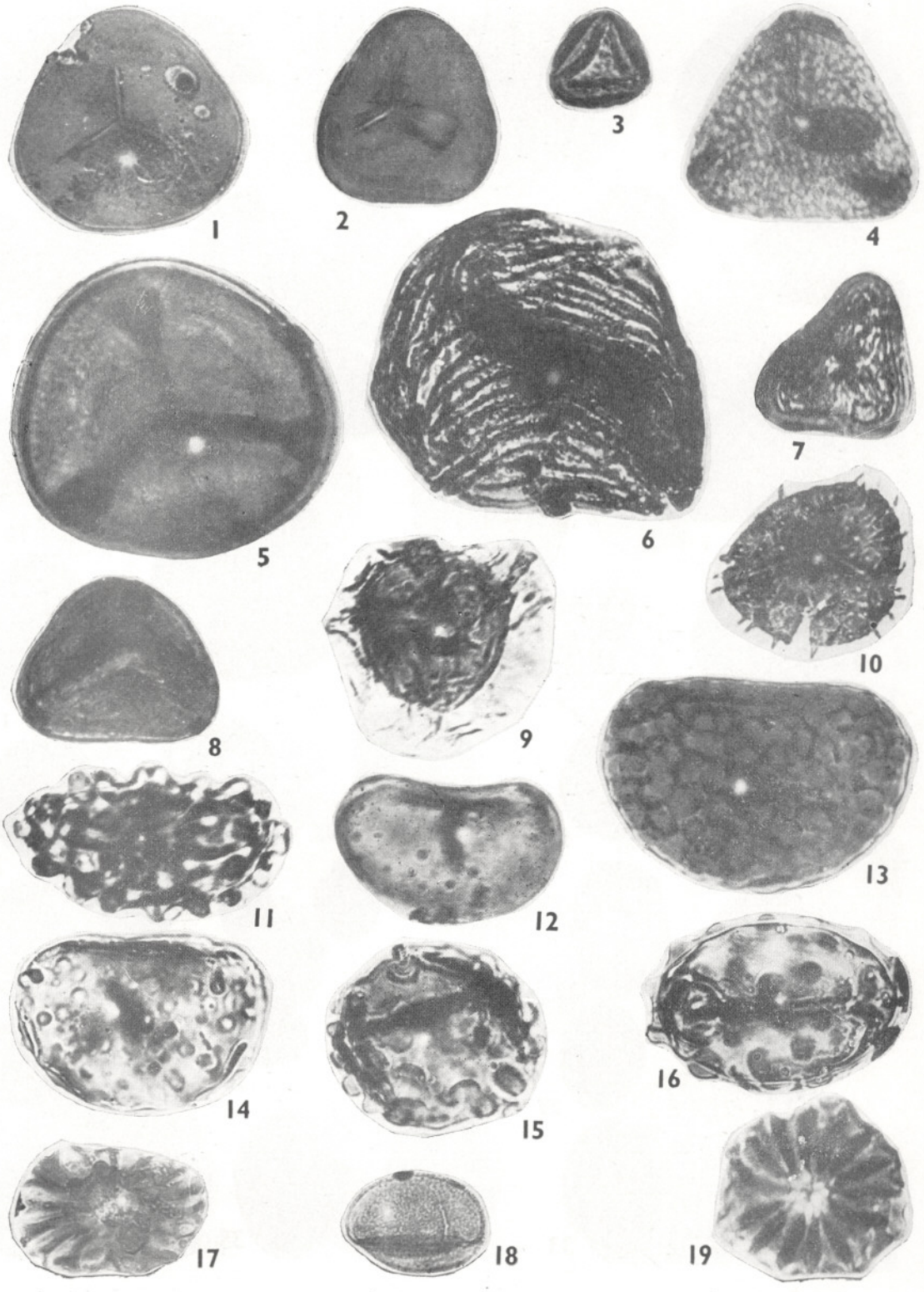
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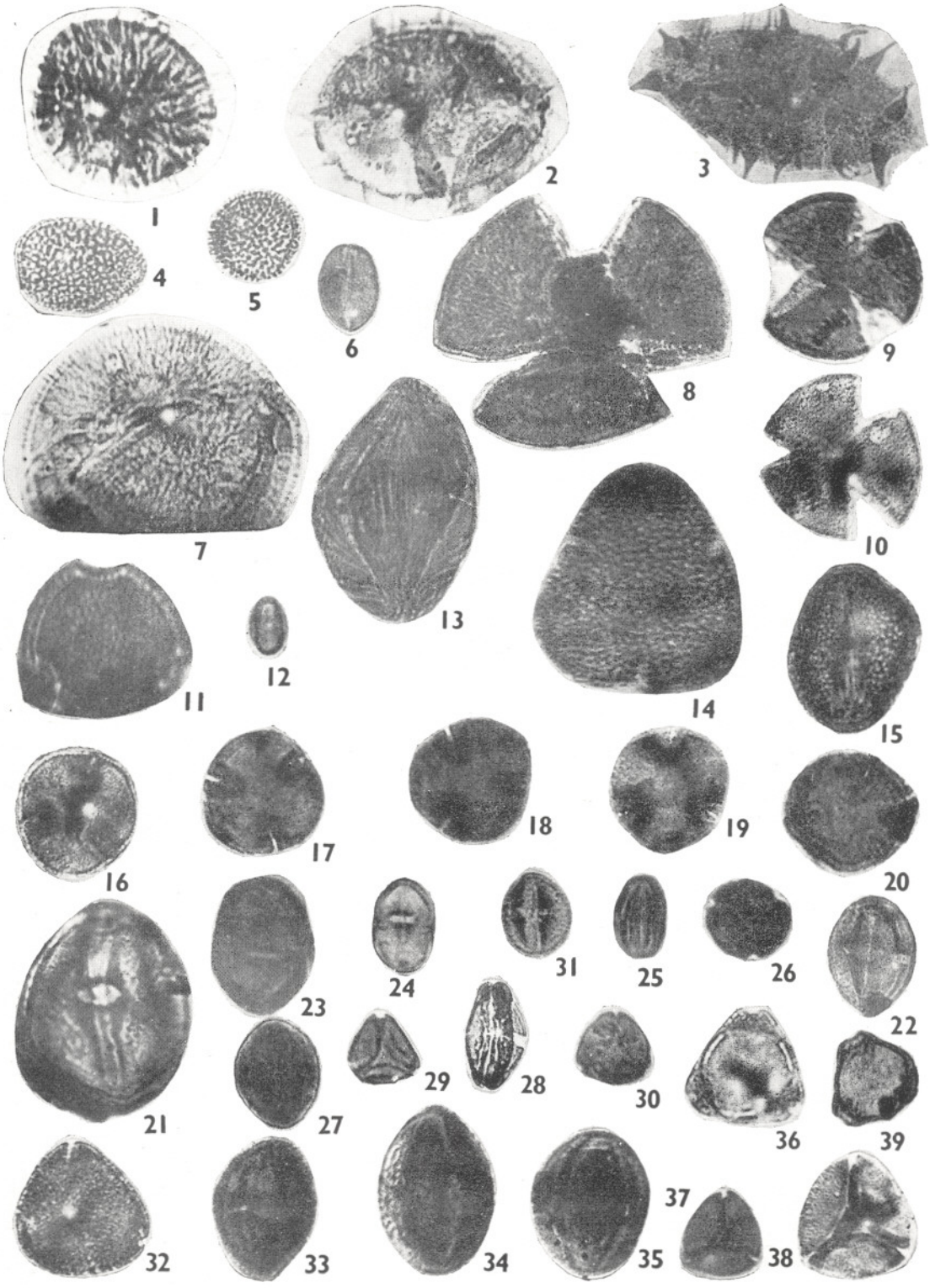
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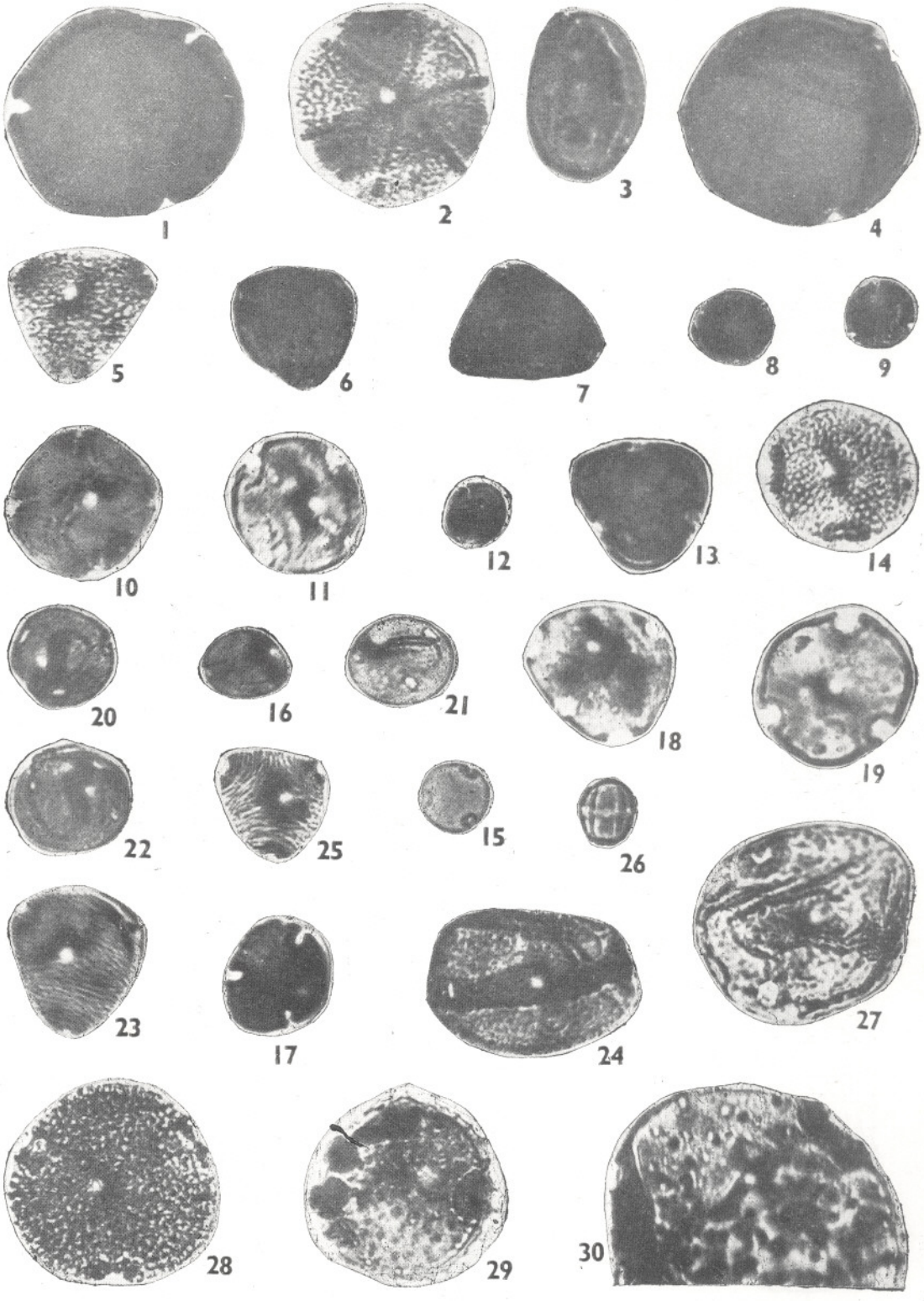
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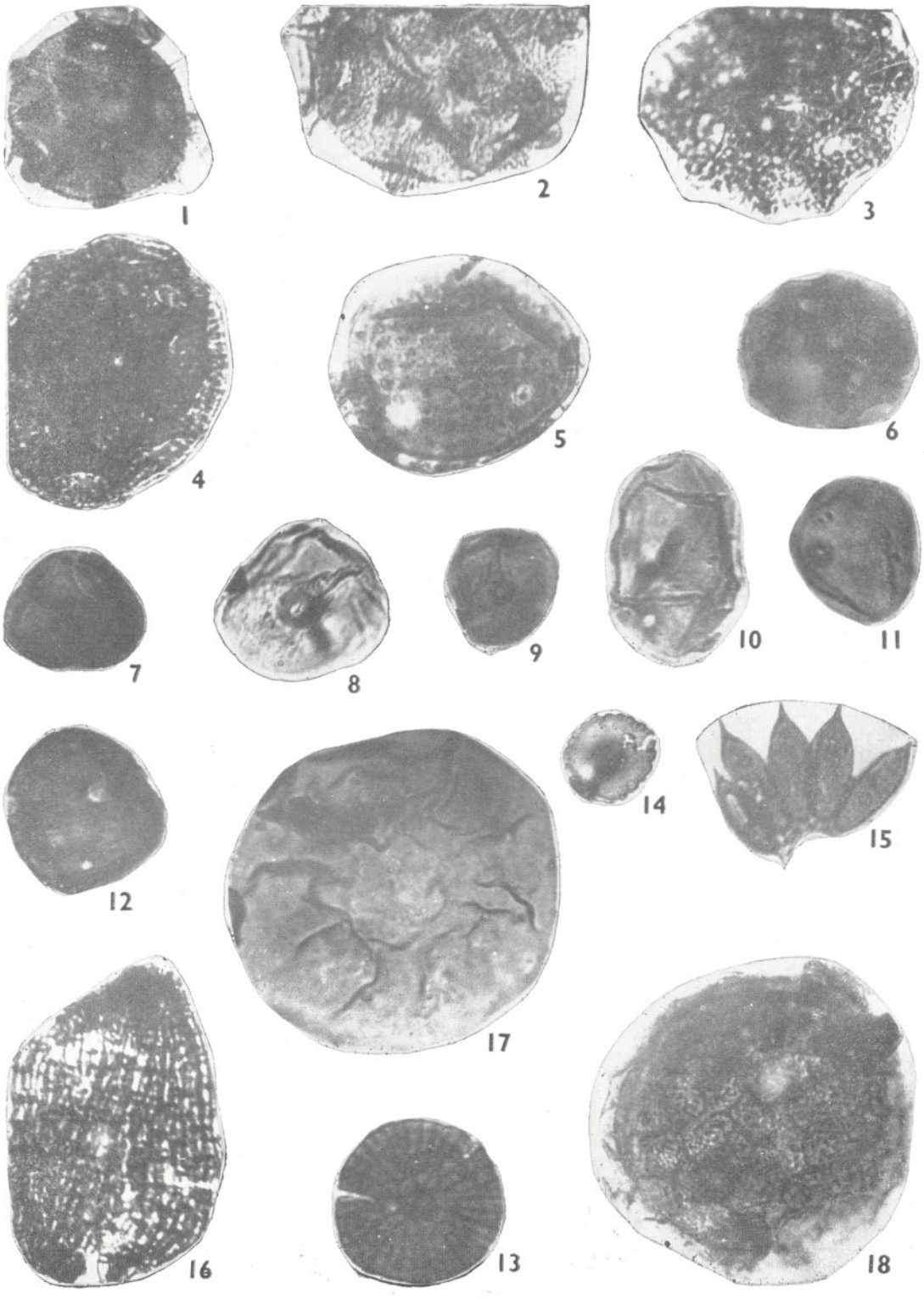
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8. *Rugulatisporites striatus* Sah (× 500).
9. Spore type (× 750).
10. *Ceratosporites conatus* sp. nov. (× 750).
11. *Verrucatosporites* sp. (× 750).
12. *Polypodiaceaesporites levis* Sah (× 750).
13. *Polypodiisporites ornatus* Sah (× 750).
14. *Verrucatosporites sparaus* sp. nov. (× 750).
15. *Verrucatosporites* sp. (× 750).
16. *Verrucatosporites bullatus* sp. nov. (× 750).
17, 19. *Oudhkusumites ankleshvarensis* Srivastava (× 500).
18. *Inaperturites* sp. (× 500).

PLATE 4

1. *Spinainaparturites densispinus* Venkatachala & Rawat (× 750).
2. *Couperipollis rarispinosus* (Sah & Dutta) Venkatachala & Kar (× 750).
3. *Couperipollis perspinosus* (Coup.) Venkatachala & Kar (× 750).
4. *Liliacidites densireticulatus* sp. nov. (× 500).
5. *Nymphaeacidites decoratus* sp. nov. (× 500).
6. *Liliacidites foveoreticulatus* Venkatachala & Rawat (× 500).
7. *Foveotricolpites perforatus* Hammen & Garcia (× 500).
8. *Foveotricolporites perforatus* Hammen & Garcia (× 500).
9. *Tricolpites crassisexinus* sp. nov. (× 750).
10. *Tricolpites* cf. *T. fissilis* Couper (× 750).
11. *Cauveripollis superbus* Gen. et sp. nov. (× 750).
12. *Sapotaceoidaepollenites dakshinii* sp. nov. (× 500).
13. *Striatopollis bellus* Sah (× 1000).
14. *Bombacacidites inausus* sp. nov. (× 750).
15, 21. *Araliaceoipollenites descretus* sp. nov. (× 500).
16-20. *Lacrimapollis pilosus* sp. nov. (× 750).
22. *Araliaceoipollenites mannargudii* Venkatachala & Rawat (× 500).
23. *Sapotaceoidaepollenites obscurus* (Pflug & Thomson) Comb. nov. (× 750).
24. *Sapotaceoidaeopollenites obscusur* (Pflug & Thomson) Comb. nov. (× 500).
25, 26. *Sapotaceoidaepollnites dakshini* sp. nov. (× 750).
27. *Favitricolporites crassisexinus* sp. nov. (× 500).
28. *Marginipollis concinnus* Clarke & Frederiksen (× 500).
29. *Myrtaceidites eucalyptoides* Cookson & Pike (× 750).
3. *Myrtaceidites mesonesus* Cookson & Pike (× 750).
31. *Rhoipites conatus* Venkatachala & Rawat (× 500).
32. *Beaupreaidites tegillatus* sp. nov. (× 750).
33-35. *Rhoipites cauveriensis* sp. nov. (× 750).
36. *Myricipites harrisii* (Coup.) Comb. nov. (× 750).
37. *Cupanieidites decoratus* sp. nov. (× 500).
38. *Cupanieidites decoratus* sp. nov. (× 750).
39. *Myricipites harrissi* (Coup.) Comb. nov. (× 500).

PLATE 5

1. *Tiliaepollenites foveolatus* sp. nov. (× 750).
2. *Margocolporites sitholeyi* Ramanujam (× 750).
3. *Rhoipites* sp. (× 500).
4. *Triatriopollenites* sp. (× 750).
5. *Proteacidites terrazus* Rouse (× 750).
6, 7. *Proteacidites granulatus* sp. nov. (× 750).
8, 9. *Costatipollenites pauciornatus* Gen. et sp. nov. (× 500).
10. *Stephanocoplites flavatus* Venkatachala & Kar (× 750).
11. *Tetracolporites insignatus* sp. nov. (× 750).
12. *Myricaceoipollenites punctitegillatus* sp. nov. (× 500).
13. *Palaeocoprosmadites arcotense* Ramanujam (× 750).
14. *Coneopollis decorus* gen. et sp. nov. (× 750).
15. *Tiliaepollenites rotundus* sp. nov. (× 750).
16, 20, 21. *Caryapollenites cauveriensis* sp. nov. (× 750).
17. *Subtriporopollis scabratus* sp. nov. (× 500).
18. *Scabratriporites triangularis* sp. nov. (× 750).
19. *Subtriporopollis scabratus* sp. nov. (× 750).
22. *Caryapollenites tetraporoides* sp. nov. (× 750).
23. *Striatriporites* cf. *S. nigeriensis* Hoeken-Klinkengerg (× 750).
24. *Thomsonipollis submarginatus* sp. nov. (× 750).
25. *Striatriporites cauveriensis* sp. nov. (× 750).
26. *Zonocostites ramonae* Germeraad, Hopping & Muller (× 500).
27. *Thomsonipollis variornatus* sp. nov. (× 750).
28. *Maculoporites reticulatus* Gen. et sp. nov. (× 750).
Fig. 29. *Tricollareporites echinatus* Gen. et sp. nov. (× 500).
31. *Tricollareporites echinatus* Gen. et sp. nov. (× 750).

PLATE 6

1. *Malvacearumpollis paucibaculatus* sp. nov. (× 500).
2. *Malvacearumpollis paucibaculatus* sp. nov. (× 750).
3. *Polyporina* sp. (× 750).
4. *Polyporina excavatus* sp. nov. (× 750).
5. *Tricollareporites echinatus* Gen. et sp. nov. (× 500).
6. *Polyporina excavatus* sp. nov. (× 500).
7. *Ericipites* sp. (× 500).
8, 10, 11. *Monoporopollenites gramineoides* (Meyer) Potonie' (× 750).
9. *Monoporopollenites gramineoides* (Meyer) Potonie' (× 500).
12. *Polyporina* sp. (× 750).
13. *Phragmothyrites* sp. (× 750).
14. Fungal spore type (× 750).
15. Fungal type-1 (× 750).
16. Fungal type-2 (× 500).
17. Algal sphaeromorph (× 500).
18. Bryophytic spore type (× 500).