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PALYNOLOGY OF THE QUILON BEDS OF KERALA STATE IN SOUTH INDIA II — POLLEN OF DICOTYLEDONS AND DISCUSSION

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ABSTRACT

This contribution deals with a systematic account of the dicotyledonous pollen recovered from the carbonaceous and calcareous clays of the Quilon Formation of Kerala and a critical analysis of the entire palynological data of this formation. In all, 54 genera encompassing 62 species have been recorded in this paper; of these 7 genera and 44 species are new. The genera abundantly represented are *Verrucosisporites*, *Polypodiisporites*, *Retipilonapites*, *Couperipollis*, *Clavapalmaedites*, *Paravuripollis*, *Longapertites*, *Quilonipollenites*, *Palmaepollenites*, *Dicolpopollis*, *Retitricolpites*, *Retirescolpites*, *Foveotricolpites*, *Ctenolophonidites*, *Zonocostites*, *Heterocolpites*, *Marginipollis*, *Hippocrateaceaedites*, *Margocolporites*, *Sapotaceoidaepollenites*, *Talisiipites*, *Verrutriporites*, *Maculoporites*, *Myrcipites*, *Anacolosidites*, *Clavaperiporites* and *Ornatetradites*.

Abundant occurrence of *Polypodiisporites*, coupled with *Pteridacidites*, *Intrabaculisporis* and *Eximospora* and in conjunction with *Dicolpopollis* (abundant), *Cauveripollis*, *Maculoporites*, *Compositoipollenites*, *Hippocrateaceaedites*, pollen-types of Caesalpiniaceae, Sapotaceae and Droseraceae supports Lower to Middle Miocene age assigned to these beds on faunal evidence.

The palynoassemblage indicates a tropical humid type climate with plenty of rain fall. The presence of pollen-types related to *Barringtonia*, *Rhizophora*, *Lumnitzera*, *Nipa*, *Iriartea*, *Calamus*, *Metroxylon*, Araliaceae, Sapindaceae, Meliaceae and Droseraceae and the spores of Polypodiaceae and Schizaeaceae testifies to the prevalence of brackish water mangrove swamps along the coastal belt of Kerala.

Key-words — Palynology, Dicotyledonous pollen, Quilon beds, Lower to Middle Miocene (India).

सारांश

दक्षिण भारत में केरल प्रदेश के क्वीलॉन संस्तरों की परागाणुस्तरिकी – भाग २। द्विबीजपत्रीयों के परागकण तथा विवेचन – के० पी० राव एवं सी० जी० के० रामानुजम्

यह शोध-पत्र केरल के क्वीलॉन शैल-समूह की कार्बनमय एवं चूनामय मृत्तिकाओं से उपलब्ध द्विबीजपत्रीय परागकणों के वर्गीकृत वर्णन तथा इस शैल-समूह के समस्त परागाणविक आँकड़ों के समीक्षात्मक विश्लेषण से सम्बन्धित है। कुल मिलाकर इसमें 62 जातियों सहित 54 प्रजातियों का वर्णन किया गया है। जिनमें से 7 प्रजातियाँ एवं 44 जातियाँ नई हैं। वेरुकॉसिस्पोराइटिस, पोलिपोडाईस्पोराइटिस, रेटिपाइलोनेपाइटिस, काउपॅरिपॉलिस, क्लेषापाल्मीडाइटिस, पैराबुरिपॉलिस, लॉंगापर्टाइटिस, क्वीलॉनिपोलनाइटिस, पाल्मीपोलनाइटिस, डाइकॉल्पोपॉलिस, रेटिट्राइकॉल्पाइटिस, रेटिरेस्कोल्पाइटिस, फ़ोविश्रोट्राइकोल्पाइटिस, टीनोलोफ़ोनिडाइटिस, जोनोकॉस्टाइटिस, हैट्रोकॉल्पाइटिस, मार्जिनीपॉलिस, हिपोक्रेटिएसीडाइटिस, मार्गोकॉल्पोराइटिस, सॅपोटेसिश्रोइडीपोलनाइटिस, तालिसिपाइटिस, वेरुट्राइपोराइटिस, मेॅक्युलोपोराइटिस, मिर्सीपाइटिस, ऍॅनाकोलोसिडाइटिस, क्लेवापॅरिपोराइटिस एवं श्रोर्नाटिट्राडाइटिस बाहुल्यता में मिलने वाली प्रजातियाँ हैं।

टेरिडेसीडाइटिस, इन्ट्राबेक्युलिस्पोरिस एवं ऐक्जिमोस्पोरा से संलग्न तथा डाइकॉल्पोपॉलिस (प्रभावी), कावेरीपॉलिस, मेॅक्युलोपोराइटिस, कम्पोज़िटोइपोलिनाइटिस, हिप्पोक्रेटिएसीडाइटिस, सेसलपिनिएसी, सेॅपोटेसी एवं ड्रोसेरेसी कुलों के परागकण-प्ररूपों से संसर्गित पोलिपोडाइस्पोराइटिस की बाहुल्यता जीवजातीय प्रमाणों पर आधारित इन संस्तरों की अधर से मध्य मध्यनूतन आयु का समर्थन करती है।

परागाणविक समुच्चय अधिक वर्षा वाली उष्णकटिबंधीय आर्द्र-सदृश जलवायु प्रदर्शित करती है। बैरिंग्टोनिआ, राइजोफ़ोरा, लुम्निट्ज़ेॅरा, इरिआर्टिआ, कैलेमस, मेॅट्रॉक्सीलॉन, अरेलिएसी, सैपिन्डेसी, मीलिएसी एवं ड्रोसेरेसी से सम्बद्ध परागकण-प्ररूपों तथा पोलिपोडिएसी एवं शाइजिएसी कुलों के बीजाणुओं की उपस्थिति केरल के तटीय कटिबंध के साथ-साथ लवणी जलयुक्त मैंग्रोव दलदल का होना इंगित करती है।

INTRODUCTION

IN the first part under this title, the authors described the spores of pteridophytes and the pollen of monocotyledons (Rao & Ramanujam, 1978). The present contribution deals with dicotyledonous pollen grains recorded from the calcareous and carbonaceous clays of the Quilon beds. It also includes the floristic analysis, comparison of the microflora with a few selected Neogene microfloras, palynological evidence for the age of the Quilon sediments and the pa'aeoenvironmental set up during the period of deposition of the Quilon sediments. The geological set up of the area and the localities which yielded the palynological samples were reported in the previous part.

SYSTEMATIC PALYNOLOGY

Anteturma — *Po'lenites* Potonié, 1931
Turma — *Aletes* Ibrahim, 1933
Subturma — *Azonoletes* (Luber) Potonié & Kremp, 1954
Infraturma — *Subpilonapiti* (Erdtman) Vimal, 1952

Genus — *Crotonoidaepollenites* gen. nov.

Type Species — *Crotonoidaepollenites euphorbioides* sp. nov.

Diagnosis — Pollen grains isopolar, spheroidal to subspheroidal, inaperturate, but generally with a central thin area towards one hemisphere. Exine 2-layered, sexine thicker than nexine, tectate, columella clear, surface pilate, pila heads free, usually triangular in surface view, aligned in a crotonoid pattern.

Remarks — The genera *Spinainaperturites* and *Verruinaperturites* instituted by Pierce (1961) differ from our new genus in the sculptural elements. *Retipilonapites* Ramanujam (1966) possesses a retipilate sculpturing without any crotonoid pattern.

Crotonoidaepollenites euphorbioides sp. nov.

Pl. 1, figs 1, 2

Diagnosis — Pollen grains isopolar, amb spheroidal to subspheroidal, polar diameter 33-45 μm; inaperturate, but usually with a small to fairly large (up to 20 μm in diameter) thin area in the centre towards one hemisphere. Exine 4-6·5 μm thick, sexine much thicker than nexine, tectate, supratectal processes pilate, pila conspicuous, 2·5-5·5 μm high, densely placed all over, pila heads 1·5-2·5 μm broad, triangular, and aligned in a reticulate manner in surface view (crotonoid pattern).

Comments — Pollen of this type are common in all the samples investigated. Similar grains were previously recovered by Traverse (1955) from the Oligocene Brandon lignite of Vermont.

Affinity — The pollen grains are particularly comparable with those of *Jatropha* and *Croton* (cf. Euphorbiaceae) but are slightly smaller (Erdtman, 1952; Guinet, 1962; Bonnefille, 1971).

Type Locality — Padappakkara.

Holotype — Pl. 1, fig. 1; Pad. II-1: 12·6 ×85·5 μm (39·5 μm).

Subturma — *Triptyches* (Naumova) Potonié, 1960

Genus — *Retitricolpites* (Hammen) Hammen & Wymstra, 1964

Genotype — *Retitricolpites ovalis* Hammen & Wymstra, 1964.

Retitricolpites dipterocarpoides sp. nov.

Pl. 1, fig. 3

Diagnosis — Pollen grains isopolar, amb rounded, polar diameter 45-60 μm; zonaperturate, tricolpate, longicolpate, colpae

narrow, streak-like, margins thin, ends pointed. Exine 1·5 μm thick, stratification indistinct, tectate, surface reticulate-rugulate, reticulum rather fine, homobrochate, brochi hexagonal, small, locally irregular, muri fine, often wavy, lumina angular or irregular.

Comments — This species forms an important element of the Quilon microflora. It differs from the known species of *Retitricolpites* in the sculptural pattern (Hammen & Wymstra, 1964; Wymstra, 1971; Lang & Meon-Vilain, 1976). Further, the rounded amb and the narrow streak-like colpae also constitute the important features of the Quilon species.

Affinity — It shows strong resemblance with the pollen of *Dipterocarpus* and *Dryobalanops* of family the Dipterocarpaceae, particularly with that of the former (Anderson & Muller, 1975; Maury, Muller & Lugardan, 1975).

Type Locality — Padappakkara.

Holotype — Pl. 1, fig. 3; Pad. III-3: 13·8×84·1 μm (53·5 μm).

Retitricolpites microreticulatus (Hammen) Hammen & Wymstra, 1964

Pl. 1, fig. 4

Description — Pollen grains isopolar, amb rounded, polar diameter 21-25 μm; zonaperturate, tricolpate, colpae fairly long, ends pointed to blunt. Exine 2·2 μm thick, tectate, sexine thicker than nexine, reticulate, reticulum with small meshes, lumina angular, smooth; meshes towards colpae extremely small.

Occurrence — Padappakkara.

Retitricolpites marginatus Hoeken-Klinkenberg, 1966

Pl. 1, fig. 5

Description — Pollen grains isopolar, amb rounded to subcircular, polar diameter 24-29 μm; zonaperturate, tricolpate, medicolpate, colpae often obscured by heavy sculpturing, margins thin, ends pointed. Exine 2·5 μm thick, sexine thicker than nexine, surface reticulate, heterobrochate, brochi larger at poles, smaller along a margin around colpae, polygonal, muri simplibaculate, lumina angular with 1-5 free bacules.

Comments — The photomicrographs of this species provided by Hoeken-Klinkenberg show free bacules in the lumina of the reticulum, although no mention of these was made in the description (Hoeken-Klinkenberg, 1966).

Affinity — Oleaceae.

Occurrence — Edavai.

Genus — *Retitrescolpites* Sah, 1967

Genotype — *Retitrescolpites typicus* Sah, 1967.

Retitrescolpites indicus sp. nov.

Pl. 1, fig. 6

Diagnosis — Pollen grains isopolar, spheroidal equatorially and prominently 3-lobed in polar view, 48-65·5 μm; zonaperturate, tricolpate, longicolpate, colpae 15-22 μm wide, gaping at equator, margins thin, ends pointed. Exine 3·5-4·5 μm thick, sexine much thicker than nexine, surface retipilate, pila up to 3·5 μm high, reticulum homobrochate, brochi hexa to polygonal, large 4-6·5 μm, muri thick, simpli to duplipilate, lumina angular and smooth.

Comments — The species resembles *R. typicus* Sah (1967) in its spheroidal amb but differs in the possession of wide gaping colpae. *R. decipiens* Sah (1967) can be distinguished in its retipilariate exine with angustimurate nature. *R. crassimuratus* Sah (1967) is brevicolpate. *Retitrescolpites indicus* is fairly common in the samples from Padappakkara.

Affinity — Caesalpiniaceae.

Type Locality — Padappakkara.

Holotype — Pl. 1, fig. 6; Pad. III-3: 20·8×71·0 μm (59 μm).

Retitrescolpites singularis sp. nov.

Pl. 1, figs 7, 8

Diagnosis — Pollen grains isopolar, amb subspheroidal to rounded triangular, lobes prominent, polar diameter 20-28 μm, zonaperturate, tricolpate, longicolpate, colpae reaching poles but not uniting, colpal surface finely granular. Exine up to 4 μm thick, sexine much thicker than nexine, surface irregularly retipilate, heterobrochate, brochi hexa to polygonal, 3-5 μm in diameter, curvimuroid, lumina irregular with free baculoid processes.

Comments— The prominently longicolpate nature and the finely granular surface of the

colpae are the distinguishing features of *Retitrescolpites singularis*.

Affinity — Oleaceae.

Type Locality — Padappakkara.

Holotype — Pl. 1, fig. 8; Pad. IV-ii: 17·5 ×95·7 μm (22·5 μm).

Genus — *Retibrevitricolpites* Hoeken-Klinkenberg, 1966

Genotype — Retibrevitricolpites triangulatus Hoeken-Klinkenberg, 1966.

Retibrevitricolpites simplex sp. nov.

Pl. 1, fig. 9

Diagnosis — Pollen grains isopolar, amb triangular to rounded triangular, sides convex, polar diameter 25-42 μm; zonaperturate, tricolpate, brevicolpate, margins thin, ends pointed. Exine 1·8 μm thick, sexine as thick as nexine, surface reticulate, brochi small ±1 μm in diameter, finer at mesocolpia.

Comments — Pollen grains of this type are occasionally found in the microflora. *Retibrevitricolpites simplex* differs from *R. triangulatus* Hoeken-Klinkenberg (1966) in its larger size and colpal margins.

Type Locality — Padappakkara.

Holotype — Pl. 1, fig. 9; Pad. II-2: 12·3 ×87·7 μm (31·5 μm).

Genus — *Foveotricolpites* Pierce, 1961

Genotype — Foveotricolpites sphaeroides Pierce, 1961.

Foveotricolpites piercei sp. nov.

Pl. 1, fig. 10

Diagnosis — Pollen grains isopolar, amb rounded, lobes distinct, polar diameter 16-33 μm; zonaperturate, tricolpate, brevicolpate (colpoidate), colpal margins thin, ends rounded or blunt. Exine 1·8 μm thick, sexine thicker than nexine, tectate, tectum perforated, surface foveolate, foveolae of uniform size all over, locally coalescing, up to 3 μm in diameter.

Comments — Pollen grains of the genus *Foveotricolpites* constitute a common element in the microflora. *F. sphaeroides* Pierce (1961) differs from *F. piercei* in its longer colpae with conspicuously thickened margins and smaller foveolae. *F. pomarius* Hammen & Garcia (1966) while generally agreeing with the Indian species, is microfoveolate.

Type Locality — Padappakkara.

Holotype — Pl. 1, fig. 10; Pad. II-9: 6·1×78·6 μm (29·5 μm).

Foveotricolpites prolatus sp. nov.

Pl. 1, figs 11, 12

Diagnosis — Pollen grains isopolar, amb triangular to rounded triangular, lobes distinct, prolate equatorially, 26-38×17·5-32 μm; zonaperturate, tricolpate, longicolpate, colpae gaping wide at equator, margins uneven, thin, ends pointed. Exine 1·8 μm thick, sexine slightly thicker than nexine, tectate, columella distinct, surface foveoreticulate, foveolae small, closely placed.

Comments — Pollen grains of this type are quite common and have been recorded from almost all the samples investigated. *Foveotricolpites sphaeroides* Pierce (1961) differs from the present species in its conspicuously thickened apertural margins. *F. perforatus* and *F. pomarius* (Hammen & Garcia, 1966) possess short colpae and a larger apocolpal area.

Type Locality — Paravur.

Holotype — Pl. 1, fig. 11; Par. 5; 18·5 ×96·3 μm (32 μm).

Genus — *Crototricolpites* Leidelmeyer, 1966

Genotype — Crototricolpites annemariae Leidelmeyer, 1966.

Crototricolpites densus Salard-Cheboldaeff, 1978

Pl. 1, fig. 13

Description — Pollen grains isopolar, amb rounded, polar diameter 26-35 μm, zonaperturate, tricolpate (colpoidate), colpae somewhat obscured by heavy ornamentation, broad at equator and tapering towards poles, margins densely beset with sculptural elements. Exine 2·5-3·5 μm thick, sexine much thicker than nexine, clavate-baculate, clava of different sizes, mostly up to 3 μm high, densely distributed, claval heads angular (± triangular), 1·5-2·5 μm broad, aligned in a crotonoid pattern.

Comments—Crototricolpites crotonisculptus Hoeken-Klinkenberg (1964) is larger and with longer colpae constricted at the equator.

Affinity — Euphorbiaceae; particularly the pollen of *Klaineanthus* (see Salard-Cheboldaeff, 1978).

Occurrence — Frequent at Padappakkara.

Genus — *Punctatricolpites* Pierce, 1961

Genotype — Punctatricolpites brevis Pierce, 1961.

Punctatricolpites sp.

Pl. 1, fig. 14

Description — Pollen grains isopolar, amb rounded triangular, sides convex, polar diameter 18-25 μm, zonaperturate, tricolpate, brevicolpate, colpae narrow, margins thin, ends pointed to blunt. Exine 1·8 μm thick, punctitectate, columella distinct, surface finely punctate.

Comments — Punctitricolpites brevis Pierce (1961) differs from the present pollen in its larger size and subtriangular amb. Only a few grains of this type are encountered.

Affinity — Symplocaceae.

Occurrence — Edavai.

Genus — *Bacubrevitricolpites* gen. nov.

Type Species — B. rotundus sp. nov.

Diagnosis— Pollen grains subprolate equatorially, amb rounded, tricolpate, brevicolpate, colpae narrow, exine intectate, beset with numerous prominent bacules, heads of bacules generally rounded in surface view.

Comments — Baculatricolporites Boltenhagen (1976) is a tricolporate pollen with simplibaculate or intectate exine.

Bacubrevitricolpites rotundus sp. nov.

Pl. 2, figs 15, 16

Diagnosis — Pollen grains isopolar, amb rounded, subprolate equatorially, polar diameter 21-26·5 μm; zonaperturate, tricolpate, brevicolpate, colpae narrow, margins thin, ends blunt. Exine 2-3 μm thick, intectate, baculate, bacules fine, densely distributed all over, up to 2·2 μm high, heads of bacules usually rounded in surface view.

Comments — This taxon is found occasionally in the Edavai and Padappakkara samples.

Type Locality — Edavai.

Holotype — Pl. 2, fig. 15; Edv. C_2; 23·7 × 73·1 μm (22·5 μm).

Genus — *Loranthipites* gen. nov.

Type Species — Loranthipites elegans sp. nov.

Diagnosis— Pollen grains with a triangular amb, distinctly 3-armed, sides concave, angles flatly arched or flared up, tricolpate, longicolpate, colpae almost extending up to poles on one side; exine tectate, smoothly or finely patterned.

Comments— *Loranthacites* Samoilovitch & Mtchedlishvili (1961) is tridiplodemicolpate and triangular with smoothly rounded apices.

Loranthipites elegans sp. nov.

Pl. 2, figs 17, 18

Diagnosis — Pollen grains isopolar, amb triangular, distinctly 3-armed, prominently concave with slightly wavy margin, angles flatly arched, polar diameter 25·5-34 μm; zonaperturate, tricolpate, longicolpate, becoming almost syncolpate on one side, colpal margins thin to slightly thickened, ends pointed. Exine 1·8 μm thick, tectate, sexine only slightly thicker than or almost as thick as nexine, columella distinct, polar area thinner and smooth, rest of the surface psilate to finely patterned.

Comments — Pollen grains of this species have been found frequently in the microflora, but always in the polar compressions.

Affinity — Loranthaceae; pollen show striking resemblance with the pollen of *Elytranthe* (*Loranthus*) and *Dendrophthoe* of Loranthaceae (Erdtman, 1952; Nair, 1965).

Type Locality — Padappakkara.

Holotype — Pl. 2, fig. 17; Pad. II-9: 9·0 × 85·5 μm (29 μm).

Genus — *Marginipollis* Clarke & Frederiksen, 1968

Genotype — Marginipollis concinnus Clarke & Frederiksen, 1968.

Marginipollis kutchensis (Venkatachala & Kar) comb. nov.

Pl. 2, fig. 19

1968 *Rostriapollenites kutchensis* Venkatachala & Kar

Description — Pollen grains isopolar, ellipsoidal (prolate) equatorially, 37·5-42 × 23-27·5 μm, zonaperturate, tricolpate, syncolplate, colpal margins incrassate, bordered

by areolate areas, colpae terminating at poles in beaked or knob-like processes. Exine 1·8 μm thick, sexine thicker than nexine, beaked projections of colpae with nexinous thickenings, surface smooth to finely granular.

Comments — Occasionally found in the Padappakkara and Paravur samples. The pollen from Quilon beds are smaller than the specimens from Kachchh.

Affinity — Lecythidaceae; *Planchonia* type of Planchonioideae (Erdtman, 1952). The fossil pollen is referable to the *Barringtonia asiatica* type of pollen and is particularly related to the pollen forms of *Barringtonia* (Muller, 1972).

Marginipollis quilonensis sp. nov.

Pl. 2, figs 20, 21

Diagnosis — Pollen grains isopolar, ellipsoidal (prolate) equatorially, 36-43×23-29 μm; zonaperturate, tricolpate, syncolpate, colpae ending in beaked (knob-like) processes at poles, margins incrassate. Exine 1·8 μm thick, sexine thicker than nexine, colpal beaks provided with nexinous thickenings, surface of mesocolpia punctate to foveolate.

Comments — Pollen grains of this type are common in the Padappakkara and Paravur samples and rare in Edavai samples. *Marginipollis grandis* Salujha, Kindra & Rehman (1972) although apparently comparable with *M. quilonensis* is distinguishable in its large and coarse foveolae which often coalesce to impart a reticulate look to the pollen. *M. quilonensis* is characterized by the absence of areolate areas bordering the colpae and its punctate to foveolate mesocolpia, in which respect it is distinguishable from the other species of the genus.

Affinity — Lecythidaceae (*Barringtonia*)

Type Locality — Padappakkara.

Holotype — Pl. 2, fig. 20; Pad. III-3: 12·0×90·5 μm (41×27 μm).

Genus — *Clavasyncolpites* gen. nov.

Type Species — *Clavasyncolpites gracilis* sp. nov.

Diagnosis — Pollen grains with triangular-rounded triangular amb, tricolpate, syncolplate. Exine intectate, clavate, clava locally seen in a reticuloid alignment.

Clavasyncolpites gracilis sp. nov.

Pl. 2, fig. 22

Diagnosis — Pollen grains isopolar, amb triangular to rounded triangular, sides convex, polar diameter 22-31 μm; zonaperturate, tricolpate, syncolpate, colpae wide and gaping at equatorial region, margins slightly thickened and beset with clavate-baculate processes. Exine 2·5-3·5 μm thick, sexine thicker than nexine, intectate, clavate, clava 1·5-2 μm high, locally mixed with bacules, densely and uniformly distributed all over, here and there seen in reticuloid alignment.

Comments — Occasionally found in almost all the samples investigated.

Type Locality — Padappakkara.

Holotype — Pl. 2, fig. 22; Pad. II-10: 10·1×95·9 μm (27·5 μm).

Genus — *Meyeripollis* Baksi & Venkatachala, 1970

Genotype — *Meyeripollis naharkotensis* Baksi & Venkatachala, 1970.

Meyeripollis baksii sp. nov.

Pl. 2, fig. 23

Diagnosis — Pollen grains isopolar, amb rounded triangular to subspherical, polar diameter 25-32 μm; zonaperturate, tricolpate, syncolpate, colpae usually obscured by heavy sculpturing, narrow at equator but widening towards poles where they meet, colpal margins densely beset with gemmae. Exine up to 4·5 μm thick, sexine much thicker than nexine, tectate, densely studded with supratectal gemmate-tuberculate processes; gemmae of different sizes, up to 3·5 μm high, rounded in surface view; apices surrounded by 2-4 gemmae only slightly larger or almost of same size as the other processes.

Comments—*Gemmatricolpites* Pierce (1961) includes only gemmate tricolpate pollen grains and hence is easily distinguishable from *Meyeripollis*. *Pistillipollenites macgregori* is a circular to broadly subtriangular triporate pollen studded with gemmate processes (Rouse & Srivastava,1970). Gemmate trisyncolpate pollen grains were first recorded from the Tertiary subsurface sediments of Naharkatia oilfields, Assam (Meyer,1958). Subsequently, Baksi (1962) reported similar grains from the Simsang River Section of the

South Shillong Plateau. These grains were formally described and designated as *Meyeripollis naharkotensis* by Baksi and Venkatachala (1970). *M. naharkotensis* is distinguishable from *M. baksii* in its more clearly triangular amb and in the possession of consistently two large, prominent tubercles of gemmae on either side of each angle.

The pollen is named in honour of Dr S. K. Baksi of Jadavpur University, Calcutta. *Meyeripollis baksii* represents an occasional element of the Padappakkara samples.

Type Locality — Padappakkara.

Holotype — Pl. 2, fig. 23; Pad. II-2: 10·1×78·0 μm (16·5 μm).

Subturma — *Polyptyches* (Naumova) Potonié, 1960

Genus — *Retistephanocolpites* Leidelmeyer, 1966

Genotype — Retistephanocolpites angelii Leidelmeyer, 1966.

Retistephanocolpites crassimuratus sp. nov.

Pl. 2, fig. 24

Diagnosis — Pollen grains isopolar, amb subspheroidal, polar diameter 29·5-38 μm; zonaperturate, stephanocolpate, hexacolpate, colpae fairly long, wide at equator, margins thin, ends pointed to blunt. Exine 3 μm thick, sexine much thicker than nexine, surface reticulate, reticulum homobrochate, brochi hexa to polygonal, 2-3 μm in diameter crassimurate, muri up to 2·5 μm high, lumina irregular and psilate.

Comments — Retistephanocolpites crassimuratus sp. nov. is characterized by its apertural features and the crassimurate reticulum. *R. williamsi* Germeraad *et al.* (1968) possesses short colpae and a reticulate-foveolate exine. *R. coramandalensis* Venkatachala & Rawat (1972) also possesses foveolate-reticulate exine.

Affinity — Labiatae.

Type Locality — Paravur.

Holotype — Pl. 2, fig. 24; Par. 2: 22·5 ×81·0 μm (33·5 μm).

Genus — *Ctenolophonidites* Hoeken-Klinkenberg, 1966

Genotype — Ctenolophonidites costatus Hoeken-Klinkenberg, 1966.

Ctenolophonidites costatus Hoeken-Klinkenberg, 1966

Pl. 2, figs 25, 26

Description — Pollen grains isopolar, amb stellate-spheroidal, barrel-shaped (sub-oblate to oblate) equatorially, polar diameter 35-45 μm; zonaperturate, stephanocolpate, colpae 6-8, medicolpate, margins incrassate, ends pointed to blunt, each apocolpium showing a ring-like nexinous thickening and the rings of the two poles interconnected by thick mesocolpial costae extending across the equator. Polar area inside each apocolpial ring smooth; nexinous thickenings up to 3·5 μm thick and about 2 μm high.

Comments — A considerable degree of variation was noticed with regard to the size of the amb and the number of colpae. Similar grains were reported previously from the Warkalli lignites as *Hexacolpites* and *Septacolpites* pollen types by Rao and Vimal (1952) and Vimal (1953). Recently, Ramanujam and Purnachandra Rao (1973) made a detailed study of the genus.

Affinity — Possibly with *Ctenolophon engleri* of Ctenolophonaceae (Erdtman, 1952; Saad, 1962).

Occurrence — Common at Edavai, Padappakkara and Paravur.

Genus — *Polycolpites* Couper, 1953

Genotype — Polycolpites clavatus Couper, 1953.

Polycolpites granulatus Sah & Kar, 1970

Pl. 2, figs 27, 28

Description — Pollen grains isopolar, amb circular to subcircular, polar diameter 26·5-38 μm, zonaperturate, stephanocolpate, colpae 7 or 8, short, margins thin, ends pointed to blunt. Exine 1·8 μm thick, thinner at polar areas, tectate, sexine as thick as nexine, columella indistinct, surface finely granular.

Comments — The Quilon specimens have a thinner exine as compared to Kachchh specimens of *Polycolpites granulatus* Sah & Kar (1970).

Affinity — Labiatae.

Occurrence — Frequent at Edavai and Padappakkara.

Subturma — *Ptychotriporines* (Naumova) Potonié, 1960
Infraturma — *Prolati* Erdtman, 1943

Genus — *Psilatricolporites* Hammen & Wymstra, 1964

Genotype — Psilatricolporites operoulatus Hammen & Wymstra, 1964.

Psilatricolporites ebenoides sp. nov.

Pl. 2, fig. 29

Diagnosis — Pollen grains isopolar, oblong equatorially with flatly rounded or truncated poles, subtriangular in polar view, 22-29×11-16 μm; zonaperturate, tricolporate, longicolpate, colpae straight, margins thin, ends pointed, ora lalongate. Exine 1·8 μm thick, sexine slightly thicker than nexine, surface smooth.

Comments — The truncated polar areas constitute the important feature of this taxon.

Affinity — With *Diospyros* of Ebenaceae.

Type Locality — Padappakkara.

Holotype — Pl. 2, fig. 29; Pad. 11-2: 17·2×86·3 μm (26·5×13·5 μm).

Genus — *Heterocolpites* Hammen, 1956

Genotype — Heterocolpites palaeocenica Hammen & Garcia, 1966.

Emended Diagnosis — Pollen grains isopolar, prolate to subprolate equatorially, six-lobed in polar view with 3 major and 3 minor lobes, zonaperturate, 3 oroid colpae alternating with 3 colpoid streaks (pseudocolpae), margins of pseudocolpae fold inwards, colpal margins generally incressate, ora distinct, rounded to lalongate. Exine tectate, surface psilate to coarsely granular.

Comments — The genus *Heterocolpites* is distinguishable from the other tricolporate genera in possessing three oroid colpae which obviously represent functional colpae, alternating with three non-oroid colpoid streaks (pseudocolpae). The inward folding of the pseudocolpae is a characteristic feature. Similar pollen grains are encountered in the families Combretaceae and Melastomataceae (Hammen, 1963; Hammen & Garcia, 1966; Leopold, 1969; Blasco & Caratini, 1973).

Heterocolpites combretoides sp. nov.

Pl. 2, figs 30, 31

Diagnosis — Pollen grains isopolar, prolate equatorially, poles rounded, 6-lobate in polar view, 3 major lobes and 3 minor lobes, 20-28×15-18 μm; zonaperturate, tricolporate, longicolpate, colpae ± straight and of uniform width, crassimarginate, ora faint to distinct, lalongate, three oroid colpae alternating with three colpoid streaks (pseudocolpae), pseudocolpal margins tend to fold inward. Exine 1·5 μm thick, sexine only slightly thicker than nexine, tectate, columella distinct, surface psilate.

Comments — Pollen grains of this species are of common occurrence and constitute a characteristic element of the Quilon microflora. Somewhat similar pollen grains were recorded from the Miocene of Marshall islands by Leopold (1969). *Heterocolpites palaeocenica* (cf. Melastomataceae) is subspheroidal with flattened poles (Hammen & Garcia, 1966). *H. laevigatus* Salard-Cheboldaeff (1978) is smaller and infragranulate to scabrate.

Affinity — Combretaceae; pollen shows close resemblance with the pollen of *Lumnitzera* (Blasco & Caratini, 1973).

Type Locality — Paravur.

Holotype — Pl. 2, figs 30, 31; Par. 4; 10·5×76·6 μm (21·5×15·5 μm).

Heterocolpites granulatus sp. nov.

Pl. 2, fig. 32

Diagnosis — Pollen grains isopolar, prolate equatorially, 28-33×18-23 μm; zonaperturate, tricolporate, colpae extending more than 2/3 distance to poles; three oriferous colpae alternating with three pseudocolpal streaks, margins of pseudocolpae tend to fold inward; ora of true colpae prominent, rounded to lalongate with slightly incrassate margins. Exine 1·5 μm thick, sexine slightly thicker than nexine, tectate, columella fairly distinct, surface coarsely granular to almost finely reticulate locally.

Comments — In its coarsely granular sculpture and slightly larger size this species is distinguishable from *Heterocolpites palaeocenica* Hammen & Garcia (1966) and *H. combretoides*. *H. pseudostriatus* and *H. verrucatus* (Salard-Cheboldaeff, 1978) are

distinguishable by their finely striate and verrucate sculpture respectively.

Affinity — Combretaceae.

Type Locality — Edavai.

Holotype — Pl. 2, fig. 32; Edv. c_1-1; 20·1 ×85·0 μm (22·5×16 μm).

Genus — *Retitricolporites* (Hammen) Hammen & Wymstra, 1964

Genotype — Retitricolporites guianensis Hammen & Wymstra, 1964.

Retitricolporites crassioratus sp. nov.

Pl. 3, fig. 33

Diagnosis — Pollen grains isopolar, amb subtriangular, polar diameter 28-35 μm; zonaperturate, tricolporate, longicolpate, colpal margins thin, ends pointed, colpae gap open at equator, ora distinct ± rounded with thickened margin, slightly protruding equatorially. Exine 1·8 μm thick, tectate, sexine thicker than nexine, thickened around ora, columella distinct, surface reticulate, brochi polygonal, small, up to 1·5 μm in diameter, lumina polygonal, smooth.

Comments — This is occasionally found. *Retitricolporites crassioratus* differs from *R. guianensis* Hammen & Wymstra (1964) in its smaller size, thickened ora and smaller-meshed reticulum. *R. annulatus* Salard-Cheboldaeff (1978) is distinguishable by its much smaller size (16-22 μm). Similar pollen were also reported by Leopold (1979).

Affinity — Rubiaceae; pollen shows particular resemblance with the pollen of *Morinda* and *Mitragyna*.

Type Locality — Padappakkara.

Holotype — Pl. 3, fig. 33: Pad. II-11: 14·2×70·1 μm (29·5 μm).

Genus — *Cauveripollis* Venkatachala & Rawat, 1973

Genotype — Cauveripollis superbus Venkatachala & Rawat, 1973.

Cauveripollis superbus Venkatachala & Rawat, 1973

Pl. 3, fig. 34

Description — Pollen grains isopolar, amb subtriangular, polar diameter 25-32 μm, zonaperturate, tricolporate, brevissimicolpate, colpae narrow, margins thin, ends blunt, ora distinct and lalongate. Exine 2·5 μm thick, sexine much thicker than nexine, tectate, columella clear, surface reticulate, heterobrochate, brochi smaller towards colpae, hexagonal to polygonal, muri thick, lumina angular to irregular, smooth.

Affinity — Caprifoliaceae (Venkatachala & Rawat, 1973).

Occurrence — Occasional at Edavai.

Genus — *Araliaceoipollenites* Potonié, 1951

Genotype — Araliaceoipollenites euphorii Potonié, 1951.

Araliaceoipollenites quilonensis sp. nov.

Pl. 3, fig. 35

Diagnosis — Pollen grains isopolar, prolate and somewhat rhomboidal equatorially, poles smoothly arched, 18-22·5× 15-17 μm; zonaperturate, tricolporate, longicolpate, colpae almost reaching poles, wide and often bent at equator, gradually tapering towards poles, ora prominently lalongate, up to 8 μm across. Exine 2·5 μm thick, thicker at poles than elsewhere, sexine thicker than nexine, columella distinct, particularly at polar regions, surface psilate to locally finely punctate.

Comments — This species is quite common in the microflora. But for its smaller size and locally punctate surface, the species compares very favourably with *Araliaceoipollenites potoniei* Ramanujam (1966). The species of *Araliaceoipollenites* described by Venkatachala and Rawat (1972, 1973) are all different in their size, shape and sculpturing.

Affinity — Araliaceae; related to *Aralia*.

Type Locality — Paravur.

Holotype — Pl. 3, fig. 35; Par. 2; 9·3× 80·4 μm (20·5×15·5 μm).

Genus — *Zonocostites* Germeraad, Hopping & Muller, 1968

Genotype — Zonocostites ramonae Germeraad, Hopping & Muller, 1968.

Zonocostites indicus sp. nov.

Pl. 3, fig. 36

Diagnosis — Pollen grains isopolar, subprolate equatorially, poles rounded, 12-16 ×10·5-13 μm; zonaperturate, tricolporate, colpae long, narrow ± straight, margins thin, ends pointed to blunt, ora prominent, lalongate, up to 10 μm across, ora of adjacent colpae touching each other to give a synorate look. Exine 1·5 μm thick, tectate, sexine as thick as nexine, columella distinct near poles, surface psilate to finely granular.

Comments — Occurrence common. *Z. ramonae* Germeraad *et al.* (1968) differs from the present species in its densely perforated tectum with coarseness at poles and fine to almost smooth at the equator. Similar but slightly larger pollen grains have been described from the Miocene of Eniwetok Atoll by Leopold (1969).

Affinity — The fossil grains are related to *Rhizophora*, *Bruguiera* and *Carallia* of Rhizophoraceae. A striking resemblance is seen with the pollen of *Rhizophora mucronata* (Blasco & Caratini, 1973; Muller & Caratini, 1977).

Type Locality — Edavai.

Holotype — Pl. 3, fig. 36; Edv. C_3-6; 21·8×86·6 μm (14×12·5 μm).

Infraturma — *Sphaeroidati* Erdtman, 1953

Genus — *Compositoipollenites* Potonié, 1951

Genotype — Compositoipollenites rhizophorus Potonié, 1951.

Compositoipollenites argutus Sah, 1967

Pl. 3, fig. 37

Description — Pollen grains isopolar, amb rounded to subtriangular, polar diameter 24-32 μm (including sculpture), zonaperturate, tricolporate, brevi to medicolpate, colpae obscured generally by heavy ornamentation, margins thickened, ends ± pointed, ora indistinct. Exine up to 5 μm thick, sexine much thicker than nexine, tectate, surface ruggedly echinate, spines robust, 2·5-4 μm high, densely placed, supratectal, base broad, tips pointed.

Comments — This is a stratigraphically important pollen.

Affinity — Compositae, Tubiflorae (Erdtman, 1952; Huang, 1972).

Occurrence — Occasional at Padappakkara and Edavai.

Genus — *Bombacacidites* Couper, 1960

Genotype — Bombacacidites bombaxoides Couper, 1960.

Bombacacidites minutus sp. nov.

Pl. 3, fig. 38

Diagnosis — Pollen grains isopolar, amb subtriangular, spheroidal equatorially, polar diameter 18·5-23 μm, planaperturate, tricolporate, brevicolpate, colpae narrow, margins thin, ends blunt, ora slightly lalongate. Exine 1·5 μm thick, sexine as thick as nexine, columella fine, surface finely reticulate.

Comments — Pollen grains of this type are met with occasionally in the Quilon beds. *Bombacacidites minutus* is distinguishable from the other species of this genus in its much smaller size and finely reticulate sculpture. *B. africanus* Sah (1967) and *B. inasus* Venkatachala & Rawat (1973) are much larger.

Affinity — The pollen shows a striking similarity with the pollen of *Bombax* and *Spirotheca* of Bombacaceae (Tsukada, 1964; Fuchs, 1967).

Type Locality — Edavai.

Holotype — Pl. 3, fig. 38; Edv. C_3-21; 17·0×82·6 μm (21·5 μm).

Infraturma — *Oblati* Erdtman, 1943

Genus — *Hippocrateaceaedites* Ramanujam, 1966 emend

Genotype — Hippocrateaceaedites vancampoae Ramanujam, 1966.

Emended Diagnosis — Pollen grains oblate to suboblate, amb triangular to subtriangular, tricolporate, longicolpate, in polar view sexine seen prolonged into characteristic knob-like processes on either side of colpus. Colpal margins thickened, ora prominent, rounded to lalongate with a thickened rim interrupted at equator. Exine punctitectate to finely reticulate.

Hippocrateaceaedites quilonensis sp. nov.

Pl. 3, fig. 39

Diagnosis — Pollen grains isopolar, amb triangular, sides convex, polar diameter 18-31 μm, zonaperturate, tricolporate, longicolpate, colpae provided with characteristic prolongation of sexine on either side at its equatorial zone in polar view, ora prominent, lalongate with a distinctly thickened rim. Exine up to 2·5 μm thick, sexine thicker than nexine, tectate, columella distinct, surface finely reticulate (microreticulate), meshes less than 1 μm in diameter.

Comments — *Hippocrateaceaedites vancampoae* Ramanujam (1966) is much larger and has punctitectate exine. *Retitricolporites* (*Favitricolporites*) *ornatus* (Salard-Cheboldaeff, 1974) compared with Hippocrateaceae pollen grains is subprolate and reticulate.

Affinity — The present species shows striking resemblance with the pollen grains of *Loeseneriella* and *Hippocratea* of Hippocrateaceae in size, apertural and sculptural features (van Campo & Halle, 1959, pl. 70, figs 2-4).

Occurrence — Common at Edavai, Padappakkara and Paravur.

Type Locality — Edavai.

Holotype — Pl. 3, fig. 39; Edv. C_3-1: 16·4×74·6 μm (22·5 μm).

Genus — *Palaeocoprosmadites* Ramanujam, 1966

Genotype — *Palaeocoprosmadites arcotense* Ramanujam, 1966.

Palaeocoprosmadites keralaensis sp. nov.

Pl. 3, fig. 40

Diagnosis — Pollen grains isopolar, amb subtriangular, suboblate equatorially, polar diameter 11-15 μm; zonaperturate, tricolporate, brevissimicolpate, colpae as long as or shorter than ora, ora prominently lalongate, with thickened margin. Exine 1·8 μm thick, sexine as thick as nexine, surface smooth to locally finely granular.

Comments — *Palaeocoprosmadites keralaensis* can be differentiated from *P. arcotense* Ramanujam (1966) in its smaller size and locally finely granular exine.

Affinity — Rubiaceae; pollen shows particular resemblance with the pollen of *Coprosma*.

Type Locality — Edavai.

Holotype — Pl. 3, fig. 40: Edv. CII: 24·3 ×95·6 μm (13 μm).

Genus — *Symplocoipollenites* Potonié, 1951

Genotype — *Symplocoipollenites vestibulum* Potonié, 1951.

Symplocoipollenites crassioratus sp. nov.

Pl. 3, fig. 41

Diagnosis — Pollen grains isopolar, amb triangular, sides ± flat, zonaperturate, polar diameter 24-30 μm, tricolporate, colpae long, slit-like, ora prominent, lalongate and thickened. Exine 1·5 μm thick, sexine as thick as nexine, surface verrucate tuberculate, verrucae small and low at mesocolpia and prominent around apertures.

Comments — Occurrence rare. The triangular amb, narrow slit-like colpae with lalongate thickened ora and the verrucate exine are the important features of this species. Pollen grains similar to *Symplocoipollenites crassioratus* were recorded previously by Stuchlik (1964).

Affinity — Symplocaceae; pollen shows close similarity with the pollen of *Symplocos* (Meijden, 1970; Gupta & Sharma, 1977).

Type Locality — Padappakkara.

Holotype — Pl. 3, fig. 41; Pad. II-8; 14·7 ×92·7 μm (25 μm).

Symplocoipollenites punctatus sp. nov.

Pl. 3, fig. 42

Diagnosis — Pollen grains isopolar, amb triangular, sides convex, polar diameter 16-24 μm, zonaperturate, tricolporate, colpae short, narrow and slit-like with blunt ends, ora prominently thickened and lalongate. Exine 1·5 μm thick, sexine as thick as nexine, surface finely punctate.

Comments — *Symplocoipollenites punctatus* is a common element of the Paravur beds. The triangular amb, short narrow colpae with prominently thickened lalongate ora and finely punctate exine are the characteristic features of this taxon.

Affinity — The pollen resembles the pollen of some species of *Symplocos* (Erdtman, 1952; Meijden, 1970; Gupta & Sharma, 1977).

Type Locality — Paravur.

Holotype — Pl. 3, fig. 42; Par-3; 12·7 ×85·6 μm (18·5 μm).

Genus — *Costatipollenites* Venkatachala & Rawat, 1973

Genotype — *Costatipollenites pauciornatus* Venkatachala & Rawat, 1973.

Costatipollentites pauciornatus Venkatachala & Rawat, 1973

Pl. 3, fig. 43

Description — Pollen grains isopolar, rounded to subtrianglar in polar view, 12-18 μm in diameter; zonaperturate, tricolporate, brevicolpate, ora prominent, margins incrassate. Exine 2 μm thick, sexine thicker than nexine, surface scabrate, scabrae locally vermiculate.

Comments — The genus *Costatipollenites* differs from *Symplocoipollenites* in its rounded to subtriangular amb. This taxon has been previously recorded from the Neogene of the Cauvery basin (Venkatachala & Rawat, 1973).

Affinity — Symplocaceae; pollen comparable with some species of *Symplocos*, viz., *S. cococinea*, *S. costata*, etc. (Meijden, 1970).

Occurrence — Paravur.

Genus — *Margocolporites* Ramanujam, 1966

Genotype — *Margocolporites tsukadai* Ramanujam, 1966.

Margocolporites tsukadai Ramanujam, 1966

Pl. 3, fig. 44

Description — Pollen grains isopolar, amb prominently 3-lobed, lobes widely spaced because of large margocolpae, oblate to sub-oblate equatorially, polar diameter 53·5-57 μm; zonaperturate, tricolporate, longicolpate, margocolpate, colpae 20-22·5 μm across and gaping at equator and tapering towards poles, margo area granular, ora large, lalongate to almost rounded, pouting in polar view at the equator. Exine 3-4, 5 μm thick, sexine much thicker than nexine, surface heavily reticulate, homobrochate, crassimurate, simpli to duplibaculate, brochi large up to 3·5 μm in diameter, hexagonal, lumina smooth.

Affinity — Caesalpiniaceae; pollen shows striking resemblance with the pollen of *Caesalpinia* and *Mezoneuron*.

Occurrence — Common at Padappakkara and Paravur.

Margocolporites oligobrochatus Ramanujam, 1966

Pl. 3, fig. 45

Description — Pollen grains isopolar, amb-rounded triangular, 3-lobed, suboblate equatorially, polar diameter 46-51 μm; zonaperturate, tricolporate, longicolpate, margocolpae 17·5 μm wide and gaping at equator, margo area granular, ora rounded to lalongate, distinctly pouting at equator in polar view, about 7 μm in diameter. Exine up to 4 μm thick, sexine much thicker than nexine, surface ruggedly reticulate, reticulum oligobrochate, homobrochate, brochi large, hexa to polygonal, crassimurate, muri duplibaculate, locally multibaculate, beaded in surface view, lumina angular with a few free baculoid processes.

Comments — *M. vanwijhei* Gemeraad *et al.* (1968) is fairly similar to *M. oligobrochatus* but has wider and longer colpae (almost becoming syncolpate) with baculate margin.

Affinity — The fossil taxon shows striking resemblance with the pollen of *Peltophorum* and *Caesalpinia* (Mittre & Sharma 1962; Tsukada, 1964).

Occurrence — Common.

Genus — *Talisiipites* Wodehouse, 1933

Genotype — *Talisiipites fisheri* Wodehouse, 1933.

Talisiipites elegans sp. nov.

Pl. 3, fig. 46

Diagnosis — pollen grains isopolar, oblate equatorially, amb triangular, sides flat, polar diameter 13-20 μm, zonaperturate, tricolporate, medicolpate, colpae narrow, margins thin, ends blunt, ora slightly lalongate, thickened. Exine 1·5 μm thick, sexine as thick as nexine, surface finely granular.

Comments — *Talisiipites wodehousei* Dutta & Sah (1970) is larger and with concave sides, long colpae and finely scabrate surface. *T. retipilatus* Venkatachala & Rawat (1972) is comparable in size and shape but is distinguishable in its finely reticulate exine.

Affinity — Sapindaceae.

Type Locality — Padappakkara.

Holotype — Pl. 3, fig. 46; Pad. II-9; 26·8 × 83·0 μm (17·5 μm).

Occurrence — Common at Edavai and Padappakkara.

Infraturma — *Syncolporiti* Ramanujam, 1966

Genus — *Gothanipollis* Krutzsch, 1959

Genotype — *Gothanipollis gothanii* Krutzsch, 1959.

Gothanipollis indicus sp. nov.

Pl. 3, fig. 47

Diagnosis — Pollen grains isopolar, amb prominently triangular with deeply concave sides, distinctly 3-armed look in polar view, angles truncated and recurved, equatorial view lens-shaped, polar diameter 25-42·5 μm; zonaperturate, tricolporate, syncolporate, ora not prominent, vestibulated, located at truncated apices as seen in polar view. Exine 1·8 μm thick, sexine as thick as nexine, structure indistinct, surface psilate.

Comments — *Gothanipollis gothanii* is smaller. *G. cockfieldensis* Engelhardt (1964) is also much smaller and with granulose exine.

Affinity — The pollen resembles that of *Taxillus* of Loranthaceae.

Type Locality — Padappakkara.

Holotype — Pl. 3, fig. 47; Pad. II-11; 16·0 × 86·1 μm (31 μm).

Occurrence — Frequent at Padappakkara.

Genus — *Cupanieidites* Cookson & Pike, 1954

Genotype — *Cupanieidites orthotechus* Cookson & Pike, 1954.

Cupanieidites punctatus sp. nov.

Pl. 3, fig. 48

Diagnosis — Pollen grains isopolar, amb triangular, sides convex, polar diameter 19·5-27 μm; zonaperturate, tricolporate, syncolpate, apocolpal area triangular, colpal margins thin, ora slightly incrassate, lalongate. Exine up to 2 μm thick, sexine as thick as nexine, punctitectate, columella indistinct, surface finely punctate.

Comments — *Cupanieidites punctatus* differs from the other species of the genus in its triangular shape with convex sides, possessing a large triangular polar island, and its punctitectate sculpture. *C. major* Cookson & Pike (1954) differs in its reticulate sculpturing and in lacking a polar island. *C. decorus* Venkatachala & Rawat (1973) is again distinctly reticulate. Pollen grains similar to *Cupanieidites* were also previously recorded by Ramanujam (1967).

Affinity — Sapindaceae.

Type Locality — Paravur.

Holotype — Pl. 3, fig. 48; Par. 4: 21-3 × 66·1 μm (23·5 μm).

Occurrence — Common.

Subturma — *Ptychopolyporines* Naumova) Potonié, 1960

Genus — *Sapotaceoidaepollenites* Potonié, Thomson & Thiergart, 1950

Genotype — *Sapotaceoidaepollenites manifestus* Potonié, Thomson & Thiergart, 1950.

Sapotaceoidaepollenites keralaensis sp. nov.

Pl. 3, fig. 49

Diagnosis — Pollen grains isopolar, prolate to subprolate equatorially, polar area smoothly arching, 24-29 × 16-20 μm; zonaperturate, tetracolporate, colpae fairly long, margins thin, ora lalongate. Exine 2·5-3·5 μm thick, sexine as thick as nexine, surface smooth to finely scabrate.

Comments — *S. dakshinii* Venkatachala & Rawat (1973) is smaller and only with three colpae. In the presence of thick exine *S. keralaensis* is distinguishable from the other species of this genus.

Affinity — Sapotaceae; particularly comparable with the pollen of *Manilkara* (Bonnefille, 1971).

Type Locality — Padappakkara.

Holotype — Pl. 3, fig. 49; Pad. II-11; 16·2 × 82·0 μm (26·5 × 10·5 μm).

Occurrence — Abundant.

Sapotaceoidaepollenites africanus Sah, 1967

Pl. 3, fig. 50

Description — Pollen grains isopolar, subprolate to broadly elliptical in equatorial view, poles smoothly rounded, 30-34× 22-25 μm; zonaperturate, tetracolporate, longicolpate, colpal margins slightly thickened, ora lalongate to slightly lalongate. Exine up to 2 μm thick, sexine thicker than nexine, columella faint, surface smooth to finely granular.

Comments — *Sapotaceoidaepollenites africanus* is an abundant element of the Quilon beds. Exine structure is clearer in the South Indian grains than in the Barundi grains (Sah, 1967).

Affinity — With the pollen of *Pouteria* and *Mimusops* of Sapotaceae (Bonnefille, 1971; Gupta & Sharma, 1977).

Sapotaceoidaepollenites neyveliensis Ramanujam, 1966

Pl. 3, fig. 51

Description — Pollen grains isopolar, prolate equatorially, poles flatly arched, 26-28·5×17-21 μm; zonaperturate, tertracolporate, longicolpate, colpae almost extending up to poles, margins slightly thickened, ends pointed to blunt, ora lalongate. Exine 1·8 μm thick, sexine slightly thicker than nexine, surface smooth to locally faintly punctate.

Comments — Ramanujam (1966) described this species as *Sapotaceoidaepollenites neyvelii*. As the specific name is after the locality Neyveli, the specific epithet should be *neyveliensis* and not *neyvelii*.

Affinity — Sapotaceae.

Occurrence — Abundant.

Genus — *Meliapollis* Sah & Kar, 1970

Genotype — Meliapollis ramanujamii Sah & Kar, 1970.

Meliapollis quilonensis sp. nov.

Pl. 4, fig. 52

Diagnosis — Pollen grains isopolar, amb rounded to ±squarish, polar diameter 12-17 μm, zonaperturate, tetracolporate, colpae considerably short with thin margins, ends pointed to blunt; ora faint, rounded. Exine 1·5 μm thick, sexine as thick as nexine, columella distinct, surface smooth to locally flecked.

Comments — *Meliapollis* is one of the common elements of the Quilon beds. The present species is smaller than most of the other members of this genus. *Meliapollis minutus* Singh (1977) is larger, squarish to oval and with thickened ora.

Affinity — Melioidae of Meliaceae.

Type Locality — Paravur.

Holotype — Pl. 4, fig. 52; Par-4; 15·2 ×64·0 μm (13·5 μm).

Genus — *Foveostephanocolporites* Leidelmeyer, 1966

Genotype — Foveostephanocolporites liracostatus Leidelmeyer, 1966.

Foveostephanocolporites leidelmeyerii

Pl. 4, fig. 53

Diagnosis — Pollen grains isopolar, amb rounded to squarish, polar diameter 20-26 μm, zonaperturate, tetracolporate, colpae of medium length, tenuimarginate, mesocolpal exine extends and arches over colpae, ends blunt, ora prominent, incrassate, slightly lalongate. Exine up to 2 μm thick, sexine as thick as nexine, columella clear, surface foveolate, foveolae closely placed to impart a foveoreticulate look.

Comments — Occurrence occasional. The incrassate ora and the extensions of the mesocolpial exine overarching the colpae are the important features of this taxon. The species is named in honour of Dr P. Leidelmeyer.

Affinity — Labiatae.

Type Locality — Paravur.

Holotype — Pl. 4, fig. 53; Par. 1; 22·9 ×76·7 μm (23·5 μm).

Foveostephanocolporites indicus sp. nov.

Pl. 4, fig. 54

Diagnosis — Pollen grains isopolar, amb spheroidal, polar diameter 25-38 μm; zonaperturate, pentacolporate, brevicolpate, margins thin, ends blunt, ora rounded. Exine up to 2 μm thick, sexine thicker than

nexine, surface foveoreticulate, imparting a spongy look to exine.

Comments — *Foveostephanocolporites liracostatus* Leidelmeyer (1966) is distinguishable in its apertural features. Similar is the case with the species described above.

Affinity — Labiatae.

Type Locality — Edavai.

Holotype — Pl. 4, fig. 54; Edv. C_1-6; 7·0×87·6 μm (28·5 μm).

Genus — *Padappakkarapollis* gen. nov.

Type Species — *Padappakkarapollis venkatachalae* sp. nov.

Diagnosis — Pollen grains isopolar, amb spheroidal to stellate-spheroidal; stephanocolporate, brevicolpate, colpae 6-8, ora lalongate. Exine differentially sculptured, nexine with undulating or vermiform thickenings, sexine finely pitted.

Comments — *Polybrevicolporites* Venkatachala & Kar (1969) shows general similarities with the present taxon, but lacks the characteristic vermiculate nexinous thickenings.

Padappakkarapollis venkatachalae sp. nov.

Pl. 4, figs 55, 56

Diagnosis — Pollen grains isopolar, amb spheroidal to stellate-spheroidal, polar diameter 38-50 μm; zonaperturate, septacolporate, brevicolpate, colpal margins thin, ends blunt. Ora lalongate with thickened margins. Exine up to 3 μm thick, sexine thicker than nexine, surface differentially sculptured, nexine showing characteristic vermiculate thickenings and sexine finely pitted, pits coalescing at many places to form short canals.

Comments — This is a common pollen type of the Padappakkara samples and is characteristic in its overall morphology. The species is named in honour of Dr B. S. Venkatachala, Oil and Natural Gas Commission, Dehradun.

Affinity — ?Ctenolophonaceae. Irregular nexinous thickenings are seen in the pollen of some recent and fossil members of this family (Saad, 1962; Ramanujam & Purnachandra Rao, 1973).

Type Locality — Padappakkara.

Holotype — Pl. 4, figs 55, 56; Pad. II-10; 22·8×72·7 (43·5 μm).

Genus — *Polybrevicolporites* Venkatachala & Kar, 1969

Genotype — *Polybrevicolporites cephalus* Venkatachala & Kar, 1969.

Polybrevicolporites karii sp. nov.

Pl. 4, figs 57, 58

Diagnosis — Pollen grains isopolar, spheroidal and distinctly lobed in polar view, ±rhomboidal in equatorial view, 21-27× 23-29 μm, zonaperturate, pentacolporate, colpae constricted and arching at equator, tenuimarginate, ends blunt, ora prominent, lalongate, 7·5 μm across, ora of adjacent colpae almost touching each other. Exine up to 3·5 μm thick, thicker at poles than elsewhere, sexine thicker than nexine, tectate, columella distinct, surface intrareticulate with columella below tectum aligned in a reticuloid manner. Mesocolpia with 2-4 prominent thickenings.

Comments — These are occasional elements of the Edavai samples. The species is easily distinguishable from *Polybrevicolporites cephalus* Venkatachala & Kar (1969) in its shape, prominent ora and intra-reticulate exine.

Affinity — Polygalaceae. The species is named in honour of Dr R. K. Kar, Birbal Sahni Institute of Palaeobotany, Lucknow.

Type Locality — Edavai.

Holotype — Pl. 4, figs 57, 58; Edv. L-23; 9·0×24·7 μm (26×23·5 μm).

Genus — *Polygalacidites* Sah & Dutta, 1966

Genotype — *Polygalacidites clarus* Sah & Dutta, 1966.

Polygalacidites singularis Sah, 1967

Pl. 4, fig. 59

Description — Pollen grains isopolar, prolate, poles somewhat flattened to smoothly arched, 20-28×17-22 μm; zonaperturate, longicolpate, pentacolporate, colpae narrow, margins thin, ora prominently lalongate almost becoming synorate. Exine 1·5 μm thick, surface smooth.

Affinity — Polygalaceae.

Occurrence — Rare.

Subturma — *Triporines* (Naumova) Potonié, 1960

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

Genotype — Triporopollenites coryloides Thomson & Pflug, 1953.

Triporopollenites minutus sp. nov.

Pl. 4, fig. 60

Diagnosis — Pollen grains isopolar, amb triangular, sides convex, polar diameter 12-16·5 μm; zonaperturate, triporate, pores ± circular, small (up to 2 μm) with annulus. Exine 1·8 μm thick, sexine as thick as nexine, slightly thickened around pores to form annulus, surface smooth to finely granular.

Comments — *Triporopollenites simplex* and *T. plicata* (Ramanujam, 1966) from the Neyveli lignite are larger. *T. triangularis* Sah (1967) is with prominently aspidote pores and finely reticulate sculpture. The present species has been encountered only occasionally in Padappakkara samples.

Affinity — Moraceae; closely resembles the pollen of *Ficus* and *Artocarpus*.

Type Locality — Padappakkara.

Holotype — Pl. 4, fig. 60; Pad. II-3; 19·5×89·0 μm (13·5 μm).

Genus — *Triorites* (Erdtman & Cookson) ex Couper, 1953

Genotype — Triorites magnificus Cookson, 1950.

Triorites microreticulatus sp. nov.

Pl. 4, fig. 61

Diagnosis — Pollen grains isopolar, amb subtriangular, sides convex, 13-18 μm; zonaperturate, triporate, pores 2-3 μm, pouting at equator, prominently aspidote. Exine 1·5 μm thick, surface microreticulate.

Comments — The above pollen type is a rare element of the microflora. *Triorites magnificus* Cookson (1950) is considerably larger. Similar is the case with *T. communis* Sah & Dutta (1966) and *T. inferius* Dutta & Sah (1970). *T. tubiferus* Venkatachala & Rawat (1972) is more distinctly triangular and larger.

Affinity — The apertural features of the fossil pollen suggest a possible affinity with the members of Onagraceae. But for their smaller size, the fossil pollen resembles the pollen of *Jussieua*.

Type Locality — Padappakkara.

Holotype — Pl. 4, fig. 61; Pad. II-10; 16·4×71·9 μm (15·5 μm).

Genus — *Myricipites* Wodehouse, 1933

Genotype — Myricipites dubius Wodehouse, 1933.

Myricipites harrisii (Couper) Venkatachala & Rawat, 1973

Pl. 4, fig. 62

Description — Pollen grains isopolar, amb triangular to subtriangular, sides flat to slightly convex, polar diameter 22-26 μm; zonaperturate, triporate, pores up to 3 μm, pore margin slightly incrassate, pores aspidote. Exine 1·5 μm thick, sexine as thick as nexine, surface smooth to finely scabrate.

Comments — *Myricaceoipollenites* Potonié (1951) is distinguishable from *Myricipites* Wodehouse (1933) in its apertural features only. In *Myricipites*, the pores are aspidote and protruding beyond the equatorial margin when compared to the former taxon. *M. harrisii* pollen grains have been encountered commonly in the Quilon beds.

Affinity — Myricaceae; closely resembles the pollen of *Myrica nagi* and *M. farguhariana*.

Genus — *Casuarinidites* Cookson & Pike, 1954

Genotype — Casuarinidites cainozoicus Cookson & Pike, 1954.

Casuarinidites sp.

Pl. 4, fig. 63

Description — Pollen grains isopolar, amb rounded triangular, sides convex, polar diameter 26-30 μm; zonaperturate, triporate, pores circular to ellipsoidal, 3-4 μm, aspidote, pore rim slightly thickened. Exine 1·5 μm thick, surface granular to flecked.

Comments — The genus *Casuarinidites* is triporate, oblate pollen with a subcircular amb and convex sides, and aspidote circular to slightly ellipsoidal pores; the surface is finely and indistinctly patterned. Only a

few grains of this were encountered in the Quilon beds.

Affinity — Casuarinaceae.

Genus — *Maculoporites* Venkatachala & Rawat, 1973

Genotype — Maculoporites reticulatus Venkatachala & Rawat, 1973.

Maculoporites quilonensis sp. nov.

Pl. 4, figs 64-66

Diagnosis — Pollen grains isopolar, amb rounded triangular, sides convex, polar diameter 20-28 μm; zonaperturate, triporate, pores up to 3 μm, with conspicuous annuli. Exine 1·5 μm thick, sexine as thick as nexine, surface finely reticulate, meshes polygonal, fine, up to 1·5 μm across, lumina smooth.

Comments — *M. reticulatus* Venkatachala & Rawat (1973) is much larger and more rounded in polar view.

Type Locality — Padappakkara.

Holotype — Pl. 4, fig. 64; Pad. II-10; 18·8×104·9 μm (21 μm).

Occurrence — Common to abundant.

Genus — *Verrutriporites* Muller, 1968

Genotype — Verrutriporites lunduensis Muller, 1968.

Verrutriporites perverrucatus sp. nov.

Pl. 4, figs 67, 68

Diagnosis — Pollen grains isopolar, amb subtriangular, sides convex, polar diameter 16-23 μm; zonaperturate, triporate, pores aspidote, 2-3 μm, pore margin bearing verrucae. Exine 1·5 μm thick, sexine slightly thicker than nexine, surface verrucate, verrucae sparse, of low height.

Comments — This is one of the dominant elements of the Quilon sediments. *Verrutriporites lunduensis* is spherical with closely placed verrucae.

Affinity — The fossil grains show remarkable resemblance with the pollen of *Duabanga moluccana* of Sonneratiaceae (Thanikaimoni & Jayaweera, 1966).

Type Locality — Padappakkara.

Holotype — Pl. 4, fig. 67; Pad. II-8; 15·0×90·4 μm (19·5 μm).

Verrutriporites vermiculatus sp. nov.

Pl. 4, figs 69, 70

Diagnosis — Pollen grains isopolar, amb subtriangular, 20-28 μm; zonaperturate, triporate, pore margins beset with small verrucae. Exine 1·5 μm thick, finely verrucate-vermiculate, verrucae low, placed closely and irregularly in vermiculate pattern; verrucae in vermiculate rows coalesce locally.

Comments — This is a common element of the Padappakkara samples and has a characteristically verrucate-vermiculate exine.

Type Locality — Padappakkara.

Holotype — Pl. 4, fig. 69; Pad. IV-11; 14·0×90·4 μm (20 μm).

Genus — *Echitriporites* Hoeken-Klinkenberg, 1964

Genotype — Echitriporites trianguliformis Hoeken-Klinkenberg, 1964.

Echitriporites sp.

Pl. 4, fig. 71

Description — Pollen grains isopolar, amb subspheroidal to rounded triangular, polar diameter 16-22 μm; zonaperturate, triporate, pores up to 3 μm, prominently annulate, annulus up to 2 μm thick. Exine 1·5 μm thick, surface densely spinulose, spinules sharply pointed.

Comments — The specimens differ from *E. trianguliformis* Hoeken-Klinkenberg (1964) in smaller size, more rounded amb and prominently annulate pores. *E. irregularis* Muller (1968) is larger and with more scattered spines.

Occurrence — Rare at Edavai.

Genus — *Ornatriporites* gen. nov.

Type Species — Ornatriporites elegans sp. nov.

Diagnosis — Pollen grains isopolar, subtriangular to rounded triangular, triporate, pore margin ornate, beset with prominent gemmae or tubercles. Exine intectate, surface gemmate-tuberculate; locally confluent to form vermiform to cribellate structures.

Comments — *Verrutriporites* Muller (1968) is triporate with verrucate exine. *Echitriporites* Hoeken-Klinkenberg (1964) is triporate and echinate. *Pistillipollenites* (see

Rouse & Srivastava, 1970) is a circular to broadly subtriangular triporate pollen studded with gemmae, each pore being bordered by two prominent gemmae or tubercles.

Ornatriporites elegans sp. nov.

Pl. 4, figs 72, 73

Diagnosis — Pollen grains isopolar, amb subtriangular, sides convex, polar diameter 18-24 μm; zonaperturate, triporate, pores up to 3 μm, pore margin incrassate, ornate, studded with 4-6 prominent gemmae or tubercles. Exine up to 3·5 μm thick, intectate, surface gemmate-tuberculate, processes up to 2·5 μm high, densely placed all over, locally anastomosing to form vermiform or cribellate structures.

Comments — Pollen grains of this type are common elements in the Quilon beds, particularly near Edavai.

Holotype — Pl. 4, fig. 72; Edv. C_1-3; 16·7×77·4 μm (20 μm).

Genus — *Proteacidites* Cookson ex Couper, 1953

Genotype — Proteacidites adenanthoides Cookson, 1950.

Proteacidites retusus Anderson, 1960

Pl. 4, fig. 74

Description — Pollen grains isopolar, amb triangular, sides flat to convex, polar diameter 18-25 μm, zonaperturate, triporate, pores 2·5-3·5 μm, slightly protruding, pore margin incrassate. Exine 1·8 μm thick, sexine thicker than nexine, tectate, surface finely reticulate-foveolate.

Comments — This is an occasional element. *Proteacidites cooksonii* Salard-Cheboldaeff (1978) while resembling the present taxon, has larger pores and finely perforate exine.

Affinity — Proteaceae.

Proteacidites truncatus Cookson, 1950

Pl. 5, fig. 75

Description — Pollen grains isopolar, amb triangular, sides flat, angles truncated, polar diameter 45-55 μm; zonaperturate, triporate, pores equatorially extended, up to 7·5 μm across, pore margin thin. Exine 3-3·8 μm thick, sexine much thicker than nexine, tectate, columella distinct, surface coarsely reticulate, reticulum homobrochate, brochi polygonal to irregular, muri up to 2·5 μm high, meshes occasionally discontinuous, lumina irregular.

Comments — This has been encountered rarely in the Quilon beds. *Proteacidites adenanthoides* Cookson (1950) is slightly smaller, indistinctly and delicately reticulate and with convex sides. *P. protrudus* Sah & Kar (1970) is comparable with the present species in the nature of its apertures, but differs in having finely scrobiculate exine. *P. granulosus* Venkatachala & Rawat (1973) is smaller with granulose exine.

Genus — *Thomsonipollis* Pflug & Thomson ex Krutzsch, 1968

Genotype — Thomsonipollis magnificus Pflug & Thomson, 1953.

Thomsonipollis sp.

Pl. 5, fig. 76

Diagnosis — Pollen grains isopolar or subisopolar, amb rounded, polar diameter 30-38 μm; triporate, pores rounded, equatorial, occasionally subequatorial, 6-10 μm with prominent annuli. Exine up to 2·2 μm thick, surface finely granular to smooth.

Comments — These are fairly common in the Padappakkara samples. *Thomsonipollis paleocenicus* Elsik (1968) differs from the present species in its smaller size, subtriangular amb and prominently invaginated pores. *T. variornatus* from the Neogene of Cauvery basin (Venkatachala & Rawat, 1973) has a coarsely granulate exine. This is a rare element of the Quilon beds.

Affinity — The fossil pollen shows resemblance with the pollen of *Palaquium ellipticum* of Sapotaceae (Gupta & Sharma, 1977). The pollen grains of *P. ellipticum* are, however, smaller than the fossil taxon.

Occurrence — Fairly common at Padappakkara.

Subturma—*Polyporines* (Naumova) Potonié, 1960

Infraturma — *Stephanoporites* (Hammen) Potonié, 1960

Genus — *Tetrapollis* Pflug, 1953

Genotype — *Tetrapollis validus* Pflug (in Thomson & Pflug) 1953.

Tetrapollis sp.

Pl. 5, fig. 77

Description — Pollen grains isopolar, amb roundly squarish, polar diameter 18-22 μm; zonaperturate, tetraporate, pores up to 2 μm with knob-like thickenings near pore margin. Exine 1·5 μm thick, tectate, surface psilate.

Comments — Only two specimens of this pollen type were encountered in the Padappakkara samples. *Tetrapollis* sp. of Venkatachala and Rawat (1972) does not possess any knob-like thickenings around the pores.

Tetrapollis rotundus sp. nov.

Pl. 5, fig. 78

Diagnosis — Pollen grains isopolar, amb spheroidal, polar diameter 18-22 μm; zonaperturate, tetraporate, pores up to 2·5 μm, pore margin provided with nexinous thickenings. Exine 1·5 μm thick, sexine as thick as nexine, surface psilate.

Comments — Rounded amb and the nexinous thickenings around the pores are the characteristic features of this taxon.

Type Locality — Padappakkara.

Holotype — Pl. 5, fig. 78; Pad. II-3; 22·8×90·1 μm (22 μm).

Occurrence— Occasional at Padappakkara.

Genus — *Haloragacidites* Couper, 1953

Genotype — *Haloragacidites trioratus* Couper, 1953.

Haloragacidites verrucatus sp. nov.

Pl. 5, fig. 79

Diagnosis — Pollen grains isopolar, amb spheroidal, mesoporia flat to slightly convex, polar diameter 16-22 μm; zonaperturate, tetraporate, pores ellipsoidal to rounded, aspidote, pouting, up to 4·5 μm across including aspis. Exine 1·8 μm thick, tectate, sexine thicker than nexine, surface verrucate, verrucae small, fine and closely placed.

Comments — *Haloragacidites myriophylloides* Cookson & Pike (1954), which is faintly verrucate, is larger and with 3-5 pores.

Affinity — Haloragaceae (*Myriophyllum*).

Type Locality — Edavai.

Holotype — Pl. 5, fig. 79; Edv. C_1-1; 23·8×88·0 μm (19 μm).

Genus — *Clavaperiporites* Ramanujam, 1966

Genotype — *Clavaperiporites jacobi* Ramanujam, 1966.

Clavaperiporites jacobi Ramanujam, 1966

Pl. 5, figs 80, 81

Description — Pollen grains spheroidal, polar diameter 45-50 μm; pantoporate, pores circular, many, 2-4 μm, usually obscured by heavy ornamentation. Exine 4·5 μm thick, tectate, sexine much thicker than nexine, densely clavate, clava 3·5-4 μm high, heads mostly triangular, clava aligned in a reticuloid manner (crotonoid pattern).

Comments— *Buxaceaepollenites* (Sah,1967) and *Thymelaepollis* (Sah & Kar, 1970) are strikingly similar in their generic circumscriptions with *Clavaperiporites* and may be junior synonyms of the latter. *Erdtmanipollis* which also seems to be similar to *Clavaperiporites* is, however, intectate and baculate (Krutzsch, 1962).

Affinity — Crotonoid pattern of sculpture as exhibited by the above fossil pollen is seen in the families Euphorbiaceae, Buxaceae and Thymeliaceae. In the Crotonoidae of Euphorbiaceae, where crotonoid pattern of sculpture is seen, the pollen grains are inaperturate. The pollen grains of Buxaceae and Thymeliaceae are, however, similar to the fossil pollen. The Padappakkara grains show particular resemblance with the pollen of Thymeliaceae and appear to be related to *Wilkstromia* (Selling, 1947).

Occurrence — Common at Padappakkara.

Genus — *Anacolosidites* Cookson & Pike, 1954

Genotype — *Anacolosidites luteoides* Cookson & Pike, 1954.

Anacolosidites luteoides Cookson & Pike, 1954

Pl. 5, figs 82, 83

Description — Pollen grains isopolar, amb subtriangular, angles rounded, sides slightly

concave, polar diameter 16-25 μm, 6-porate, (3-diploporate), three pores in each hemisphere and aligned in a triangle, pores subequatorial, circular to broadly elliptical, 3-4 μm across, margins slightly thickened. Exine 1·5 μm thick, slightly thicker at sides, surface smooth.

Comments — The Indian specimens are generally smaller as compared to the Australian ones.

Affinity — The fossil pollen shows striking resemblance with the pollen of *Anacolosa* of Olacaceae.

Occurrence — Common at Edavai, Padappakkara and Paravur.

Turma — *Jugates* Erdtman, 1960
Subturma — *Tetradites* Cookson, 1947

Genus — *Inaperturotetradites* Hoeken-Klinkenberg, 1964

Genotype — Inaperturotetradites lacunosus Hoeken-Klinkenberg, 1964.

Inaperturotetradites psilatus sp. nov.

Pl. 5, fig. 84

Diagnosis — Pollen grain in rhomboidal tetrads, 37-49×42 μm; individual grains oblate equatorially, 18-21·5×17-26 μm; inaperturate. Exine 1·8 μm thick, surface psilate to finely scabrate.

Comments — The rhomboidal nature of the tetrads and the psilate exine are the important features of this pollen type. *Inaperturotetradites lacunosus* shows distinct reticulate sculpture (Hoeken-Klinkenberg, 1964; Salard-Cheboldaeff, 1978).

Type Locality — Padappakkara.

Holotype — Pl. 5, fig. 84; Pad. II-10; 22·6×77·4 μm (48×35·5 μm).

Genus — *Ornatetradites* gen. nov.

Type Species — Ornatetradites droseroides sp. nov.

Diagnosis — Pollen grains in tetrahedral tetrads, individual grains rounded to suboblate, porate; pores 4-8 or more, usually indistinct and masked by heavy ornamentation; confined more towards proximal facets. Exine tectate, clavate, gemmate or verrucate, surface between sculptural elements punctate.

Comments — *Dicotetradites* Couper (1953) includes tetrads of tricolporate pollen grains with clavate-baculate elements and a reticulate sculpture. In *Droseridites* Cookson (1947) the pollen grains are apparently nonaperturate and bear spines or spinules. *Triporotetradites* Hoeken-Klinkenberg (1964) contains tetrads of psilate triporate pollen grains. *Polyporotetradites* Salard-Cheboldaeff (1978) incorporates tetrads of polyporate, psilate pollen grains.

Ornatetradites droseroides sp. nov.

Pl. 5, figs 85, 86

Diagnosis — Pollen grains in tetrahedral tetrads, tetrads 34-45 μm, individual grains rounded to suboblate equatorially, 15-25× 20-27 μm; porate, pores up to 8, somewhat obscured by closely placed sculptural process, confined more towards proximal facets, circular to flattened, 2·5 to 3 μm across, with thin margins. Exine up to 3·5 μm thick, sexine thicker than nexine, tectate, columella distinct, appearing as radial striae at the periphery of the pollen; supratectal ornamentation gemmate-tuberculate; gemmae up to 2·5 μm high, rather densely placed all over, surface in between gemmae rugulate-punctate.

Comments— Tetrads of *Ornatetradites droseroides* were abundantly found in some Padappakkara samples and constitute a characteristic element of the Quilon microflora.

Affinity — Droseraceae (Chanda, 1965; Raj, 1970; Huang, 1972). The tetrahedral tetrads, presence of pores with faint margins masked by sculpture towards proximal facets and the overall sculptural pattern of the fossil pollen indicate its affinities with certain species of *Drosera*.

Type Locality — Padappakkara.

Holotype — Pl. 5, fig. 85; Pad. II-12; 16·2×83·6 μm (42·5 μm).

Ornatetradites chandae sp. nov.

Pl. 5, figs 87, 88

Diagnosis — Pollen grains in tetrahedral tetrads, occasional with a tendency towards rhomboidal nature, 35-43 μm; individual grains rounded, 16-23·5×18·5-25 μm; porate, pores 4-6, rounded to ellipsoidal, confined

more towards proximal facets, tenuimarginate, obscured by heavy sculptural elements. Exine up to 3 μm thick, tectate, columella distinct, surface verrucate, verrucae up to 2 μm high, surface between verrucae psilate to finely punctate.

Comments — This has been found in Padappakkara and Edavai samples. The species is named in honour of Dr Sunirmal Chanda, Bose Institute, Calcutta.

Affinity — Droseraceae.

Type Locality — Padappakkara.

Holotype — Pl. 5, fig. 87; Pad. II-11; 14·3×76·2 μm (41·5 μm).

Genus — *Droseridites* Cookson emend. Potonié, 1960

Genotype — *Droseridites spinosa* Cookson, 1947.

Droseridites sp.

Pl. 5, fig. 89

Description — Pollen grains in loose tetrahedral tetrads, 20-25 μm, individual grains rounded, 10-13×15-17 μm; apparently inaperturate, but faint indication of few pores confined towards proximal facets in some specimens. Exine up to 2·5 μm thick, sexine thicker than nexine, tectate, surface with spinose-baculate processes, 1·5 μm high, uniformly distributed all over.

Comments — This is an occasional element of the Edavai samples.

Affinity — ?Droseraceae; in Droseraceae, however, the pollen grain are generally porate, although the pores are marked by the heavy sculptural elements.

DISCUSSION

The Quilon beds of Kerala, consisting of limestones, calcareous clays, carbonaceous clays and sands, exhibit a variety of spores of pteridophytes and pollen grains of angiosperms. In addition to these, a sizeable number of fungal spores and fruiting bodies and hystrichosphaerids have also been recorded from these beds (Jain & Gupta, 1970; Ramanujam & Rao, 1976; Rao & Ramanujam, 1975, 1976). No recognizable gymnospermous pollen grains (saccate or nonsaccate) are, however, encountered by the authors in any of the samples studied. This discussion is based upon the information contained in both parts of the investigation.

Floristic Analysis — The pteridophytes in the Quilon microflora are represented by 14 genera and 20 species, belonging to Lycopodiaceae, Gleicheniaceae, Ophioglossaceae, Schizaeaceae, Dicksoniaceae and Polypodiaceae. Of these, polypodiaceous spores are the abundant ones, followed by the schizaeaceous types. *Polypodiisporites* constitutes qualitatively and quantitatively the predominant taxon. The bulk of the Quilon microflora consists of angiospermous pollen. The monocotyledons are represented by 17 genera and 27 species, and the dicotyledons by 54 genera and 62 species.

The pollen of the monocotyledons are referable to Potamogetonaceae, Aroidae, Palmae, Liliaceae, Lemnaceae and Graminae. The predominant taxon among these is Palmae.

The spinascent and reticulate monosulcate pollen types, such as *Couperipollis*, *Spinizonocolpites*, *Longapertites*, *Quilonipollenites* and *Paravuripollis* are abundantly represented; these are followed by the reticulate, inaperturate *Retipilonapites*.

The dicotyledonous pollen types are referable to the families, viz., Euphorbiaceae, Dipterocarpaceae, Caesalpiniaceae, Oleaceae, Ebenaceae, Combretaceae, Loranthaceae, Lecythidaceae, Rubiaceae, Araliaceae, Symplococaceae, Rhizophoraceae, Caprifoliaceae, Compositae, Ctenolophonaceae, Labiatae, Sapindaceae, Meliaceae, Hippocrateaceae, Sapotaceae, Polygalaceae, Moraceae, Sonneratiaceae, Onagraceae, Proteaceae, Casuarinaceae, Myricaceae, Haloragaceae, Olacaceae, Thymeliaceae and Droseraceae. Of these, the more commonly represented families are, viz., Euphorbiaceae, Caesalpiniaceae, Sapotaceae, Combretaceae, Rhizophoraceae, Sapindaceae, Lecythidaceae, Hippocrateaceae, Olacaceae, Ctenolophonaceae, Myricaceae and Droseraceae.

Among the dicotyledonous pollen types, 3- or 4-colporate and 3-porate ones constitute the predominant elements. The polycolpate (colporate) grains too represent a fair proportion of this palynoassemblage.

The following is the break up of the known botanical affinities of the various spore and pollen taxa recovered from the Quilon beds.

PTERIDOPHYTES

Lycopodiaceae (*Lycopodium*)	*Verrucosisporites*
Ophioglossaceae (*Ophioglossum*)	*Foveosporites*
Dicksoniaceae	*Cibotidites*
Schizaeaceae	*Lygodiumsporites*, *Schizaeosporites*, *Crassoretitriletes*
Gleicheniaceae (*Gleichenia*)	*Gleicheniidites*
Polypodiaceae (*Pteris*, *Adiantum* and other taxa)	*Pteridacidites*, *Laevigatosporites*, *Polypodiisporites*

ANGIOSPERMS

Monocotyledons

Potamogetonaceae (*Potamogeton*)	*Retipilonapites*, *Clavainaperturites*
Liliaceae (*Lilium*, *Nomocharis*)	*Liliacidites*, *Crotonisulcites*
Palmae (*Cocos*, *Areca*, *Hyphene*, *Nipa*, *Calamus*, *Metroxylon*, *Iriartea*, etc.)	*Palmaepollenites*, *Arecipites*, *Couperipollis* (some spp.) *Clavapalmaedites*, *Spinizonocolpites*, *Verrumonocolpites*, *Paravuripollis*, *Longapertites*, *Quilonipollenites*, *Dicolpopollis*
Aroidae	*Spinainaperturites*
Lemnaceae (*Lemna*)	*Spinamonoporites*
Graminae	*Monoporopollenites*

Dicotyledons

Euphorbiaceae	*Crotonoidaepollenites*, *Crototricolpites*
Dipterocarpaceae (*Dipterocarpus*)	*Retitriescolpites*, *Dipterocarpoides*
Oleaceae	*Retitrescolpites* (some spp.) *Retitricolpites* (some spp.)
Combretaceae (*Lumnitzera*)	*Heterocolpites*
Ebenaceae (*Diospyros*)	*Psilatricolpites ebenoides*
Loranthaceae (*Loranthus*, *Dendrophthae*)	*Loranthipites*, *Gothanipollis*
Rubiaceae (*Randia*, *Coprosma*)	*Retitricolporites crassioratus*, *Palaeocoprosmadites*
Caesalpiniaceae (*Caesalpinia*, *Peltophorum*, *Mazoneuron*)	*Retitrescolpites* (some spp.), *Margocolporites*
Sapindaceae	*Talisiipites*, *Cupanieidites*
Araliaceae (*Aralia*)	*Araliaceoipollenites*
Symplocaceae (*Symplocos*)	*Symplocoipollenites*, *Costatipollenites*
Rhizophoraceae (*Rhizophora*)	*Zonocostites*
Bombacaceae (*Bombax*)	*Bombacacidites*
Hippocrateaceae (*Hippocratea*)	*Hippocrateaceaedites*
Caprifoliaceae	*Cauveripollis*
Compositae (Tubiflorae)	*Compositoipollenites*
Ctenolophonaceae (*Ctenolophon*)	*Ctenolophonidites*
Labiatae	*Polycolpites*, *Retistephanocolpites*
Meliaceae	*Meliapollis*
Sapotaceae (*Manilkara*, *Mimusops*, *Pouteria*)	*Sapotaceoidaepollenites*
Myricaceae (*Myrica*)	*Myricipites*
Casuarinaceae (*Casuarina*)	*Casuarinidites*
Sonneratiaceae (*Duabanga*)	*Verrutriporites perverrucatus*
Proteaceae	*Proteacidites*
Haloragaceae (*Myriophyllum*)	*Haloragacidites*
Onagraceae (*Jussieua*)	*Triorites microreticuloides*
Olacaceae (*Anacolosa*)	*Anacolosidites*
Thymeliaceae (*Wilkstroemia*)	*Clavaperiporites*
Droseraceae (*Drosera*)	*Ornatetradites*, *Droseridites*

The following spore and pollen genera have been found to be commonly to abundantly represented in the Quilon beds: *Verrucosisporites*, *Polypodiisporites* (abundant), *Retipilonapites* (abundant), *Couperipollis* (abundant), *Clavapalmaedites* (abundant), *Paravuripollis* (abundant), *Longapertites* (abundant), *Quilonipollenites*, *Palmaepollenites*, *Dicolpopollis* (abundant), *Retitricolpites* (abundant), *Retitrescolpites* (abundant), *Foveotricolpites*, *Ctenolophonidites* (abundant), *Zonocostites*(abundant), *Heterocolpites*, *Marginipollis*, *Hippocrateaceaedites* (abundant), *Margocolporites* (abundant), *Sapotaceoidaepollenites* (abundant), *Talisiipites*, *Verrutriporites* (abundant), *Maculoporites* (abundant), *Myricipites*, *Anacolosidites*, *Clavaperiporites*, and *Ornatetradites* (abundant).

COMPARISON OF QUILON MICROFLORA WITH OTHER NEOGENE MICROFLORAS

Neyveli Microflora — A rich assemblage of spores, pollen grains and diverse fungal remains has been recorded from the Neyveli lignite of the South Arcot District of Tamil Nadu in South India (Thiergart & Frantz, 1962; Ramanujam, 1963a, 1963b, 1966, 1966-67, 1974; Ramanujam & Ramachar, 1963; Navale, 1961, 1973; Urmila Deb, 1972; Kalavathi, 1977). The diversity and richness of the pteridophytic spores, the predominance of the angiospermous pollen and the general absence of the

gymnospermous pollen are common in the Quilon and Neyveli assemblages. The following genera are common to both the assemblages: *Laevigatosporites*, *Verrucosisporites*, *Crassoretitriletes*, *Polypodiisporites* (= *Polypodiidites*), *Schizaeoisporites*, *Retipilonapites*, *Spinainaperturites*, *Arecipites*, *Palmaepollenites*, *Liliacidites*, *Dicolpopollis* (= *Disulcites*), *Quilonipollenites*, *Longapertites*, *Polycolpites*, *Psilatricolporites*, *Araliaceoipollenites*, *Hippocrateaceaedites*, *Zonocostites**, *Symplocopollenites*, *Palaeocoprosmadites*, *Retitricolpites*, *Polygalacidites**, *Margocolporites*, *Sapotaceoidaepollenites*, *Padappakkarapollis**, *Ctenolophonidites**, *Marginipollis**, *Polygonacidites**, *Maculoporites**, *Proteacidites*, *Anacolosidites**, *Meliapollis* = *Tetracolporites*), *Polycolpites*, *Retistephanocolpites**, *Monoporopollenites*, *Triporopollenites*, *Haloragacidites*, *Clavaperiporites* and *Inaperturotetradites* (* — information from Dr G. K. B. Navale and the work in progress in our own lab.) The Quilon microflora on the whole appears to be more varied and richer than that of the Neyveli lignite.

Microflora of the Cauvery Basin — The Neogene microflora of the Cauvery basin has been studied recently by Venkatachala and Rawat (1973). The Quilon microflora shows significant similarities with that of the Cauvery basin. *Verrucatosporites* (= *Polypodiisporites*), *Cauveripollis*, *Maculoporites*, *Costatipollenites*, *Sapotaceoidaepollenites*, *Bombacacidites*, *Foveotricolpites*, *Palaeocoprosmadites*, *Proteacidites*, *Talisiipites*, seen commonly in Lower to Middle Miocene of the Cauvery basin, are also known from the Quilon beds. Further, a number of taxa common to both Palaeogene and Neogene of the Cauvery basin have also been recorded from the Quilon beds. The hystrichosphaerids recorded from the Quilon beds are known from the Oligocene-Lower Miocene sediments of the Cauvery basin.

Despite the close similarity between the microfloral assemblages of the Quilon beds and the Lower to Middle Miocene of the Cauvery basin, one difference looms, i.e. the presence of a number of polycolpate (or colporate) pollen types and the absence of the saccate coniferous pollen in the former. *Magnastriatites* spores and *Malvacearumpollis* pollen known from the Neogene of the Cauvery basin are also not found in the Quilon sediments.

Neogene Microfloras of Assam and Bengal — The microfloral complexes of the Miocene and Pliocene (Surma, Tipam & Dihing series) of Assam have been studied by Baksi (1962), Banerjee (1964), Sah and Dutta (1968), Sah and Singh (1977), and Salujha, Kindra and Rehman (1977). The beginning of the Miocene in Assam is recognized by an abundance of bisaccate coniferous pollen, and the frequent occurrence of Parkeriaceae spores and *Polygonacidites*. But for the Parkeriaceae spores and the coniferous pollen most of the other palynotaxa known from the Lower Miocene of Assam are also known from the Quilon beds.

A comparison of the microfloral assemblages of palynological zones of the Bengal Basin (Baksi, 1972, 1974) with that of the Quilon beds indicates a general similarity of the palynological Zone V (representing the Miocene age) of the former with the spore and pollen complex of the latter, in the following criteria, viz. (i) presence of *Barringtonia* (= *Marginipollis*) pollen, (ii) great abundance of the tricolpate (colporate) and triporate pollen, (iii) fairly abundant occurrence of the spinose monosulcate pollen, and (iv) the presence of hystrichosphaerids.

Microflora of Barundi (*Africa*) — The Miocene-Pliocene microflora of the Rusizi Valley, Barundi (Sah, 1967) shows a close agreement with that of the Quilon sediments. The pteridophytic spores such as *Pteridacidites*, *Cibotidites*, *Cingulatisporites*, *Foveosporites*, and *Polypodiisporites* are common to both these microfloras. Among the angiospermic pollen types, the following are common to both the Quilon and Barundi palynoassemblages, viz., *Palmaepollenites*, *Arecipites*, *Retipilonapites*, *Retitrescolpites*, *Compositoipollenites*, *Bombacacidites*, *Sapotaceoidaepollenites*, *Proteacidites*, *Meliapollis* (=*Tetracolporites*), *Polycolpites*, *Spinamonoporites*, *Anacolosidites* and *Triporopollenites*. Saccate coniferous grains recorded from the Neogene of Barundi, however, have not been recorded from the Quilon beds.

Thus, on the whole, the spore and pollen complex of the Quilon beds exhibits a significant resemblance with the Neogene microfloras of the Neyveli lignite, Cauvery basin and Rusizi Valley of Barundi. At the same time, a number of taxa are rather peculiar to Quilon beds, viz., *Crotonoidae-*

pollenites, *Clavapalmaedites*, *Crotonisulcites*, *Paravuripollis*, *Quilonipollenites*, *Heterocolpites*, *Loranthipites*, *Ornatriporites* and *Ornatetradites*.

PALYNOLOGY AND GEOLOGICAL AGE OF THE QUILON BEDS

Jacob and Sastry (1952) on foraminiferal evidence assigned a Burdigalian (Lower Miocene) age to the Quilon limestones. Dey (1962) assigned a Vindobanian age (Middle Miocene) to the Quilon limestones on the basis of molluscs. Poulose and Narayana Swamy (1968) opined that the Burdigalian age assigned by Jacob and Sastry (1952) for the bore-hole cores and the Vindobanian age assigned by Dey (1962) for the topmost limestone beds (outcrops) at Padappakkara, probably constitutes the lower and upper age limits for the Quilon beds. Rao and Dutta (1976) support the Burdigalian age of the Quilon beds on the basis of foraminifers and ostracods.

The spore and pollen complex of the Quilon beds, as has been pointed out in previous pages, agrees significantly with the Neogene microfloral assemblages of India and Africa. The profusion of *Polypodiisporites*, coupled with the occurrence of *Crassoretitriletes*, *Pteridacidites*, *Intrabaculisporis* and *Eximospora* among the pteridophytes when taken in conjunction with the presence of *Dicolpopollis* (abundant), *Cauveripollis*, *Maculoporites*, *Compositoipollenites*, *Hippocrateaceaedites*, *Retitricolpites dipterocarpoides* and the abundance of the pollen types of Caesalpiniaceae, Sapotaceae and Droseraceae also point unequivocally towards the Miocene age for these beds. The abundance of *Dicolpopollis* and pollen grain of Caesalpiniaceae and Sapotaceae is characteristic of the Miocene floras of south-east Asia (Muller, 1974). The palynoassemblage thus supports the Lower to Middle Miocene age assigned to the Quilon beds on faunal evidence.

Palaeoclimate and Depositional Environment — An overwhelming majority of the fossil spores and pollen grains with recognizable botanical affinities indicates the presence of either exclusively or chiefly tropical families in the Quilon microflora. The abundance of ferns (Polypodiaceae, Schizaeaceae and Dicksoniaceae) and the presence of Dipterocarpaceae, Ctenolophonaceae, Olacaceae and *Duabanga* of Sonneratiaceae points toward heavy precipitation. It may then safely be concluded that the climate of Kerala during the Miocene was of the tropical humid type with plenty of rain fall. As the present day climate of Kerala is of the same kind, one is tempted to visualize that perhaps there has not been much change in the climate of this region since the Miocene epoch.

On the whole, among the angiosperms the pollen of arborescent plants predominate over that of the herbaceous ones. The rarity of the graminaceous pollen indicates the paucity of grass cover in the region. The majority of the pollen grains exhibit diverse types of exine sculpturing, often of a very ornate type, which incidentally indicates that they were produced by entomophilous plants and that there was not much of long distance transport of palynomorphs either by wind or water as most of them originated from plants growing in and around the vicinity of the depositional site. A few pollen types referable to the subtropical or temperate taxa (Myricaceae, Thymeliaceae, Symplocaceae, etc.) may have had their source in the mountainous region nearby.

The microfloral investigation of the Quilon sediments has brought to light the following data that could suitably be utilized in assessing and evaluating the nature of their depositional environment.

(a) Occurrence of hystrichosphaerids.
(b) Occurrence of Polypodiaceae and Schizaeaceae spores
c) Occurrence of pollen comparable to *Barringtonia*, *Rhizophora*, *Lumnitzera*, *Nipa*, *Metroxylon*, *Calamus*, *Iriartea* and pollen referable to Araliaceae, Sapindaceae, Meliaceae and Droseraceae
(d) Occurrence of pollen types related to *Potamogeton*, *Lemna* and *Myriophyllum*.

The faunal evidence indicated neritic and shallow marine conditions at the time of deposition of the Quilon beds (Poulose & Narayana Swamy, 1968). The record of hystrichosphaerids such as *Achmosphaera*, *Cleistosphaeridium*, *Spiniferites*, etc. and acritarchs represented by *Baltisphaeridium* from clays and calcareous clays of the Quilon Formation fully substantiates this contention. The presence of pollen types related to

Barringtonia, *Rhizophora*, *Lumnitzera*, *Nipa*, *Iriartea*, *Calamus*, *Metroxylon*, Araliaceae, Sapindaceae, Meliaceae and Droseraceae and the spores of Polypodiaceae and Schizaeaceae clearly testifies to the prevalence of brackish water mangrove swamps all along the coast line. The mangrove forests encompass extensive areas typically between the low and high tide regions. Depending upon the degree of salinity and tidal influences, the mangrove swamps in tropics are found in the littoral regions, at the river estuarines, along the creeks and lagoons and on low mud flats along the sea coast.

The non-mangrove members of Palmae may have occupied a position away from the storm tide. The occurrence of pollen types referable to Potamogetonaceae (*Potamogeton*), Lemnaceae (*Lemna*) and Haloragaceae (*Myriophyllum*) highlights the presence of freshwater lakes or ponds dotting the landscape, away from the mangrove belt towards inland.

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EXPLANATION OF PLATES

(All figs × 1000 unless otherwise mentioned)

PLATE 1

1, 2. *Crotonoidaepollenites euphorbioides* gen. et sp. nov., fig. 1 — holotype.
3. *Retitricolpites dipterocarpoides* sp. nov., holotype.
4. *Retitricolpites microreticulatus*.
5. *R. marginatus*.
6. *Retitrescolpites indicus* sp. nov., holotype.
7, 8. *R. singularis* sp. nov., holotype.
9. *Retibrevitricolpites simplex* sp. nov., holotype.
10. *Foveotricolpites piercei* sp. nov., holotype.
11, 12. *F. prolatus* sp. nov., fig. 11 — holotype.
13. *Crototricolpites densus*.
14. *Punctatricolpites* sp.

PLATE 2

15, 16. *Bacubrevitricolpites rotundus* gen. et sp. nov., fig. 15 — holotype. × 800.
17, 18. *Loranthipites elegans* gen. et sp. nov., fig. 17 — holotype.
19. *Marginipollis kutchensis* comb. nov.
20, 21. *M. quilonensis* sp. nov., fig. 20 — holotype.
22. *Clavasyncolpites gracilis* gen. et sp. nov., holotype.
23. *Meyeripollis baksii* sp. nov., holotype.
24. *Retistephanocolpites crassimuratus* sp. nov., holotype.
25, 26. *Ctenolophonidites costatus*.
27, 28. *Polycolpites granulatus*.

29. *Psilatricolporites ebenoides* sp. nov., holotype.
30, 31. *Heterocolpites combretoides* sp. nov., fig. 31 — holotype.
32. *H. granulatus* sp. nov., holotype.

PLATE 3

33. *Retitricolporites crassioratus* sp. nov., holotype. × 750.
34. *Cauveripollis superbus.* × 800.
35. *Araliaceoipollenites quilonensis* sp. nov., holotype.
36. *Zonocostites indicus* sp. nov., holotype.
37. *Compositoipollenites argutus.*
38. *Bombacacidites minutus* sp. nov., holotype.
39. *Hippocrateaceaedites quilonensis* sp. nov., holotype.
40. *Palaeocoprosmadites keralaensis* sp. nov., holotype.
41. *Symplocoipollenites crassioratus* sp. nov., holotype.
42. *S. punctatus* sp. nov., holotype.
43. *Costatipollenites pauciornatus.*
44. *Margocolporites tsukadai.*
45. *M. oligobrochatus.*
46. *Talisiipites elegans* sp. nov., holotype.
47. *Gothanipollis indicus* sp. nov., holotype.
48. *Cupanieidites punctatus* sp. nov., holotype.
49. *Sapotaceoidaepollenites keralaensis* sp. nov., holotype.
50. *S. africanus.*
51. *S. neyveliensis.*

PLATE 4

52. *Meliapollis quilonensis* sp. nov., holotype.
53. *Foveostephanocolporites leidelmeyerii* sp. nov., holotype.
54. *F. indicus* sp. nov., holotype.
55, 56. *Padappakkarapollis venkatachalae* gen. et sp. nov., holotype.
57, 58. *Polybrevicolporites karii* sp. nov., holotype.
59. *Polygalacidites singularis* sp. nov., holotype.
60. *Triporopollenites minutus* sp. nov., holotype.
61. *Triorites microreticulatus* sp. nov., holotype.
62. *Myricipites harrisii.*
63. *Casuarinidites* sp.
64-66. *Maculoporites quilonensis* sp. nov., fig. 64 — holotype.
67, 68. *Verrutriporites perverrucatus* sp. nov., holotype.
69, 70. *Verrutriporites vermiculatus* sp. nov., fig. 69, holotype.
71. *Echitriporites* sp.
72, 73. *Ornatriporites elegans* gen. et sp. nov., fig. 72 — holotype.
74. *Proteacidites retusus.*

PLATE 5

75. *Proteacidites truncatus.*
76. *Thomsonipollis* sp.
77. *Tetrapollis* sp.
78. *T. rotundus* sp. nov., holotype.
79. *Haloragacidites verrucatus* sp. nov., holotype.
80, 81. *Clavaperiporites jacobi.*
82, 83. *Anacolosidites luteoides.*
84. *Inaperturotetradites psilatus* sp. nov., holotype.
85, 86. *Ornatetradites droseroides* gen. et sp. nov., fig. 85 — holotype.
87, 88. *O. chandae* sp. nov., fig. 87 — holotype.
89. *Droseridites* sp. × 800.

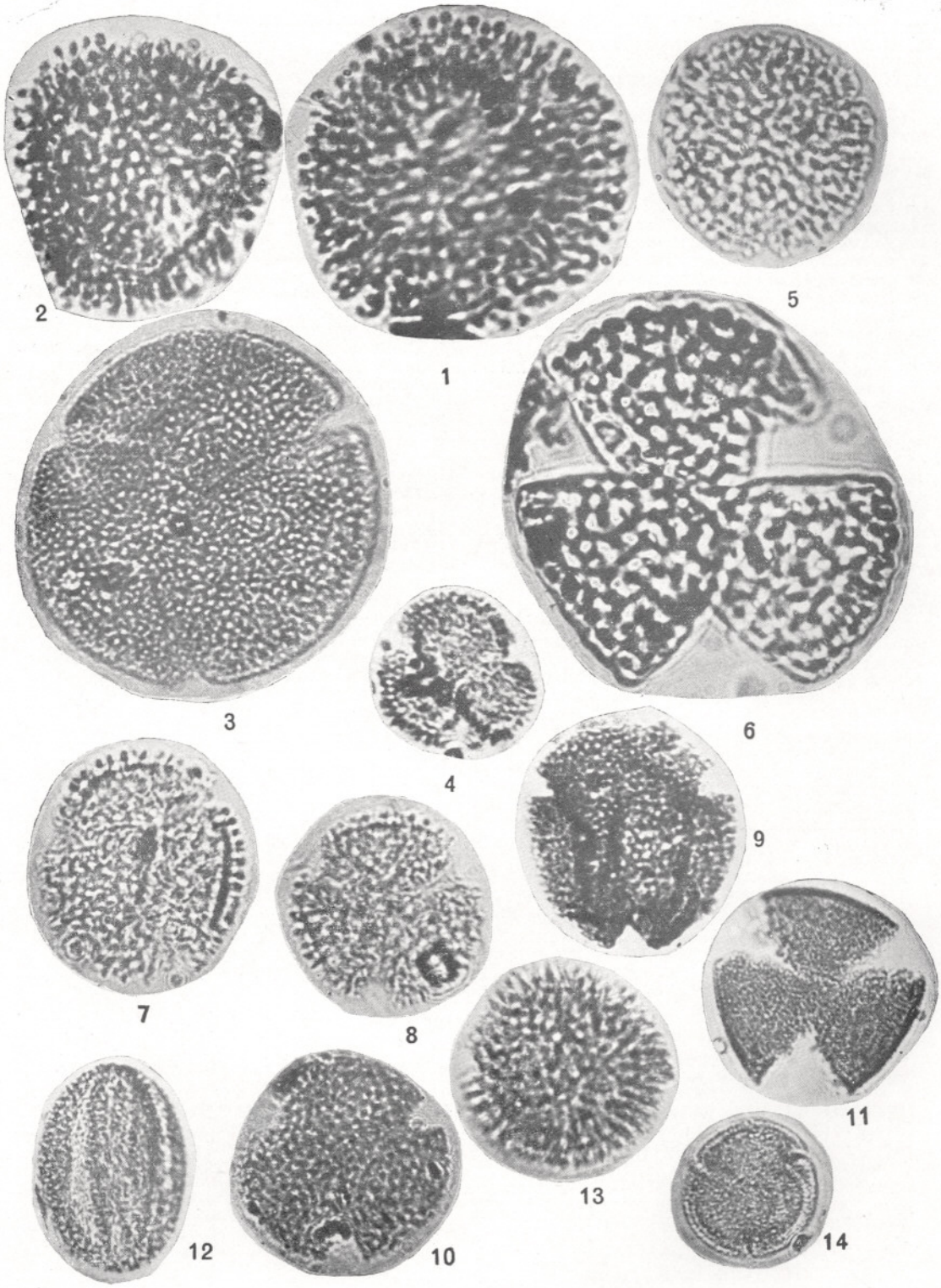

PLATE 1

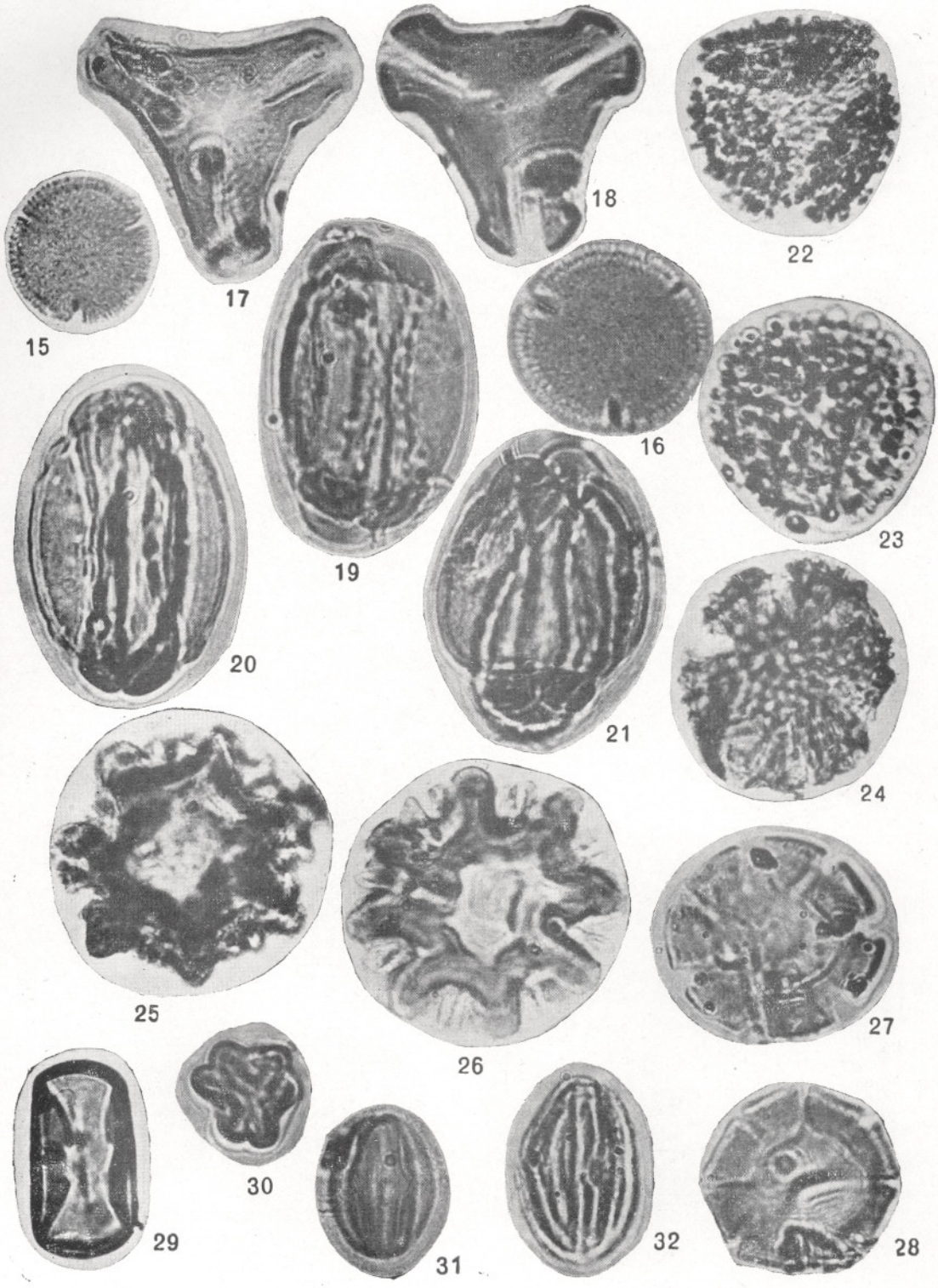

PLATE 2

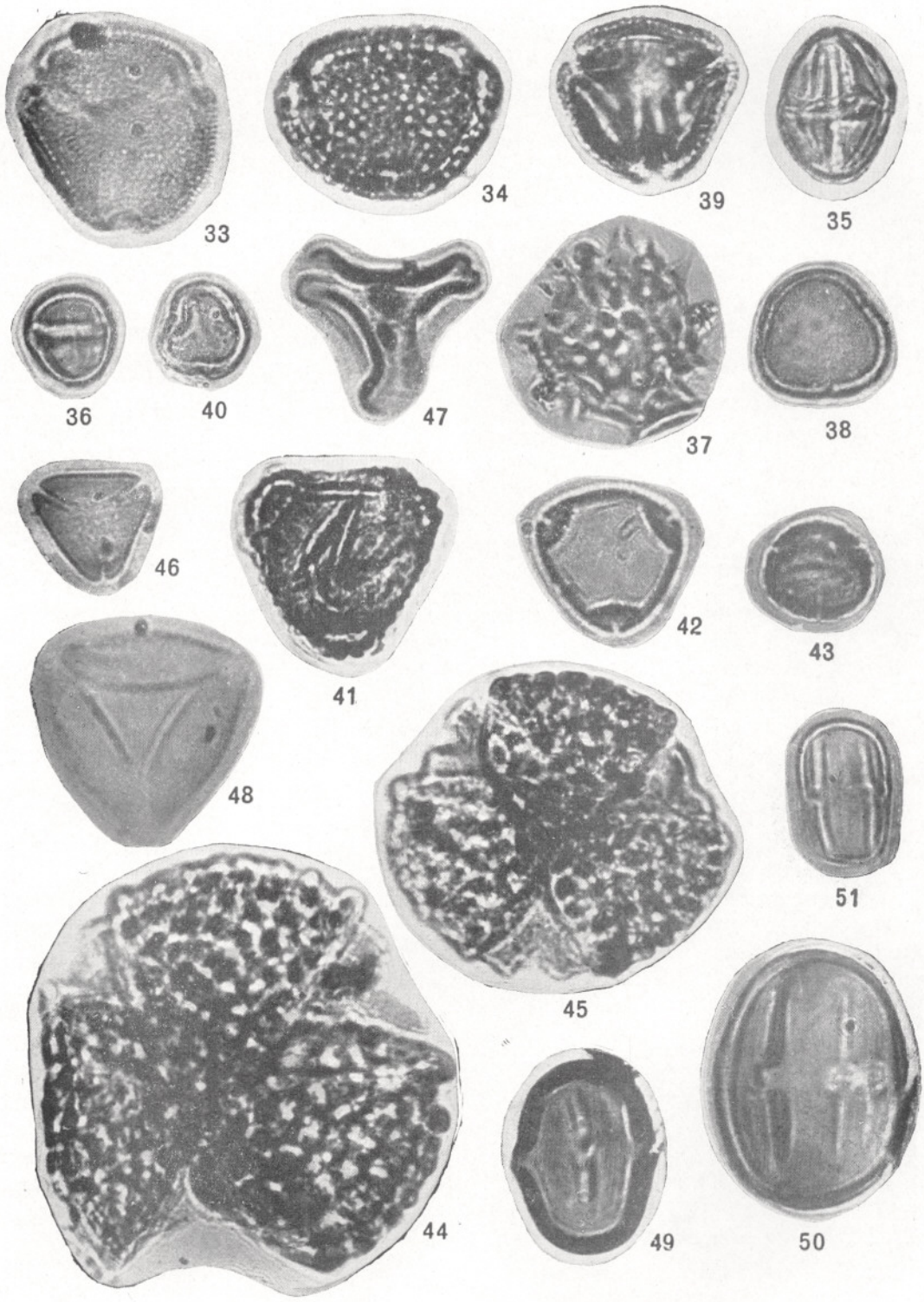

PLATE 3

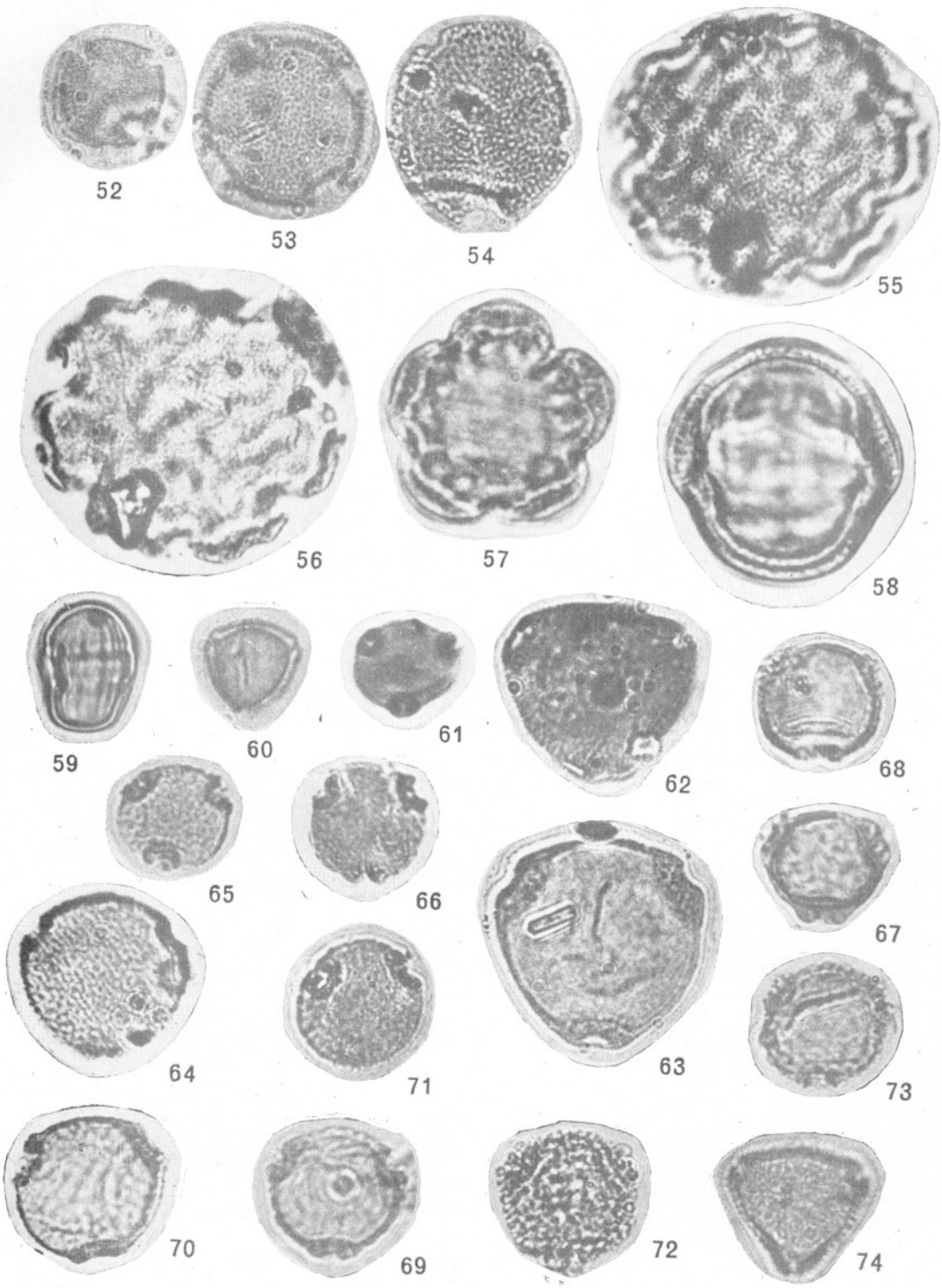

PLATE 4

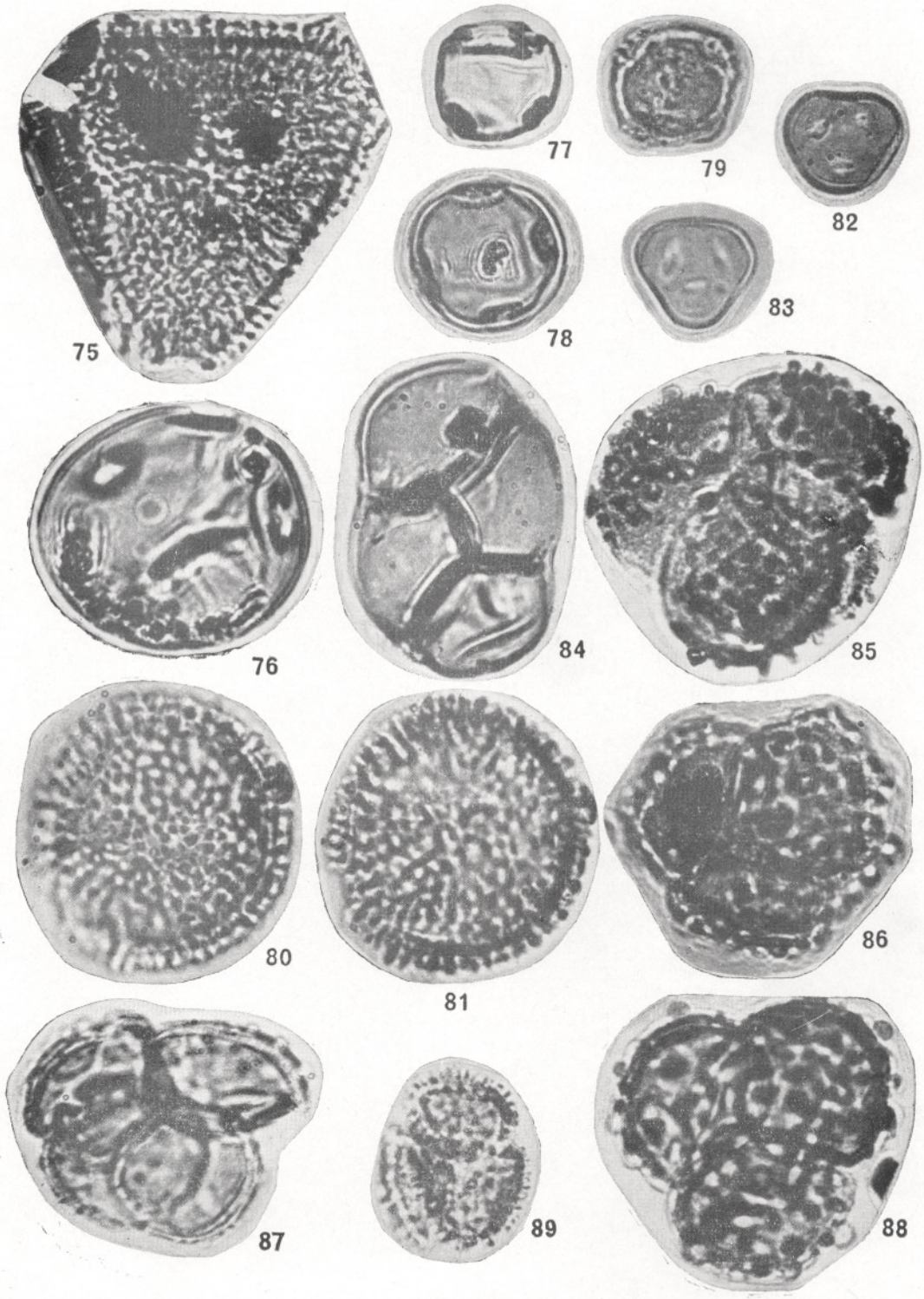

PLATE 5