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PALYNOLOGY OF NEOGENE SEDIMENTS AROUND QUILON AND VARKALA, KERALA COAST, SOUTH INDIA — 2. SPORES AND POLLEN GRAINS

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ABSTRACT

The morphotaxonomy of dispersed spores and pollen grains, recovered from the Miocene sediments around Quilon and Varkala, Kerala Coast, South India, forms the basis of the present article. The palynological assemblage includes 44 genera and 56 species and is dominated by angiospermic pollen having subdominant pteridophytic elements. The occurrence of gymnospermic pollen is very rare.

Key-words — Palynology, Morphotaxonomy, Pteridophytic elements, Kerala Coast, Neogene (India).

सारांश

दक्षिण भारत में केरल तट पर कोल्लम् एवं वरकला के आस-पास निओजीन अवसादों का परागाणविक अध्ययन-2. बीजाण एवं परागकण – रंजीत कुमार कर एवं कृष्ण प्रसाद जैन

दक्षिण भारत में केरल तट पर कोल्लम् एवं वरकला के आस-पास मायोसीन अवसादों से प्राप्त परिक्षिप्त बीजाणुओं तथा परागकणों का बाह्य-वर्गीकणिक अध्ययन इस शोध-पत्र का विषय है। आवृतबीजी परागकणों से प्रभावी तथा टेरिडोफ़ाइटी तत्वों से उपप्रभावी इस परागाणविक समुच्चय में 44 वंश तथा 56 जातियाँ विद्यमान हैं। अनावृतबीजी परागकणों की प्राप्ति बहुत प्रकीर्ण है।

INTRODUCTION

THE spores and pollen grains described here were recovered from the Neogene sediments collected from six measured sections developed near Padappakara, Edvai and Varkala (Jain & Kar, 1979). The slides and negatives of the figured specimens are housed at the Museum, Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC PALYNOLOGY

PTERIDOPHYTES

Cyathidites australis Couper (Pl. 1, figs 1, 2; Pl. 2, figs 23, 24) *Punctatisporites sarangwarensis* Kar (Pl. 1, fig. 3), *Intrapunctisporis intrapunctis* Krutzsch (Pl. 2, fig. 55), *I. harudiensis* Kar (Pl. 1, figs 4-6), *Dandotiaspora plicata* (Sah & Kar) Sah, Kar & Singh (Pl. 1, fig. 7), *Alsophilidites kerguelensis* Cookson (Pl. 2, figs 25-27), *Biretisporites convexus* Sah & Kar (Pl. 1, fig. 9), *B. scabratus* sp. nov., *Osmundacidites kutchensis* Sah & Kar (Pl. 2, fig. 28), *Scantigranulites triangulus* Kar, *S. sparsus* Kar (Pl. 2, fig. 30), *Lycopodiumsporites austroclavatidites* (Cookson) Potonié (Pl. 2, fig. 31), *L. bellus* Sah & Kar (Pl. 2, fig. 32), *Cheilanthoidspora mioceneca* sp. nov., *Striatriletes susannae* (van der Hammen) Kar (Pl. 1, figs 14, 15), *Crassoretitriletes vanraadshooveni* Germeraad, Hopping & Muller, *Laevigatosporites lakiensis* Sah & Kar (Pl. 2, figs 40, 41), *Polypodiaceaesporites intrapunctatus* sp. nov., *Monolites major* Cookson (Pl. 2, figs 45, 46), *Polypodiisporites repandus* Takahashi (Pl. 2, fig. 47), *Seniasporites verrucosus* Sah & Kar (Pl. 2, figs 49, 50), *S. minutus* Sah & Kar (Pl. 2, figs 51-53) and *Microfoveolatosporis polyaperturata* (Thiergart & Frantz) Potonié.

GYMNOSPERMS

Podocarpidites classicus Salujha, Kindra & Rehman.

ANGIOSPERMS

Palmaepollenites neyvelii Ramanujam, *P. kutchensis* Venkatachala & Kar, *P. nadhamunii* Venkatachala & Kar (Pl. 3, figs 60,61), *Palmidites maximus* Couper, *Spinizonocolpites echinatus* Muller, *Quilonipollenites sahnii* Rao & Ramanujam (Pl. 3, figs 65-69), *Q. microreticulatus* sp. nov., *Proxapertites operculatus* van der Hammen (Pl. 4, fig. 92), *P. cursus* van Hoeken-Klinkenberg (Pl. 3, fig. 76), *Dicolpopollis kalewensis* (Potonié) Potonié, *Tricolpites reticulatus* Cookson (Pl. 3, fig. 77), *T. retipilatus* sp. nov., *T. baculatus* sp. nov., *T. incognatus* sp. nov., *Symplocoipollenites kutchensis* Venkatachala & Kar (Pl. 4, figs 95,96), *Paleosantalaceaepites primitiva* Biswas (Pl. 3, figs 83-85), *P. minutus* Sah & Kar (Pl. 4, fig. 98), *Margocolporites tsukadai* Ramanujam (Pl. 3, figs 86,87), *M. sitholeyi* Ramanujam (Pl. 3, figs 88-90), *Lakiapollis ovatus* Venkatachala & Kar (Pl. 3, fig. 91; Pl. 4, fig. 125), *Jandufouria seamrogiformis* Germeraad, Hopping & Muller, *Ctenolophonidites costatus* van Hoeken-Klinkenberg (Pl. 4, figs 102-108), *C. palaeoparvifolius* sp. nov., *Sparganiaceaepollenites microreticulatus* sp. nov., *Triporopollenites robustus* sp. nov., *T. verrucatus* sp. nov., *Verrutriporites annulus* sp. nov., *V. gregarus* sp. nov., *Sonneratioipollis bellus* Venkatachala & Kar (Pl. 4, fig. 99), *Proteacidites triangulus* sp. nov., *Malvacearumpollis rudis* (Pl. 4, fig. 122) and *Chenopodipollis miocenica* sp. nov.

SYSTEMATIC DESCRIPTION

Genus — *Dandotiaspora* Sah, Kar & Singh, 1971

Dandotiaspora plicata (Sah & Kar) Sah, Kar & Singh, 1971

Pl. 1, fig. 7

Remarks — *D. plicata* is the only species of the genus that extends in the Upper Tertiaries.

Dandotiaspora sp. cf. *D. plicata* (Sah & Kar) Sah, Kar & Singh, 1971

Pl. 1, fig. 8

Description — Spores subcircular, 60-65 μm. Trilete rays ill-developed, extending about half of radius. Crescent-shaped fold at each ray end distinct. Exine up to 2·5 μm thick, very closely intrapunctate.

Remarks — *Dandotiaspora plicata* (Sah & Kar) Sah, Kar & Singh (1971) resembles the present species in shape, size and crescent-shaped fold at ray ends but the latter differs in the presence of intrapunctate structure.

Genus — *Biretisporites* Delcourt & Sprumont emend. Delcourt, Dettmann & Hughes, 1963

Biretisporites scabratus sp. nov.

Pl. 1, figs. 10, 11

Holotype — Pl. 1, fig. 10, size 76 μm; slide no. 5446/1.

Type Locality — Padappakara, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Subtriangular spores, 65-86 μm, apices broadly rounded, interapical margins convex. Trilete rays raised, ridged, extending generally up to 2/3 radius. Exine up to 2 μm thick, faintly scabrate-granulose.

Comparison — *B. scabratus* sp. nov. is differentiated from all the known species of *Biretisporites* by its scabrate-granulose exine.

Remarks — *Biretisporites crassisexinus* Venkatachala & Rawat (1973) reported from the Oligocene-Miocene subsurface sediments of the Cauvery basin, seems to belong to *Dandotiaspora* Sah, Kar & Singh (1971). The specimen illustrated by Venkatachala and Rawat (1973, pl. 3, fig. 5) is unfortunately not very clear. But it seems to possess thickening at the ray ends. This thickening is characteristic of *Dandotiaspora*. Besides, they have also compared this species with *B. triglobosus* Sah & Dutta (1966) and the specimens illustrated by Vimal (1952) from Dandot, West Pakistan. Both of them have been transferred to *Dandotiaspora* by Sah, Kar and Singh (1971) after studying the specimens.

Genus — *Dictyophyllidites* Couper emend. Dettmann, 1963

Dictyophyllidites sp.

Pl. 1, fig. 12

Description — Spore triangular with rounded apices and straight interapical margins, 40 μm. Trilete rays extending up to 3/4 radius, surrounded by a broad thickening of exine on all sides. Exine about 1·5 μm thick, psilate, weakly intrastructured in haptotypic area.

Comparison — The present specimen is distinguished from *Dictyophyllidites harrisii* Couper (1958) by its broader kyrtome and smaller size.

Ramarks — Only a single specimen could be obtained.

Genus — *Osmundacidites* Couper, 1953

Osmundacidites sp.

Pl. 2, fig. 29

Description — Spore subcircular, 30 μm, trilete rays distinct, extending up to margin. Exine less than 1 μm thick, granulose, grana sparse, scattered throughout.

Comparison — *Osmundacidites kutchensis* Sah & Kar (1969) is much bigger in size than the present species. *O. wellmanii* Couper (1953) is also bigger in size range and is characterized by confluent bases of the sculptural elements.

Genus — *Scantigranulites* Kar, 1978

Scantigranulites triangulus Kar, 1978

Pl. 1, fig. 13; Pl. 4, fig. 126

Remarks — The specimens are generally folded along one of the rays of the trilete mark. The grana are about 1 μm high and very sparsely placed, exine in between the grana is laevigate.

Genus — *Lycopodiumsporites* Thiergart ex. Delcourt & Sprumont, 1955

Lycopodiumsporites sp.

Pl. 2, fig. 33

Description — Spore triangular, 36 μm; interapical margins straight to convex. Trilete rays distinct, raised, extending up to margin. Exine about 2 μm thick, proximally laevigate, distally muri thickened.

Comparison — The present species is distinguished from *Lycopodiumsporites austroclavatidites* (Cookson) Potonié (1956) and *L. bellus* Sah & Kar (1969) by its very thickened muri on the distal side.

Genus — *Cheilanthoidspora* Sah & Kar, 1970

Cheilanthoidspora miocenec a sp. nov.

Pl. 2, figs 34, 35

Holotype — Pl. 2, fig. 34, size 60 μm; slide no. 5393/6.

Type Locality — Chennakodi, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Spores subcircular, 35-64 μm. Monolete distinct, extending up to 3/4 along longer axis. Exine broadly reticulate, reticulation more pronounced on distal side.

Comparison — *Cheilanthoidspora enigmata* Sah & Kar (1974) is closely comparable to the present species in subcircular shape and broad reticulation on both the surfaces but is distinguished by the presence of distinct trilete mark. *C. monoleta* Sah & Kar (1974) and *C. reticulata* Sah & Kar (1974) possess monolete mark but are distinguished by their oval shape.

Remarks — *Cheilanthoidspora* was first reported by Sah and Kar (1974) from the Palana lignites (Lower Eocene) of Rajasthan, western India. Subsequently, it was also found in the Lower Tertiary sediments of Kutch. This genus has been recorded for the first time here in the Miocene.

Ramanujam (1966) instituted *Jacobipollenites* which seems to be very close to *Cheilanthoidspora* in sculptural pattern but in his opinion the former is monoporate.

Genus — *Cicatricosisporites* Potonié & Gelletich emend. Potonié, 1966

Cicatricosisporites sp.

Pl. 1, fig. 16; Pl, 2, fig. 36

Description— Spores subtriangular, 40 μm. Trilete indistinct, exine costate, costae closely placed, proximal costae seems to be parallel to costae on distal side.

Comparison — *Cicatricosisporites* sp. described by Salujha, Kindra and Rehman (1974, p. 272, pl. 1, fig. 17) from the Palaeogene of Assam is a folded specimen and possesses a few costae and they are not placed parallel on both sides. *Cicatricosisporites dorogensis* Potonié & Gelletich, in Germeraad, Hopping and Muller (1968) is larger in size and the costae are rugulate. Besides, they have also a costae free area on the contact area.

Remarks — Only a single spore has been recorded from the material.

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

Crassoretitriletes vanraadshooveni Germeraad, Hopping & Muller, 1968

Pl. 1, figs 17-22; Pl. 2, fig. 37

Remarks — Germeraad, Hopping and Müller (1968) diagnosed *Crassoretitriletes* as " spherical, trilete, entirely coarsely reticulate with undulating muri, thick-walled, laesura indistinct ". A large number of well-preserved specimens belonging to this genus have been studied and it has been observed that the muri on the proximal side are comparatively few than the distal ones and they never form perfect reticulum. The muri on the distal side, on the other hand, anastomose to provide distinct reticulum and subcircular-polygonal lumina. The muri are sometimes very thick and they join together to give foveolate appearance. The smallest spore recorded here is 45 μm. The spores have a tendency to form irregular folds on the proximal side which minimizes the chance of occurrence of fully proximo-distally flattened specimens in large numbers. The exine has been found up to 4 μm thick in certain spores.

Specimens described as *Microreticulatisporites* spp. by Elsik (1968, pl. 12, figs 1-8) from the Rockdale lignite (Palaeocene) of Texas seem to belong to *Crassoretitriletes*. In these specimens also, the proximal side is generally laevigate at least in the contact area while the distal side is distinctly reticulate.

The specimens described as *Lycopodiumsporites perplexus* by Potonié and Sah (1961) from the Cannanore lignites, Kerala closely resemble the present specimens in subcircular shape and perfect reticulum on distal side.

Germeraad, Hopping and Muller (1968) advocated the affinity of *Crassoretitriletes* with *Lygodium microphyllum*. The spores of *Pteris longifolia* described and photographed by Nayar and Devi (1966) also resemble the spores assignable to *Crassoretitriletes* in their subcircular-subtriangular shape, trilete, imperfect reticulum on proximal and perfect reticulum on distal side. Besides, the exine is also about 4 μm thick and the muri are strongly built, thick, forming deep lumen.

Genus — *Foveosporites* Balme, 1957

Foveosporites sp.

Pl. 2, figs 38, 39

Remarks — *Foveotriletes* van der Hammen emend. Potonié (1956) and *Foveosporites* Balme (1957) both are trilete and triangular-subtriangular spores. In the opinion of Potonié (1956), *Foveotriletes* is finely reticulate and the lumina are circular in shape. The lumina in *Foveosporites*, on the other hand, are pore-like and sometimes join together to form canal-like structures.

Description — Spore subtriangular, 60 μm. Trilete rays distinct, extending more than 2/3 radius. Exine about 3 μm thick, foveolate on both sides, foveola 1 μm in diameter, uniformly distributed.

Comparison — *Foveosporites triangulus* Dutta & Sah (1970) described from the Palaeogene of Assam resembles the present species in the nature of foveola but the latter is much bigger in size and is subtriangular in shape. In *F. pseudoreticulatus* Dutta & Sah (1970), the foveola are closely placed to form pseudoreticulum in surface view.

Genus — *Laevigatosporites* Ibrahim, 1932

Genus — *Polypodiaceaesporites* Thiergart emend. Thiergart, 1940

Polypodiaceaesporites intrapunctatus sp. nov.

Pl. 2, figs 42-44; Pl. 4, fig. 127

Holotype — Pl. 4, fig. 127, size 81 × 52 μm; slide no. 5450/4.

Type Locality — Vettor, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Spores monolete, bean-shaped, 56-85×28-55 μm; exine laevigate and intrapunctate.

Comparison — *Polypodiaceaesporites chatterjii* Kar (1979) resembles the species described here in shape and size range but the latter is easily distinguished by its intrapunctate structure. *P. tertiarus* Sah & Kar (1966) is smaller in size range and is occasionally scabrate to verrucose.

Remarks — The genus *Polypodiaceaesporites* in the opinion of Potonié (1956) is laevigate and occasionally intrastructured but never sculptured. So the externally ornamented, bean-shaped monolete spores should be placed somewhere else.

Genus — *Polypodiisporites* Potonié, 1934

Polypodiisporites sp.

Pl. 2, fig. 43

Description — Spore elliptical, 54×45 μm, monolete distinct, extends up to 3/4 radius. Exine tuberose, sculptural elements narrow at base, pin headed at top, sparsely placed.

Comparison — The present species is distinguished from *Polypodiisporites repandus* Takahashi (1964) by its tuberose processes.

Genus — *Microfoveolatosporis* Krutzsch emend. Potonié, 1966

Remarks — Monolete, elliptical-oval spores with foveolate ornamentation are common in various Tertiary sediments. But the authors proposed different names for the same type of spores creating a great deal of confusion in nomenclature. Van der Hammen (1954) was the first to christen *Foveomonoletes* for this type of spores but unfortunately it was not validly published. Krutzsch (1959) introduced *Microfoveolatosporis* for the similar type of spores referred by van der Hammen (1954) as *Foveomonoletes*. Potonié (1966) accepted it as the valid genus and he placed *Reticulosporis* Krutzsch (1959), *Retimonoletes* Pierce (1961) and *Cuddaloria* Thiergart & Frantz (1962) as junior synonyms under it. Following Potonié (1966), Ramanujam (1972) maintained *Microfoveolatosporis* and transferred *Cuddaloria polyaperturata* Thiergart & Frantz (1962) which he (1966) recovered from Neyveli lignites.

Meanwhile, Banerjee (1964) referred some spores as *Foveomonoletes* from the Surma (Miocene) of Assam. Mathur (1966) rediagnosed *Foveomonoletes* van der Hammen (1954) and selected *Foveomonoletes breviletes* Mathur (1966) as the type species for the genus from the Supratrappean beds (Palaeocene) of western Kutch. Potonié (1970), however, placed *Foveomonoletes* as synonym of *Microfoveolatosporis* on nomenclatural ground.

Microfoveolatosporis polyaperturata Thiergart & Frantz emend. Potonié, 1966

Pl. 2, fig. 54

Remarks — Ramanujam (1972) observed this species as a common type in Warkalli lignite. But the samples studied by us from Warkalli, Quilon, Papanasam and other localities show this as a very rare species. The spores are 60-75×32-44 μm in size and elliptical in shape. The monolete mark is distinct, sometimes open, extending up to 3/4 radius along longitudinal axis. The exine is up to 2 μm thick and foveolate. The foveolae are 2-3 μm in diameter, closely and uniformly distributed to provide pseudoreticulate appearance on surface view.

The botanical affinity of this species is supposed to be with *Schizaea* (Dettmann, 1963; Mathur, 1966; Ramanujam, 1966, 1972). In the opinion of Dettmann (1963), the abnormal spores of *Schizaea pectinata* described by Selling (1944) are more or less similar to this taxon.

Genus — *Podocarpidites* Cookson emend. Potonié, 1958

Podocarpidites classicus Salujha, Kindra & Rehman, 1972

Pl. 3, figs 56, 57

Remarks — The pollen grains assignable to this species are very rare. It is interesting to note that Podocarpaceous pollen grains are very rare in the Miocene sediments of southern India while

they are very common in the equivalent sediments of northern India.

Genus — *Palmaepollenites* Potonié, 1951

Remarks — Pollen grains assignable to *Palmaepollenites* are produced by *Calyptronoma dulcis* (Thanikaimoni, 1970, pl. 5, figs 76, 77), *Iguanura geonomaeformis* (Thanikaimoni, 1970, pl. 6, figs 86, 87), *Ptychosperma angustifolium* (Thanikaimoni, 1970, pl. 9, figs 155, 156), *Elaeis guineensis* (Thanikaimoni, 1970, pl, 15, fig. 301) and many other species. The pollen grains produced by these plants are quite similar and in the dispersed state it would be very difficult to distinguish one from the other.

Palmaepollenites neyvelii Ramanujam, 1966

Pl. 3, fig. 58

1966 *Palmaepollenites indicus* Ramanujam p. 157, pl. 1, figs 13, 14.

Remarks — Ramanujam (1966) made two species of *Palmaepollenites*, viz., *P. neyvelii* and *P. indicus* from the Neyveli lignites. Both these species have similar characters except that *P. neyvelii* is crassimarginate while *P. indicus* is tenuimarginate. The difference of exine thickness between the two species is only 1 μm. The latter is a junior synonym of *P. neyvelii*.

Palmaepollenites kutchensis Venkatachala & Kar, 1969

Pl. 3, fig. 59

Remarks — This species resembles the extant pollen grains of *Iguanura geonomaeformis* (Thanikaimoni, 1970, pl. 6, figs 86, 87) in shape, size and nature of the colpus.

Genus — *Couperipollis* Venkatachala & Kar, 1969

Couperipollis sp.

Pl. 3, figs 62, 63

Description — Pollen grain elliptical, 30 × 23 μm. Colpus distinct, uniformly broad, extending from one end to other. Exine pilate, pila up to 3 μm long, closely placed, appearing as negative reticulum in surface view.

Comparison — The present species is distinguished from *Couperipollis perspinosus* (Couper) Venkatachala & Kar (1969), *C. kutchensis* Venkatachala & Kar (1969) and other species referred by them by its pilate exine.

Genus — *Spinizonocolpites* Muller, 1968

Spinizonocolpites echinatus Muller, 1968

Pl. 3, fig. 64

Description — Pollen grain elliptical, 48 × 42 μm. Colpus distinct, equatorially placed, continuous on both sides. Exine spinose, spines scantily placed, sexine thicker than nexine, intramicroreticulate.

Remarks — This species resembles the extant pollen grains of *Nypa fruticans*. The pollen of the latter have been illustrated by Germeraad, Hopping and Muller (1968, pl. 5, fig. 1) and also by Thanikaimoni (1970, pl. 21, figs 428, 429).

Genus—*Quilonipollenites* Rao & Ramanujam, 1978

Quilonipollenites microreticulatus sp. nov.

Pl. 3, fig. 70

Holotype — Pl. 3, fig. 70, size 40 × 31 μm; slide no. 5432/3.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains oval, 30-45 μm. Colpus distinct, broad, reaching end to end. Exine up to 2 μm thick, microreticulate.

Comparison — *Quilonipollenites sahnii* Rao & Ramanujam (in press) is easily distinguished from this species by its broad reticulation.

Remarks — The ornamentational pattern comes close to *Eugeissona brachystachys* pollen grains (Thanikaimoni, 1970, pl. 20, figs 401, 402).

Genus — *Dicolpopollis* Pflanzl emend. Potonié, 1966

Remarks — Dicolpate or disulcate pollen grains are rather rare in the Tertiary sediments. Pflanzl (1956) first reported the

dicolpate pollen grains from the brown coal (Miocene) of Hirschberg. Potonié (1960) reported disulcate pollen from Eocene coal of Kalewa in Burma as *Disulcites kalewensis* Potonié (1960). Nagy (1963) described *Dicolpopollis calamoides* Nagy (1963) from Oligocene-Miocene of North Hungary. Mathur (1963) also reported pollen assignable to *Dicolpopollis* from Eocene of Kutch, western India. Potonié (1966) transferred *Disulcites kalewensis* to *Dicolpopollis* as the latter has nomenclatural priority.

Dicolpopollis kalewensis (Potonié) Potonié, 1966

Pl. 3, figs 71-74

Description — Pollen grains elliptical, 30-40 × 17-25 μm; dicolpate, colpi small, funnel-shaped. Exine 1·5-2·5 μm thick, sexine as thick as nexine, foveolate, weakly micro-reticulate.

Remarks — Potonié (1960, pl. 2, figs 27-43) put many specimens into *Dicolpopollis* (*Disulcites*) *kalewensis* where dicolpate nature is not clear. Pollen grains similar to *Dicolpites* (pl. 2, figs 32-34) have later been placed to *Longapertites* van Hoeken-Klinkenberg (1964) by Germeraad, Hopping and Muller (1968) as *Longapertites vaneendenburgi*. Besides, some other pollen grains photographed by Potonié (1960, pl. 2, figs 29-31) show resemblance with *Proxapertites* van der Hammen (1956).

Regarding the taxonomic affinity of *Dicolpopollis kalewensis*, Potonié (1966) postulated that this species might relate to *Calamus*. According to Thanikaimoni (1970), dicolpate pollen grains are found in the genera *Bejaudia*, *Calamus*, *Ceratolobus*, *Cornera*, *Daemonorhops*, *Myrialepis*, *Plectocomia*, *Plectocomiopsis*, *Schizospatha* and *Korthalsia* of the family Palmae. The type species of *D. kalewensis* designated by Potonié (1960, pl. 2, fig. 39) comes closer to the extant pollen grains of *Calamus andamanicus* (Thanikaimoni, 1970, pl. 18, fig. 357) and *Daemonorhops geniculata* (Thanikaimoni, 1970, pl. 18, fig. 368). Of them, the pollen of *D. geniculata* shows very close resemblance with *Dicolpopollis kalewensis* in shape, size, nature of colpi and above all in the ornamentational pattern. So it seems that the species described by Potonié (1960) is more related to *Daemonorhops* than *Calamus*.

Dicolpopollis sp.

Pl. 3, fig. 75

Description — Pollen grain elliptical, 44 × 35 μm, dicolpate, colpi short. Exine pilate, pila closely placed, provides negative reticulum in surface view.

Comparison — The present specimen is readily distinguished from *Dicolpopollis kalewensis* (Potonié) Potonié (1966) by its heavily pilate ornamentation.

Remarks — The sculptural elements of this species closely resemble that of *Korthalsia scaphigera* described and illustrated by Thanikaimoni (1970, pl. 21, figs 415-418).

Genus — *Tricolpites* Erdtman emend. Potonié, 1960

Tricolpites retipilatus sp. nov.

Pl. 3, figs 78-80

Holotype — Pl. 3, fig. 78, size 60 μm; slide no. 5397/6.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subcircular in equatorial view, 56-66 μm. Tricolpate, colpi long, prominent, wide in polar view. Exine up to 2 μm thick, sexine thicker than nexine, reticulate, forming negative reticulum.

Comparison — *Tricolpites reticulatus* Cookson (1947) comes nearer to the species described here in shape but is distinguished by its ornamentational pattern. *T. levis* Sah & Dutta (1966) is weakly intrastructured.

Remarks — *Retitricolpites circumcanaliculatus* Wymstra (1971) described from the Tertiary sediments of Guiana coastal basin by Wymstra (1971, pl. 3, figs 3, 7) seems to be retipilate. It may be mentioned here that the genus *Retitricolpites* was first proposed by van der Hammen in 1956 and later rediagnosed by van der Hammen and Wymstra (1964). This genus like *Tricolpites* Cookson (1947) is also tricolpate and reticulate. So it is to be observed whether *Retitricolpites* could be differentiated from *Tricolpites*.

Tricolpites baculatus sp. nov.

Pl. 3, figs 81, 82

Holotype — Pl. 3, fig. 81, size 54 μm; slide no. 5397/15.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains originally subcircular but may be of various shapes due to irregular folds, 41-56 μm. Tricolpate, colpi long, narrow, slit-like. Exine less than 2 μm thick, baculate-pilate, sculptural elements very closely placed to appear as reticulate.

Comparison — *Tricolpites retipilatus* is easily differentiated from the present species by its wide colpus in polar view. *T. baculatus* is distinguished from the other known species of *Tricolpites* by its narrow, slit-like colpus and closely placed baculate-pilate sculptural elements.

Tricolpites incognatus sp. nov.

Pl. 4, figs 93, 94

Holotype — Pl. 4, fig. 93, size 92 μm; slide no. 5414/7.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subtriangular-subcircular in equatorial view, 18-22 μm. Tricolpate, colpi long, funnel-shaped in equatorial view. Sexine as thick as nexine, scrobiculate.

Comparison — *Tricolpites retipilatus* and *T. baculatus* are easily distinguished from the present species by their retipilate and baculate sculptural elements respectively. *T. incognatus* is separated from *T. reticulatus* Cookson (1947) by its smaller size.

Genus — *Symplocoipollenites* Potonié, 1957

Symplocoipollenites sp.

Pl. 4, fig. 97

Description — Pollen grain subtriangular in equatorial view, 31 μm. Tricolporate, colpi short, slit-like; pore margin thickened. Exine about 4 μm thick, sexine as thick as nexine, verrucose.

Comparison — *Symplocoipollenites* sp. is differentiated from *Symplocoipollenites kutchensis* Venkatachala & Kar (1969) and *S. minutus* Venkatachala & Kar (1969) by its verrucose exine.

Genus — *Paleosantalaceaepites* Biswas emend. Sah & Dutta, 1970

Remarks — Biswas (1962) instituted *Paleosantalaceaepites* to accommodate 3 colporate, elliptical-oval pollen grains with lalongate pores which are almost fused in some cases. From the name it seems, that he postulated, that the pollen grains described from the Eocene of Assam were related to Santalaceae. Langenheim, Hackner and Bartlett (1967) described pollen of various species of *Rhizophora* while working on the Oligo-Miocene amber from Mexico. From their description and illustration it became evident that hitherto described *Paleosantalaceaepites* Biswas (1962) could also be related to *Rhizophora* pollen grains. Sah and Kar (1970) described *Paleosantalaceaepites minutus* from Eocene of Kutch which resembles the extant pollen grains of *Rhizophora*.

Germeraad, Hopping and Muller (1968) proposed *Zonocostites* for the spherical-subprolate, tricolporate pollen grains with pores equatorially elongated or almost fused and the exine is almost psilate on equator. This genus was intended to accommodate fossil dispersed pollen of *Rhizophora-Bruguiera* type.

Genus — *Margocolporites* Ramanujam, 1966

Remarks — Ramanujam (1966) instituted *Margocolporites* for the subcircular-circular pollen grains with 3 zonimargocolporate condition. He coined the word "margocolpus" from Tsukada (1963) for an equatorially wide and longitudinally furrow-like streak with a short colpus and/or so at the centre of each margocolpus. This region is provided with somewhat thick and distinctly sculptured ectexine. This character is commonly found amongst the Eucaesalpinieae pollen like *Caesalpinia*, *Libidibia*, *Poincianella*, etc. On the basis of margocolpus, Tsukada (1963) divided 12 pollen types in Eucaesalpinieae. The difference between certain types are subtle and in the fossil condition it would be very difficult to recognize them.

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

Jandufouria seamrogiformis Germeraad, Hopping & Muller, 1968

Pl. 4, fig. 100

Description — Pollen grains subcircular, 46-53 μm, pentacolporate, colpi short, funnel-shaped, pore mostly indistinct. Exine 2·3 μm thick, sexine thicker than nexine, intrabaculate.

Remarks — Germeraad, Hopping and Muller (1968) think that this species resembles the extant pollen of *Catostemma* of Bombacaceae.

Jandufouria sp.

Pl. 4, fig. 101

Description — Pollen grain subcircular, 40 μm, hexacolporate, colpi distinct, short, funnel-shaped in polar view, pore distinct only in few cases. Exine 2 μm thick, scrobiculate.

Remarks — *Jandufouria seamrogiformis* Germeraad, Hopping & Muller (1968) is comparable with the present species in general organization but the latter is separated by its scrobiculate ornamentation.

Genus — *Ctenolophonidites* van Hoeken-Klinkenberg, 1966

Remarks — Rao and Vimal (1952) and Vimal (1953) described pollen grains assignable to *Ctenolophonidites* from the Warkalli lignite. Erdtman (1956) advocated their affinity with *Ctenolophon* though Germeraad, Hopping and Muller (1968) were not sure to include them into *Ctenolophon* type due to insufficient description and illustration. Ramanujam and Rao (1973) illustrated many specimens from Warkalli lignites belonging to *Ctenolophon* type.

It is interesting to note that *Ctenolophonidites* is first recorded in Upper Cretaceous of Nigeria but their number dwindles down in Palaeocene and Eocene and then again found in Neogene in good percentage. Sah and Kar (1970) described *Ghoshiacolpites* from the Lower Eocene of Kutch which comes closer to *Ctenolophonidites*. The former genus is polycolpate, subcircular and is characterized by a solid shield-like meridional thickening which projects a ridge in each apocolpate region. This type of exinal thickening is not found in any of the types described by Germeraad, Hopping and Muller (1968). It, however, seems to be an intermediate form between *Ctenolophon engleri* type and *C. parvifolius* type.

Ramanujam and Rao (1973) reported 4 species, viz., *Ctenolophonidites costatus* van Hoeken-Klinkenberg (1966), *C. erdtmanii* Ramanujam & Rao (1973), *C. keralensis* Ramanujam & Rao (1973) and *C. saadii* Ramanujam & Rao (1973) depending on the nature of exinal thickening in the apocolpate and meridional regions.

It has been observed that *Ctenolophonidites* shows much variations on the exinal thickenings. In some of the specimens (Pl. 4, fig. 102) there is very slight thickening on the meridional region which makes it difficult to distinguish it from the ordinary polycolpate pollen grains. In others (Pl. 4, fig. 105) well-developed exinal ridges interconnected at the apocolpi with or without ridges on the meridion are developed. The ridges may be branched and very closely placed to provide the appearance of cereberum in surface view. The extant pollen of *Ctenolophon engleri* studied by Erdtman (1952) and Germeraad, Hopping and Muller (1968) also shows variations of exinal ridges. So it would be better to restrain the institution of many new taxa on the basis of exinal ridges, thickenings and their ramifications.

Ctenolophonidites palaeoparvifolius sp. nov.

Pl. 4, fig. 109

Holotype — Pl. 4, fig. 109, size 46×42 μm; slide no. 5425/12.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subcircular, 39-50×30-41 μm, mostly 7 colpate, colpi short. Exine 2-4 μm thick, sexine thicker than nexine, laevigate and intrabaculate. Exinal thickening uniformly spread like a blanket in apocolpate and mesocolpate regions.

Comparison — The species proposed here is distinguished from *Ctenolophonidites costatus* van Hoeken-Klinkenberg (1966) by the presence of blanket-like uniformly

spread exinal thickening in apocolpate and mesocolpate regions.

Remarks — The present species closely resembles the extant pollen of *Ctenolophon parvifolius* illustrated by Germeraad, Hopping and Muller (1968, pl. 14, figs 3, 4) by its subcircular shape, 7 colpate condition and uniformly thickened exinal thickening. The ornamentational pattern in both are also more or less similar.

Incidentally, Germeraad, Hopping and Muller (1968) regarded *Retistephanocolpites williamsi*, a species instituted by them, as *Ctenolophon parvifolius* type. But the colpi in *R. williamsi* Germeraad, Hopping & Muller (1968, pl. 14, figs 1, 2) are bigger and it is devoid of distinct exinal thickening as found in the pollen grains of *C. parvifolius*. According to Hutchinson (1967), *C. parvifolius* grows only in Malayasia. Germeraad, Hopping and Muller (1968) think that the differentiation of *C. engleri* and *C. parvifolius* took place sometime in Upper Cretaceous and the latter reached in Malayasia probably in Eocene. The pollen grains assignable to this type have also been recorded from the Neogene of Borneo by Germeraad, Hopping and Muller (1968). The record of *C. parvifolius* and *C. engleri* pollen types in Miocene of Kerala is very significant. It seems that both the types were prevalent in southern India during Miocene but later became extinct due to some unknown reasons. If the quantity of pollen grains should be taken as criterion for judging abundance then it seems that *C. engleri* was more prevalent than *C. parvifolius* during Miocene in Kerala.

Genus — *Graminidites* Cookson, 1947

Remarks — Monoporate pollen grains assignable to Gramineae have been reported by van der Hammen (1954) from the Upper Cretaceous of Colombia. In Tertiary, these pollen grains have been recorded by Thiergart (1937), Cookson (1947), Chitaley (1951), Meyer (1956), Jones (1962) and others.

In the dispersed state, they have been referred as *Monoporopollenites* (Meyer) Potonié (1960), *Graminidites* Cookson (1947) and *Sparganiaceaepollenites* Thiergart (1937). *Monoporopollenites* is laevigate while *Graminidites* and *Sparganiaceaepollenites* are granulate and intrareticulate respectively.

In the dispersed condition, the pollen grains of Gramineae are very difficult to identify up to generic level. According to Faegri and Iversen (1964) the homogeneous nature of grass pollen causes one of the greatest difficulties in pollen analysis. Rowley (1960) studied the grass pollen in details and in his opinion the microstructure and microsculpture of the exine are of great importance in delimitating the different genera.

Besides Gramineae, the monoporate pollen grains are also found in the families Cyperaceae, Flagellariaceae and Restionaceae (Chanda & Erdtman, 1965; Chanda, 1966). The exine pattern of pollen grains in these families is rather inconspicuous and does not differ much from the graminoid type.

Graminidites sp.

Pl. 4, fig. 110

Description — Pollen grain subcircular, 70 μm. Exine less than 1 μm thick, irregularly folded, faintly granulose. Monoporate, pore distinct, annulus thick.

Comparison — The present specimen is distinguished from *Graminidites granulatus* by its distinct annulus. *Graminidites* sp. described by Ramanujam (1966) is much smaller in size (25 μm).

Genus — *Sparganiaceaepollenites* Thiergart, 1937

Sparganiaceaepollenites microreticulatus sp. nov.

Pl. 4, figs 111, 112

Holotype — Pl. 4, fig. 111, size 40 μm; slide no. 5393/16.

Type Locality — Chanakkodi, Padappakara, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subcircular, 40-48 μm, monoporate, pore distinct with annulus. Exine 1-1·5 μm thick, sexine as thick as nexine, microreticulate, irregularly folded.

Comparison — *Sparganiaceaepollenites microreticulatus* proposed here resembles *S. polygonalis* Thiergart (1937) in shape and structural pattern but the former is about double in size than *S. polygonalis*.

Remarks — Rao and Vimal (1952) described some forms as *Monoporosa* (pl. 18, figs 2, 3) from Palana lignites (Eocene) of Rajasthan. From the illustration, these forms do not appear as angiospermic ones. Similarly, pollen grains described by Ramanujam (1966) as *Monoporopollenites gramineoides* Meyer: Ramanujam (1966, pl. 5, fig. 87) and *Jacobipollenites magnificus* Ramanujam (1966, pl. 5, figs 88, 89) do not seem to be convincingly monoporate.

Genus — *Triporopollenites* Pflug emend. Potonié, 1960

Triporopollenites robustus sp. nov.

Pl. 4, fig. 113

Holotype — Pl. 4, fig. 113, size 60 μm; slide no. 5480/3.

Type Locality — Edvai, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains triporate, pore margin thickened, 45-65 μm, exine up to 3 μm thick, laevigate.

Comparison — *Triporopollenites vimalii* Sah & Dutta (1966) described from the Palaeogene of Assam is only up to 30 μm in size. *T. plicata* Ramanujam (1966) and *T. simplex* Ramanujam (1966) are also not more than 26 μm in size. So the present species is easily distinguished from the above mentioned species by its bigger size range.

Triporopollenites verrucatus sp. nov.

Pl. 4, figs 114-116

Holotype — Pl. 4, fig. 114, size 20 μm; slide no. 5411/5.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subtriangular in polar view, 18-25 μm. Triporate, pores generally protruding, margin thickened. Exine verrucose-granulose.

Comparison — *Triporopollenites plicata* Ramanujam (1966) and *T. simplex* Ramanujam (1966) described from the Neyveli lignite are distinguished from the present species by their laevigate exine. Moreover, in the former species, the pore margin is not thickened. *T. robustus* is much larger in size range and is also psilate.

Genus — *Verrutriporites* Muller, 1968

Verrutriporites annulatus sp. nov.

Pl. 4, figs 117, 118

Holotype — Pl. 4, fig. 117, size 80 μm; slide no. 5453/8.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subcircular, 60-80 μm, 3 porate, pores distinct, margin thickened. Exine verrucose, sometimes interspersed with pila and bacula, sculptural elements closely placed providing negative reticulum in surface view.

Comparison — *Verrutriporites lunduensis* Muller (1968) is much smaller in size (24 μm) than the present species.

Verrutriporites gregarus sp. nov.

Pl. 4, figs 119, 120

Holotype — Pl. 4, fig. 119, size 42 μm; slide no. 5429/2.

Type Locality — Chanakkodi, Padappakara, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subcircular, 38-49 μm, 3 porate, pores not always traceable, margin not thickened. Exine verrucose/pilate, robustly built, closely placed forming negative reticulum.

Comparison — *Verrutriporites annulatus* resembles the present species in shape and sculptural elements but is larger than the species described here. Besides, the pore margin in *V. annulatus* is also appreciably thickened.

Genus — *Proteacidites* Cookson, 1950

Proteacidites triangulus sp. nov.

Pl. 4, fig. 121

Holotype — Pl. 4, fig. 121, size 60 μm; slide no. 5411/7.

Type Locality — Papanasam, Varkala, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains triangular in polar view, 49-60 μm; 3 porate, pores distinct, not protruding, margin not thickened. Exine pilate, tegillate, sexine thicker than nexine, retipilate.

Comparison — This species resembles *Proteacidites protrudus* Sah & Kar (1970) described from the Eocene of Kutch in shape and size range but the latter is finely scrobiculate. *P. dehaani* Germeraad, Hopping & Muller (1968) is distinguished by its duplicolumellate and reticulate-foveolate tectum. *P. adenanthoides* Cookson (1950) and *P. thalmanni* Anderson (1960) are both reticulate.

Remarks — In general appearance, this species broadly resembles the pollen grains of *Guevina avellana* and *Lomatia ilicifolia* of Proteaceae illustrated by Germeraad, Hopping and Muller (1968, pl. 9, figs 5-8).

Genus — *Chenopodipollis* Krutzsch, 1966

Chenopodipollis miocenica sp. nov.

Pl. 4, figs 123, 124

Holotype — Pl. 4, fig. 123, size 38 μm; slide no. 5474/1.

Type Locality — Chanakkodi, Padappakara, Kerala Coast, South India.

Age — Miocene.

Diagnosis — Pollen grains subcircular, 36-42 μm. Exine 3-5 μm thick, sexine thicker than nexine, intrabaculate. Pores many, uniformly distributed on both sides, pores 2-3 μm in diameter, margin not thickened.

Comparison — *Chenopodipollis multiplex* (Weyland & Pflug) Krutzsch (1966) described originally from the Pliocene resembles the present species in subcircular shape and polyporate nature but *C. multiplex* is distinguished from the latter by its sunken pores.

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EXPLANATION OF PLATES

(All microphotographs are enlarged. × 500)

PLATE 1

1, 2. *Cyathidites australis* Couper, slide nos 5445/3, 5429/1.
3. *Punctatisporites sarangwarensis* Kar, slide no. 5446/1.
4-6. *Intrapunctisporis harudiensis* Kar, slide nos 5398/11, 5428/5.
7. *Dandotiaspora plicata* (Sah & Kar) Sah, Kar & Singh, slide no. 5430/3.
8. *Dandotiaspora* sp. cf. *D. plicata* (Sah & Kar) Sah, Kar & Singh, slide no. 5449/2.
9. *Biretisporites convexus* Sah & Kar, slide no. 5426/2.
10, 11. *B. scabratus* sp. nov., slide nos. 5446/1, 5444/2.
12. *Dictyophyllidites* sp., slide no. 5422/4.
13. *Scantigranulites triangulus* Kar, slide no. 5427/1.
14, 15. *Striatriletes susannae* (van der Hammen) Kar, slide nos 5440/1, 5434/3.
16. *Cicatricosisporites* sp. (proximal view), slide no. 5393/8.
17-22. *Crassoretitriletes vanraadshooveni* Germeraad, Hopping & Müller, slide nos 5439/5, 5438/1, 5436/1, 5470/2.
33. *L.* sp., slide no. 5414/9.
34, 35. *Cheilanthoidspora mioceneca* sp. nov., slide nos 5393/6, 5393/5.
36. *Cicatricosisporites* sp. (distal view), slide no. 5393/8.
37. *Crassoretitriletes vanraadshooveni* Germeraad, Hopping & Müller, slide no. 5440/2.
38, 39. *Foveosporites* sp., slide no. 5425/6.
40, 41. *Laevigatosporites lakiensis* Sah & Kar, slide nos 5394/14, 5411/6.
42-44. *Polypodiaceaesporites intrapunctatus* sp. nov., slide nos 5447/5, 5422/6.
45, 46. *Monolites major* Cookson, slide nos 5397/3, 5394/4.
47. *Polypodiisporites repandus* Takahashi, slide no. 5413/6.
48. *Polypodiisporites* sp., slide no. 5454/6.
49, 50. *Seniasporites verrucosus* Sah & Kar, slide nos 5455/8, 5447/4.
51-53. *S. minutus* Sah & Kar, slide nos 5428/10, 5457/7, 5456/7.
54. *Microfoveolatosporis polyaperturata* (Thiergart & Frantz) Potonié, slide no. 5394/3.
55. *Intrapunctisporis intrapunctis* Krutzsch, slide no. 5424/1.

PLATE 2

23, 24. *Cyathidites australis* Couper, slide nos 5443/3, 5441/7.
25-27. *Alsophilidites kerguelensis* Cookson, slide nos 5466/2, 5398/8, 5428/9.
28. *Osmundacidites kutchensis* Sah & Kar, slide no. 5432/2.
29. *O.* sp., slide no. 5411/3.
30. *Scantigranulites sparsus* Kar, slide no. 5433/1.
31. *Lycopodiumsporites austroclavatidites* (Cookson) Potonié, slide no. 5429/1.
32. *L. bellus* Sah & Kar, slide no. 5428/1.

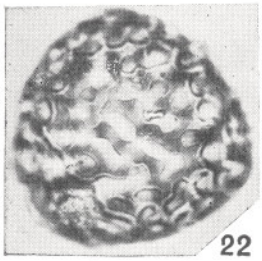
PLATE 3

56, 57. *Podocarpidites classicus* Salujha, Kindra & Rehman, slide nos 5475/5, 5475/6.
58. *Palmaepollenites neyvelii* Ramanujam, slide no. 5392/5.
59. *P. kutchensis* Venkatachala & Kar, slide no. 5458/7.
60, 61. *P. nadhamunii* Venkatachala & Kar, slide nos 5399/15, 5478/11.
62, 63. *Couperipollis* sp., slide nos 5471/6, 5457/7.
64. *Spinizonocolpites echinatus* Müller, slide no. 5471/2.

65-69. *Quilonipollenites sahnii* Rao & Ramanujam, slide nos 5394/8, 5425/6, 5481/1, 5426/5, 5456/1.
70. *Quilonipollenites microreticulatus* sp. nov., slide no. 5432/3.
71-74. *Dicolpopollis kalewensis* (Potonié) Potonié, slide nos 5457/4, 5428/2, 5478/2, 5478/5.
75. *Dicolpopollis* sp., slide no. 5411/11.
76. *Proxapertites cursus* van Hoeken-Klinkenberg, slide no. 5454/3.
77. *Tricolpites reticulatus* Cookson, slide no. 5397/7.
78-80. *T. retipilatus* sp. nov., slide nos 5397/6, 5461/5, 5470/3.
81, 82. *T. baculatus* sp. nov., slide nos 5397/15, 5394/7.
83-85. *Paleosantalaceaepites primitiva* Biswas, slide nos 5414/12, 5392/8, 5478/6.
86, 87. *Margocolporites tsukadai* Ramanujam, slide nos 5473/1, 5397/5.
88-90. *M. sitholeyi* Ramanujam, slide nos 5397/16, 5441/6, 5480/6.
91. *Lakiapollis ovatus* Venkatachala & Kar, slide no. 5423/3.

PLATE 4

92. *Proxapertites operculatus* van der Hammen, slide no. 5461/6.
93, 94. *Tricolpites incognatus* sp. nov., slide nos 5414/7, 5411/9.
95, 96. *Symplocoipollenites kutchensis* Venkatachala & Kar, slide nos 5458/3, 5458/19.
97. *Symplocoipollenites* sp., slide no. 5441/5.
98. *Paleosantalaceaepites minutus* Sah & Kar, slide no. 5457/4.
99. *Sonneratioipollis bellus* Venkatachala & Kar, slide no. 5399/4.
100. *Jandufouria seamrogiformis* Germeraad, Hopping & Müller, slide no. 5419/9.
101. *Jandufouria* sp., slide no. 5456/6.
102-108. *Ctenolophonidites costatus* van Hoeken-Klinkenberg, slide nos 5478/6, 5428/9, 5397/4, 5465/4, 5449/1, 5397/14.
109. *C. palaeoparvifolius* sp. nov., slide no. 5425/12.
110. *Graminidites* sp., slide no. 5468/1.
111, 112. *Sparganiaceaepollenites microreticulatus* sp. nov., slide nos 5393/16, 5393/11.
113. *Triporopollenites robustus* sp. nov., slide no. 5480/3.
114-116. *Triporopollenites verrucatus* sp. nov., slide nos 5411/5, 5425/2, 5399/2.
117, 118. *Verrutriporites annulatus* sp. nov., slide nos 5453/8, 5453/6.
119, 120. *Verrutriporites gregarus* sp. nov., slide nos 5429/2, 5398/6.
121. *Proteacidites triangulus* sp. nov., slide no. 5411/7.
122. *Malvacearumpollis rudis* Kar, slide no. 5424/3.
123, 124. *Chenopodipollis miocenica* sp. nov., slide nos 5474/1, 5467/2.
125. *Lakiapollis ovatus* Venkatachala & Kar, slide no. 5425/5.
126. *Scantigranulites triangulus* Kar, slide no. 5431/6.
127. *Polypodiaceaepsorites intrapunctatus* sp. nov., slide no. 5450/4.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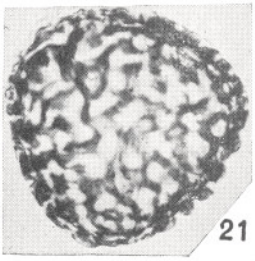
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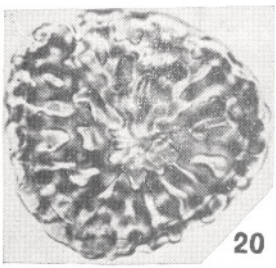
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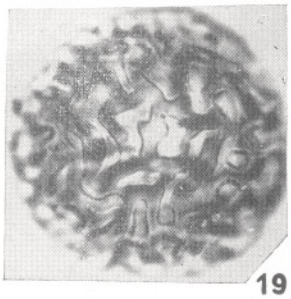
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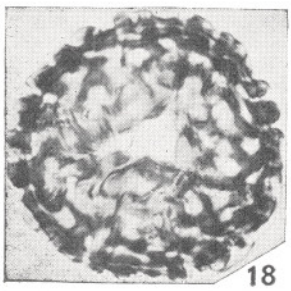
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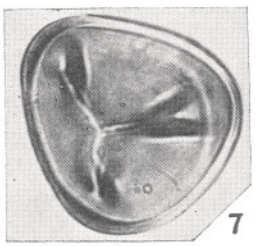
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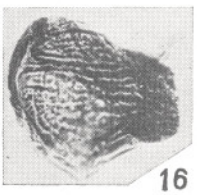
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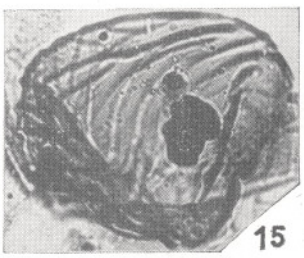
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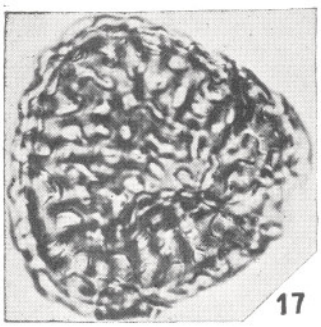
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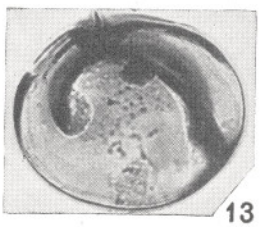
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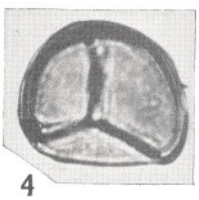
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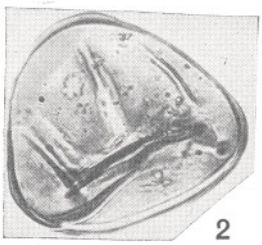
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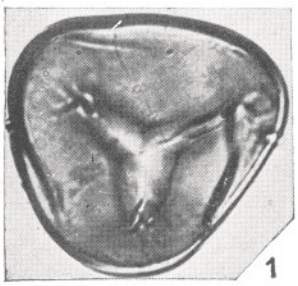
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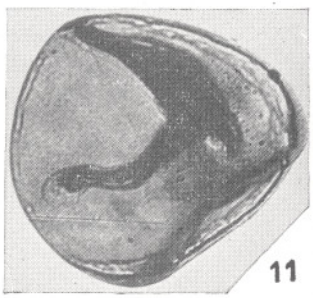
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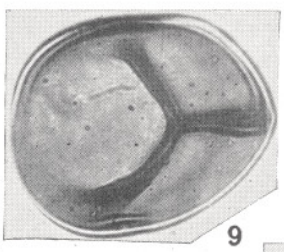
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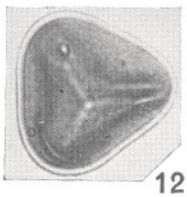
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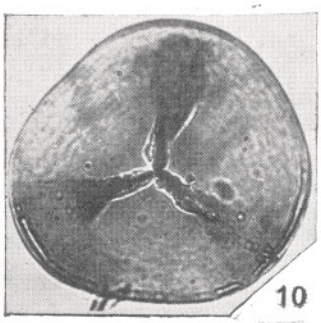
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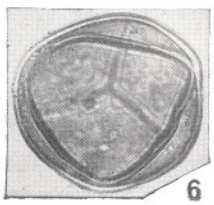
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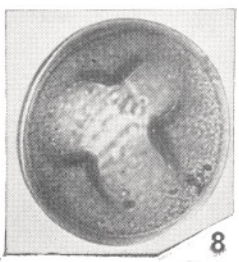
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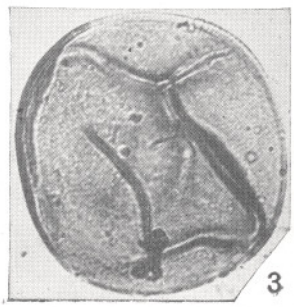
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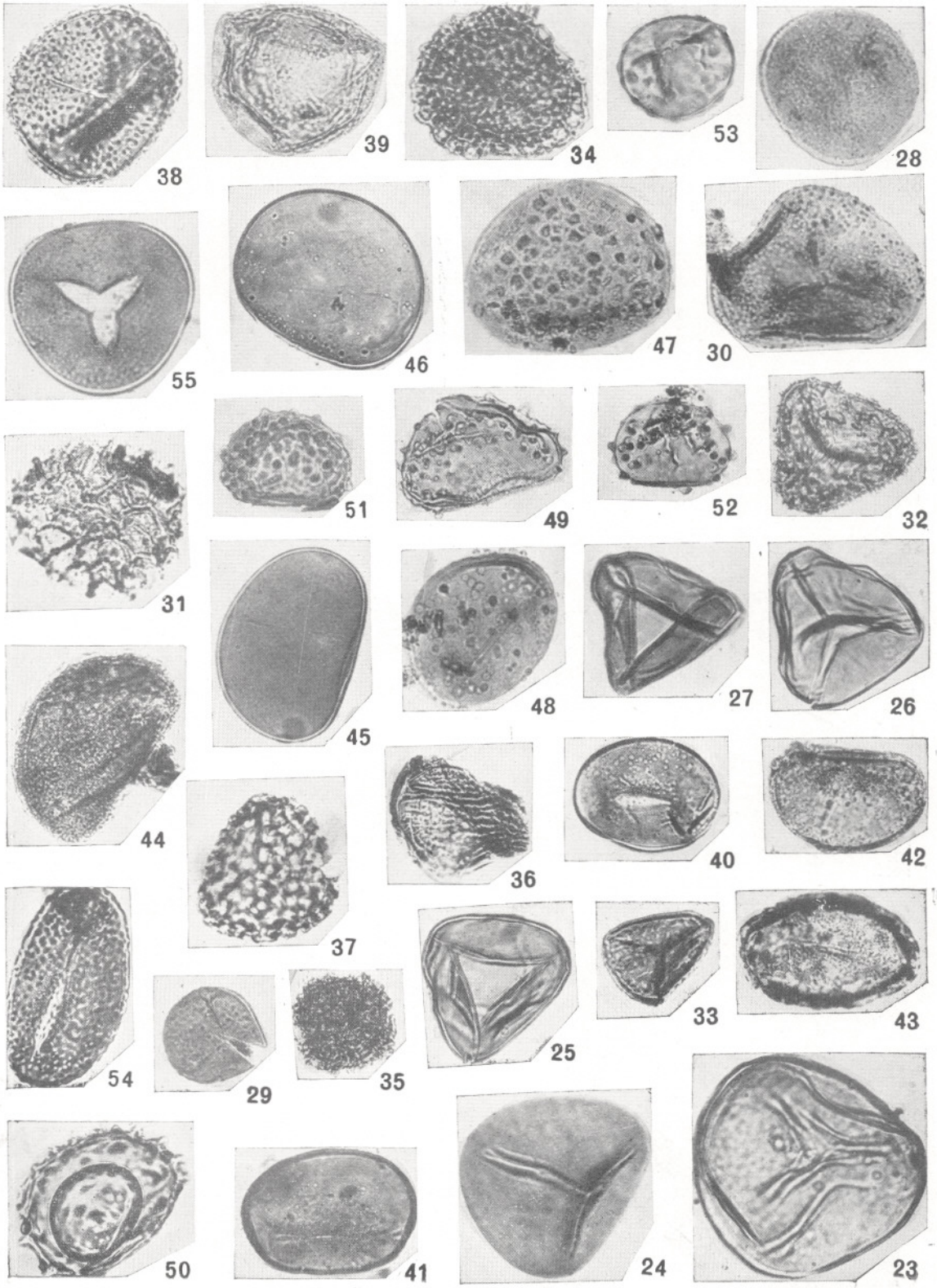
PLATE 1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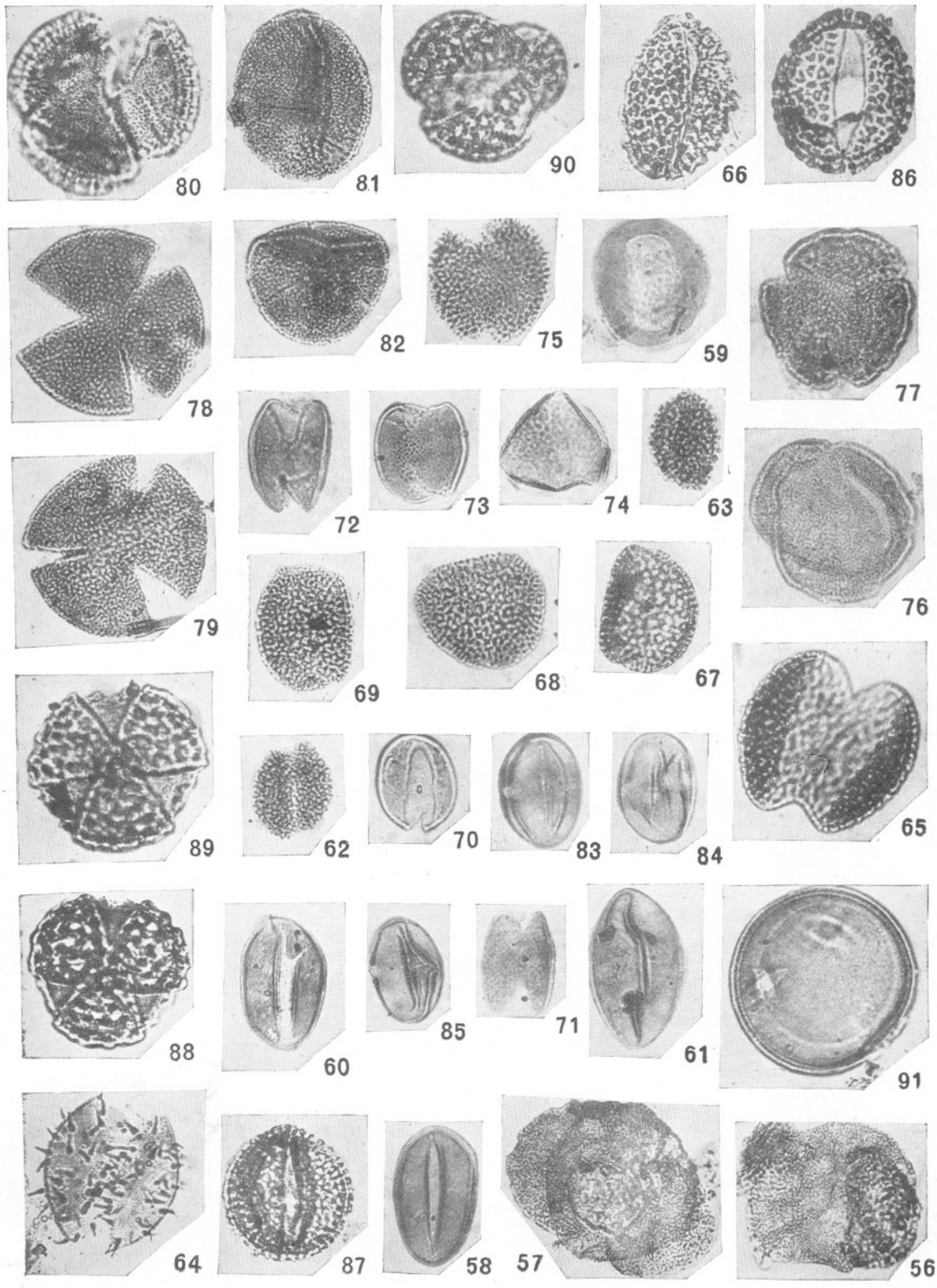
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PLATE 3

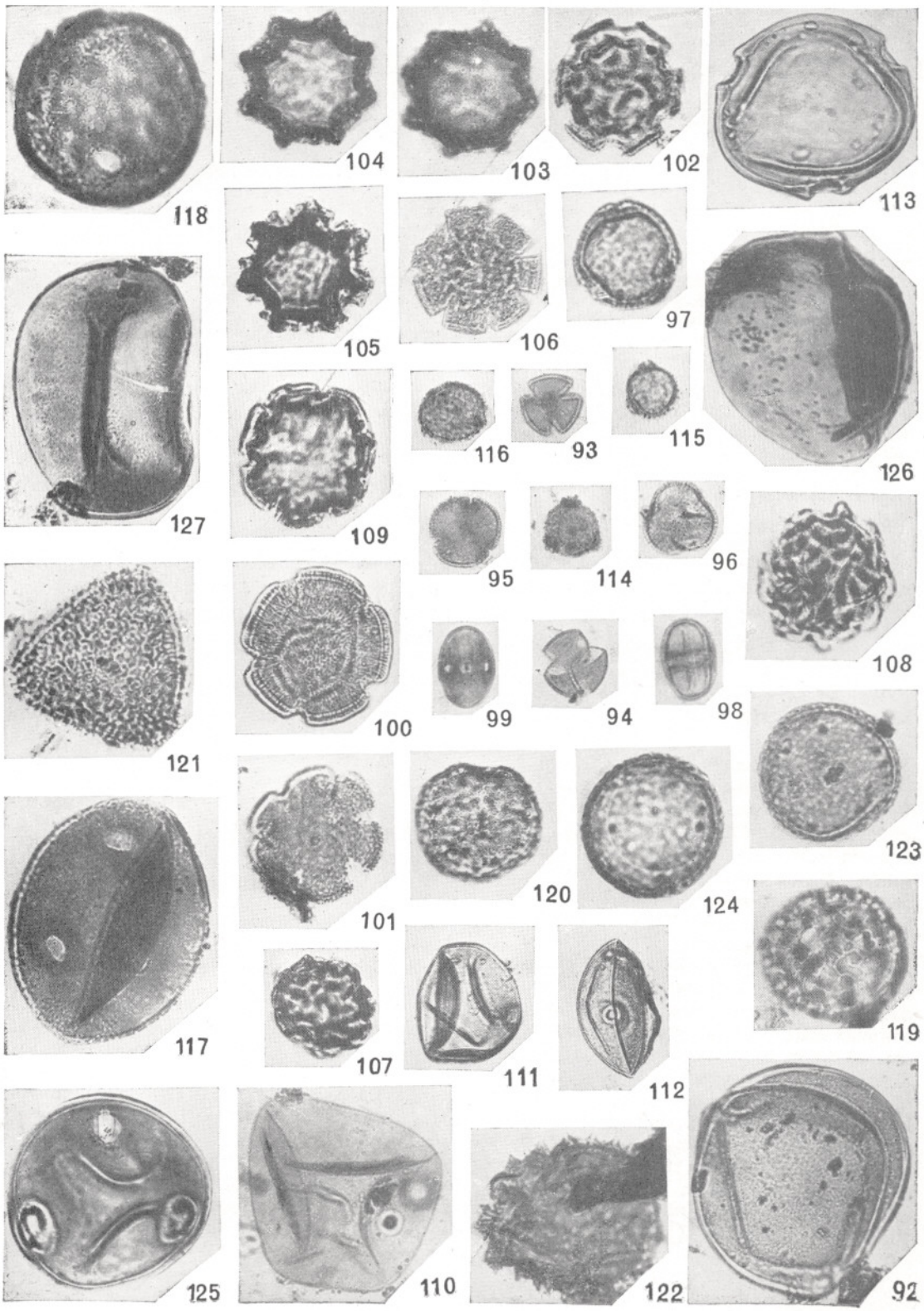
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PLATE 4