PALYNOLOGY OF THE LAKI SEDIMENTS IN KUTCH — 3. POLLEN FROM THE BORE-HOLES AROUND JHULRAI, BARANDA AND PANANDHRO

S. C. D. SAH & R. K. KAR

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The present paper deals with the pollen grains recovered from ten bore-holes around Jhulrai, Baranda and Panandhro drillled through the Laki sediments in the district of Kutch, Gujarat State, India. The palynological assemblage comprises 43 dispersed genera and 68 species. Out of these 7 genera, viz. *Dracaenoipollis, Verrucolporites, Striacolporites, Pellicieroipollis, Meliapollis, Ghoshiacolpites* and *Thymelaepollis* and 33 species are new.

The palynological assemblage reflects a predominance of angiospermic pollen. The gymnospermous pollen are very rare and represented by *Callialasporites, Laricoidites, Araucariacites* and *Podocarpidites*. Among the angiosperms, dicotyledonous pollen dominate over the monocotyledonous both in variety as well as in numbers. The monocotyledon are represented by genera like *Monosulcites, Liliacidites* and *Palmaepollenites. Umbelliferoipollenites, Margocolporites, Stephanocolpites* and *Polycolpites*, representing the dicotyledonous plants, are also well represented in the assemblage. A few pollen genera, viz. *Sonneratiopollis* and *Pellicieroipollis*, closely comparable to some of the extant pollen of mangroves, have also been recovered.

INTRODUCTION

PALYNOLOGY of the Laki sediments in Kutch, Gujarat, India, has been investigated by Mathur (1963, 1966); Sah and Kar (1969); Venkatachala and Kar (1969a, 1969b). The present paper deals with the systematic description of pollen grains recovered from core samples representing 10 bore-holes drilled around Jhulrai, Baranda and Panandhro in the district of Kutch. The material has been supplied by the Directorate of Geology and Mining, Government of Gujarat. Extensive drilling in the area is still in progress, hence the lithology of the bore-holes, condition of deposition, palaeoecology, probable age and basin correlation will be dealt with later after comprehensive study of the Laki sediments from different parts of the Kutch basin.

SYSTEMATIC PALYNOLOGY

Genus — *Callialasporites* Dev, 1961

Callialasporites (*Applanopsis*) *lenticularis* Dör., 1961

Pl. 1, Fig. 22

Callialasporites (*Applanopsis*) *trilobatus* (Balme) Dev, 1961

Pl. 1, Fig. 23

Genus — *Podocarpidites* (Cook.) Pot., 1958

Podocarpidites ellipticus Cook., 1947

Remarks — The present specimen is larger (70×40 μ) than those described by Cookson (*l.c.*). The central body in the present one is also not very well defined.

Podocarpidites sp. 1

Pl. 1, Fig. 24

Description — Pollen grain bisaccate, bilaterally symmetrical, diploxylonoid, 60×52 μ. Central body distinct, vertically oval, 52×30 μ, intramicroreticulate. Proximal attachment of sacci to central body equatorial, distal attachment subequatorial, straight, associated with semilunar body fold. Sacci hemispherical, coarsely intrareticulate.

Comparison — *Podocarpidites ellipticus* Cook. (1947) approximates the present species in shape but the latter is distinguished by its vertically oval central body. *P. congoensis* Sah (1968) is smaller in size.

Remarks — One specimen has only been obtained.

Podocarpidites sp. 2

Pl. 1, Fig. 25

Description — Pollen grain bisaccate, 106×48 μ. Central body horizontally oval, ill-defined, intramicroreticulate. Distal attachment of sacci to central body ± straight. Sacci hemispherical, coarsely intrareticulate.

Comparison—*Podocarpidites* sp. 1 is smaller in size than the present species and has vertically oval central body. *P. ellipticus* Cook. and *P. congoensis* Sah are also smaller in size.

Remarks — Only a single specimen has been recovered.

Genus — *Laricoidites* Pot. et al., 1950

Laricoidites kutchensis Venkat. *et al.*, 1969

Pl. 1, Fig. 26

Genus — *Araucariacites* Cook., 1947

Araucariacites australis Cook., 1947

Pl. 1, Fig. 27

Genus — *Monosulcites* Cook., 1947

Monosulcites ovatus sp. nov.

Pl. 1, Fig. 17

Holotype — Pl. 1, Fig. 17. Size 64×48 μ. Slide no. 3353.

Type Locality — Bore-core no. 13, Depth. 60′, Laki Series, Kutch, India.

No. of specimens studied — 14.

Diagnosis — Pollen grains oval, 58-68× 45-50 μ. Monocolpate, colpus funnel-shaped. Exine ± laevigate.

Description — Pollen grains oval with unequally broad lateral ends. Colpus distinct, unequally broad, extending from one end to other. Exine about 1·5 μ thick, generally laevigate. Sometimes weakly intrastructured.

Comparison — *Monosulcites minimus* Cook. (1947) resembles the present species in shape and monosulcate condition but is distinguished by its smaller size and ± uniformly broad sulcus.

Remarks — Monocolpate pollen grains with coni, spines and bacula hitherto described under *Monosulcites* has been transferred to *Couperipolles* Venkatachala & Kar (1969b). *Monosulcites* is here restricted for the monocolpate pollen grains with ± laevigate exine.

Genus — *Liliacidites* Coup., 1953

Liliacidites baculatus Venkat. & Kar, 1969b

Cf. *Liliacidites*

Pl. 1, Fig. 21

Description — Pollen grain oval with unequally broad lateral ends, 180×152 μ. Monocolpate, colpus funnel-shaped. Exine 1·5 μ thick, baculate, bacula 1-2 μ long, closely placed, uniformly distributed.

Remarks — The specimen is large in size and possesses funnel-shaped colpus. So it has only been compared with *Liliacidites*.

Monocolpate pollen type-1

Pl. 1, Fig. 16

Description — Pollen grains oval with unequally broad lateral ends, 190×90 μ. Monocolpate, colpus funnel-shaped, closed at one end. Exine ± 2 μ thick, weakly punctate.

Remarks — Only a single specimen has been recovered. The specimen is unusually large in size and hence it has only been described as Monocolpate pollen type-1.

Genus — *Clavatipollenites* Coup., 1958

Clavatipollenites cephalus sp. nov.

Pl. 1, Figs. 10-11

Holotype — Pl. 1, Fig. 10. Size 56×33 μ. Slide no. 3352.

Type Locality — Bore-core no. 13, Depth 48′, Laki Series, Kutch, India.

No. of specimens studied — 17.

Diagnosis — Pollen grains oval, 50-60 ×42-48 μ. Monocolpate, colpus not extending from end to end, clavate.

Description — Pollen grains oval with unequally broad lateral ends. Colpus distinct – indistinct, uniformly broad, extending up to three-fourths along longer axis. Exine 2-3·5 μ thick, sexine thicker than nexine, tegillate, clavate projections densely placed, inter-locking each other to form microreticulate ornamentation.

Comparison — *Clavatipollenites hughesii* Coup. (1958) closely resembles the present species in size, shape and ornamentational pattern, but is distinguished by its extension of colpus from one end to other.

Genus — *Arecipites* Wodeh., 1933

Arecipites bellus sp. nov.

Pl. 1, Figs. 19-20

Holotype — Pl. 1, Fig. 19. Size 64×52 μ. Slide no. 3367.

Type Locality — Bore-core no. 15, Depth 33′, Laki Series, Kutch, India.

Diagnosis — Pollen grains oval, 58-66× 48-55 μ. Monocolpate, colpus extending end to end. Exine punctate.

No. of specimens studied — 16

Description — Pollen grains mostly oval with equally rounded lateral ends. Colpus generally closed or open only at ends. Exine ± 2 μ thick, sexine thicker than nexine. Puncta ± 0·5 μ in size, closely placed, uniformly distributed.

Comparison — *Arecipites punctatus* Wodehouse (1933) resembles the present species in shape and punctate exine but is distinguished by its smaller size range.

Remarks — *Calamuspollenites* Elsik (1966) closely resembles *Arecipites* in shape and ornamentational pattern. In the opinion of Elsik (*l.c.*) the separation of puncta by spaces wider than them and the tendency to be aligned into rows distinguishes *Calamuspollenites* from *Arecipites*.

The present species is also comparable to the pollen grains of *Pleodendron macranthum* belonging to the family Canellaceae (WILSON, 1964, PL. 1, FIG. 2) in shape, size but is distinguished in ornamentational pattern.

Genus — *Palmaepollenites* Pot., 1951

Palmaepollenites nadhamunii Venkat. & Kar, 1969b

Palmaepollenites ovatus sp. nov.

Pl. 1, Fig. 13

Holotype — Pl. 1, Fig. 13. Size 41×38 μ. Slide no. 3364.

Type Locality — Bore-core no. 15, Depth 10′, Laki Series, Kutch, India.

No. of specimens studied — 11.

Diagnosis — Pollen grains roundly oval, 38-45×35-40 μ. Monocolpate, colpus restricted in middle region. Exine intragranulose.

Description — Pollen grains oval with equally rounded lateral ends. Colpus distinct, uniformly broad, not extending more than two-thirds along longer axis. Exine up to 2 μ thick, intrastructure well recognizable.

Comparison — *Palmaepollenites kutchensis* and *P. nadhamunii* described by Venkat. & Kar (1969b) from the same Series are more longer in shape and the colpus in both the species is extending end to end. *P. ovatus* is distinct from all the known species of *Palmaepollenites* in its roundly oval shape and extension of the colpus only in middle region.

Palmaepollenites plicatus sp. nov.

Pl. 1, Figs. 14-15

Holotype — Pl. 1, Fig. 15. Size 54×27 μ. Slide no. 3365.

Type Locality — Bore-core no. 15, Depth 23′, Laki Series, Kutch, India.

No. of specimens studied — 9.

Diagnosis — Pollen grains elliptical, 48-60×20-40 μ. Monocolpate, colpus end to end, associated with folds. Exine ± laevigate.

Description — Pollen grains mostly elliptical, sometimes oval, with equally broad lateral ends. Colpus closed or slightly open at ends, associated with one fold on each side. Exine up to 2 μ thick, laevigate, sometimes weakly intrastructured.

Comparison — *Palmaepollenites neyvelli* Raman. (1966) is comparable to the present species in shape but the latter is differentiated by its association of folds along the colpus margin. *P. nadhamunii* Venkat. & Kar (1969b) is smaller in size.

Palmaepollenites magnus sp. nov.

Pl. 1, Fig. 18

Holotype — Pl. 1, Fig. 18. Size 152×60 μ. Slide no. 3366.

Type Locality — Bore-core no. 15, Depth 30′, Laki Series, Kutch, India.

No. of specimens studied — 13.

Diagnosis — Pollen grains oval, 130-160×50-70 μ. Monocolpate, colpus extending end to end. Exine ± laevigate.

Description — Pollen grains large in size. Colpus closed, indistinct in some specimens, may be associated with fold. Exine up to 2 μ thick, mostly laevigate, sometimes weakly granulose.

Comparison — *Palmaepollenites magnus* is distinguished from *P. kutchensis*, *P. nadhamunii* and *P. plicatus* by its larger size. No species has been recorded within this genus having such a large size range.

Genus — *Dracaenoipollis* gen. nov.

Type Species — *Dracaenoipollis circularis* sp. nov.

Diagnosis — Pollen grains circular-subcircular. Aperture circular-subcircular. Exine ± laevigate, weakly granulose or intrastructured.

Description — Pollen grains mostly ± circular in shape, 22-36×19-34 μ. Aperture mostly distinct, 12-26×10-20 μ. Exine up to 2·5 μ thick, generally laevigate, sometimes weakly granulose.

Comparison — *Spheripollenites* Coup. (1958) is comparable to the present genus in shape and ornamentational pattern, but is distinguished by its monoporate condition. *Palmaepollenites* Pot. (1951), *Arecipites* Wodeh. (1933) and *Monosulcites* Cook. (1947) are oval — elliptical in shape. *Dracaenoipollis* is conspicuous by its presence of circular-subcircular shape and aperture.

Remarks — The pollen grains of *Dracaena surculosa* of Liliaceae resembles the present genus in shape, exine thickness but they are larger in size than the specimens studied here (NAIR & SHARMA, 1965). It may, however, be mentioned here that the pollen grains with circular shape are rare in this species. The pollen grains of *D. thalioides* in the opinion of Nair & Sharma (*l.c.*) are circular with circular aperture and the exine is 2-2·5 μ thick. The pollen grains are slightly bigger in size (37-46 μ) than the present specimens and the margin of the aperture is thickened and wavy. The present genus comes very near to the pollen grains of this species in other respects.

Dracaenoipollis circularis sp. nov.

Pl. 1, Figs. 1-4

Holotype — Pl. 1, Fig. 1. Size 30×29 μ. Slide no. 3346.

Type Locality — Bore-core no. 36, Depth 83′, Laki Series, Kutch, India.

No. of specimens studied — 29.

Diagnosis — Pollen grains circular-subcircular, 22-36×19-34 μ. Aperture circular-subcircular, distinct. Exine ± laevigate, weakly granulose or intrastructured.

Description — Pollen grains mostly circular, aperture 12-26×10-20 μ, margin of aperture ± smooth. Exine 1·5-2 μ thick, generally laevigate, sometimes weakly granulose, intrastructure while present is very weak.

Genus — *Couperipollis* Venkat. & Kar, 1969b

Couperipollis achinatus sp. nov.

Pl. 1, Figs. 8-9

Holotype — Pl. 1, Fig. 8. Size 42×30 μ. Slide no. 3351.

Type Locality — Bore-core no. 13, Depth 48′, Laki Series, Kutch, India.

No. of specimens studied — 12.

Diagnosis — Pollen grains oval, 38-46×26-34 μ. Monocolpate, colpus extending end to end. Exine spinose-baculate.

Description — Pollen grains generally oval with equally broad lateral ends. Colpus distinct, ± uniformly broad. Exine 1·5-2 μ thick, spines 5-8 μ long, generally mixed with ± pin-headed bacula, spines not closely placed, uniformly distributed, space in between spines laevigate.

Comparison — *Couperipollis perspinosus* (Coup.) Venkat. & Kar (1969b) resembles the present species in size and shape but is distinguished by its strongly build spines. *C. rarispinosus* (Sah & Dutta) Venkat. & Kar (1969b) is comparable to *C. achinatus* in the presence of sparsely placed spines and shape but is differentiated by its circular-subcircular shape. *C. kutchensis* Venkat. & Kar (1969b) is subcircular and the sulcus is hardly distinguishable.

Couperipollis sp.

Pl. 1, Fig. 12

Description — Pollen grains oval with equally broad lateral ends, 34×24 μ. Monocolpate, colpus extending end to end, not distinct due to sculptural elements. Exine about 2 μ thick, baculate-pilate, 2-5 μ long, densely placed.

Comparison — *Couperipollis achinatus* closely resembles the species described here in shape and size but the latter is distinguished by its very closely placed sculptural elements.

Genus — *Nymphaeoipollis* Venkat. & Kar, 1969b

Nymphaeoipollis marginatus Venkat. & Kar, 1969b

Genus — *Tricolpites* (Erdt.) Pot., 1960

Tricolpites brevis sp. nov.

Pl. 1, Figs. 5-6

Holotype — Pl. 1, Fig. 5. Size 33×31 μ. Slide no. 3348.

Type Locality — Bore-core no. 36, Depth 190′, Laki Series, Kutch, India.

No. of specimens studied — 17.

Diagnosis — Pollen grains triangular, 30-35×30-34 μ. 3 colpate, brevicolpate, colpi

placed in interapical margin. Exine 2·5-5 μ thick, ± laevigate — finely scrobiculate.

Description — Pollen grains with rounded apical ends, interapical margin slightly convex. Colpi narrow, well defined. Sexine thicker than nexine, generally laevigate, sometimes finely scrobiculate.

Comparison — *Tricolpites foxi* (Biswas) Raman. (1966) is comparable to the present species in size but is distinguished by its broad, well developed colpi.

Tricolpites minutus sp. nov.

Pl. 1, Fig. 7

Synonym —
1966 — *Tricolpites* sp. Ramanujam, 1966, pl. 2, fig. 24.

Holotype — Pl. 1, Fig. 7. Size 20×20 μ. Slide no. 3350.

Type Locality — Bore-core no. 13, Depth 58′, Laki Series, Kutch, India.

No. of specimens studied — 18.

Diagnosis — Pollen grains subcircular-subtriangular, 18-25×17-24 μ. 3 colpate, brevicolpate. Exine thin, laevigate-finely scrobiculate.

Description — Pollen grains mostly subcircular, sometimes subtriangular in polar view. Colpi narrow, ± uniformly broad. Exine up to 2·5 μ thick, generally laevigate, sometimes finely scrobiculate.

Comparison — *Tricolpites brevis* resembles the specimen in ornamentational pattern but is distinguished by its larger size and thicker exine.

Tricolpites sp. 1

Pl. 1, Fig. 29

Description — Pollen grain in equatorial view, 52×46 μ. 3 colpate, colpi well defined, broad, extending up to two-thirds along longer axis. Exine about 4 μ thick, heavily sculptured with pila, bacula and verrucae

Remarks — Only a single specimen has been recovered. The specimen differs from all the known species by its densely placed, strongly built sculptural elements.

Tricolpites sp. 2

Pl. 1, Fig. 28

Description — Pollen grain subcircular, 100×80 μ. 3 colpate, colpi long, funnel shaped, well developed. Exine about 4 μ thick, pilate-tegillate, pila forming negative reticulum in surface view.

Remarks — A single specimen has only been found. The specimen distinguishes from all the known species by its larger size and pilate-tegillate condition.

Genus — *Ranunculacidites* Sah, 1968

Ranunculacidites communis Sah, 1968

Genus — *Retitricolpites* Pier., 1961

Retitricolpites robustus sp. nov.

Pl. 1, Fig. 30

Holotype — Pl. 1, Fig. 30. Size 50×46 μ. Slide no. 3364.

Type Locality — Bore-core no. 15, Depth 10′, Laki Series, Kutch, India.

No. of specimens studied — 15.

Diagnosis — Pollen grains subcircular, 40-54×38-52 μ. 3 colpate, colpi well developed. Exine thick, reticulate, meshes duplibaculate.

Description — Pollen grains subcircular with three constricted ends due to apertures. Colpi funnel shaped, mesocolpia broad. Exine 2·5-4 μ thick, sexine thicker than nexine, lumina deep, mesh ± polygonal.

Comparison — *Retitricolpites sitholeyi* Raman. (1966) approximates the present species in shape but the latter is distinguished by its larger size.

Genus — *Rostripollenites* Venkat. & Kar, 1968

Rostripollenites kutchensis Venkat. & Kar, 1968

Genus — *Umbelliferoipollenites* Venkat. & Kar, 1969b

Umbelliferoipollenites ovatus Venkat. & Kar, 1969b

U. constrictus Venkat. & Kar, 1969b

Genus — *Araliaceoipollenites* Pot., 1951

Araliaceoipollenites matanamadhensis Venkat. & Kar, 1969b

Genus — *Cupuliferoipollenites* Pot., 1951

Cupuliferoipollenites ovatus Venkat. & Kar, 1969b

Genus — *Rhoipites* Wodeh., 1933

Rhoipites kutchensis Venkat. & Kar, 1969b

Genus — *Symplocoipollenites* Pot., 1951

Symplocoipollenites constrictus sp. nov.

Pl. 2, Figs. 31-32

Holotype — Pl. 2, Fig. 31. Size 38×36 μ. Slide no. 3370.

Type Locality — Bore-core no. 15, Depth 49′, Laki Series, Kutch, India.

No. of specimens studied — 27.

Diagnosis — Pollen grains triangular-subtriangular, 30-40×28-38 μ. 3 colporate, colpi well developed, pore without thickened margin. Exine thick, finely scrobiculate.

Description — Pollen grains always found in polar view. Colpi narrow, easily traceable. Pore not always distinct, generally lalongate. Exine 2-5 μ thick, sexine thicker than nexine, scrobiculate structure well developed in most specimens.

Comparison — *Symplocoipollenites indicus* Raman. (1966) closely resembles the present species in shape and size, but is distinguished by its thinner exine and ill-developed colpi. *S. kutchensis* and *S. minutus* described by Venkat. & Kar (1969b) are differentiated by their smaller size.

Genus — *Nyssapollenites* Thierg., 1937

Nyssapollenites kutchensis Venkat. & Kar, 1969b

Genus — *Palaeocoprosmadites* Raman., 1966

Palaeocoprosmadites arcotense Raman., 1966

Genus — *Margocolporites* Raman., 1966

Margocolporites tsukadai Raman., 1966

M. sitholeyi Raman., 1966

M. sahnii Raman., 1966

Genus — *Lakiapollis* Venkat. & Kar, 1969b

Lakiapollis ovatus Venkat. & Kar, 1969b

Lakiapollis matanamadhensis Venkat. & Kar, 1969b

Genus — *Sastriipollenites* Venkat. & Kar, 1969b

Sastriipollenites trilobatus Venkat. & Kar, 1969b

Genus — *Verrutricolpites* Pier., 1961

Verrutricolpites triangulus sp. nov.

Pl. 2, Figs. 37-38

Holotype — Pl. 2, Fig. 37. Size 44×42 μ. Slide no. 3367.

Type Locality — Bore-core no. 15, Depth 33′, Laki Series, Kutch, India.

No. of specimens studied — 10.

Diagnosis — Pollen grains triangular, 34-44×34-42 μ. 3 colpate, brevicolpate. Exine 3-7 μ thick, verrucose, verrucae closely placed.

Description — Pollen grains found in equatorial view. Colpi distinct, funnel shaped. Verrucae very closely placed, 4-8 μ high, forming negative reticulum in surface view.

Comparison — *Verrutricolpites perverrucatus* Raman. (1966) resembles the present species in shape but the latter is distinguished by its larger size, thicker exine and more closely placed verrucae.

Genus — *Verrucolporites* gen. nov.

Type Species — *Verrucolporites verrucus* sp. nov.

Diagnosis — Pollen grains oval-elliptical in equatorial and subcircular in polar view. 3 colporate, colpi long, pore generally indistinct. Exine thick, verrucose.

Description — Pollen grains mostly found in equatorial view. Size range 30-50×25-44 μ. Colpi long, narrow, extending up to three-fourths along axis. Pore indistinct, generally masked by sculptural elements. Exine 1-5-3 μ thick, strongly verrucose, verrucae of different sizes, closely placed, uniformly distributed to form negative reticulum in surface view.

Comparison — *Ilexpollenites* Thierg. (1937) closely resembles the present genus in shape and 3 colporate condition but the latter is distinguished by its verrucose sculptural elements. *Verrutricolpites* Pier. (1961) approximates the present genus in verrucose exine but is 3 colpate. *Psilatricolporites* v.d. Hamm. (1965) is 3 colporate but has psilate exine. *Verrucolporites* proposed here is distinguished from all the known 3 colporate genera by its oval-elliptical shape in equatorial view and presence of verrucae of different sizes.

Verrucolporites verrucus sp. nov.

Pl. 2, Figs. 33-36

Holotype — Pl. 2, Fig. 33. Size 36×32 μ. Slide no. 3351.

Type Locality — Bore-core no. 13, Depth 48′, Laki Series, Kutch, India.

No. of specimens studied — 18.

Diagnosis — Pollen grains oval-elliptical in equatorial and subcircular in polar view. 30-50×25-44 μ. 3 colporate. Colpi long, pore indistinct. Exine strongly verrucose.

Description — Pollen grains generally found in equatorial view. Colpi well developed, long and narrow, extending up to three-fourths along longer axis. Pore mostly indistinct, generally masked by sculptural elements. Exine up to 3 μ thick, verrucose, verrucae 4-8 μ high, closely placed, uniformly distributed, forming negative reticulum in surface view.

Genus — *Pellicieroipollis* gen. nov.

Type Species — Pellicieroipollis langenheimii sp. nov.

Diagnosis — Pollen grains triangular-subtriangular in polar view. 3 colporate, brevicolpate. Pore distinct, lalongate, generally with thickened margin. Exine thick, tegillate, bacula forming negative reticulum in surface view.

Description — Pollen grains mostly triangular with three notches due to the opening of apertures. Colpi short, funnel shaped, distinct. Pore well developed with variable thickened margin. Exine 3-6 μ thick, sexine as thick as nexine or thicker, in some specimens nexine seems to be thicker around apertural region. Bacula well developed, closely placed, uniformly distributed, pseudoreticulum well developed, in some specimens it gives the appearance of punctoid or scrobiculoid pits.

Comparison — *Psilatricolporites* v.d. Hamm. (1965) is comparable to the present genus in shape and tricolporate nature but is distinguished by its laevigate exine. *Hippocrateaceaedites* Raman. (1966) resembles the present genus in shape but is distinguished by its colpi which are long and surrounded by thickened exine.

Remarks — *Pellicieroipollis* closely resembles the extant pollen grains of *Pelliciera rhizophoreae* of Theaceae. This is a mangrove plant and found around the Pacific coast. Langenheim *et al.* (1967) have studied the living as well as fossil pollen of this species. The specimens studied here approximate the figures (LANGENHEIM *et al.*, PL. 42, FIGS. 7-8) and description.

Pellicieroipollis langenheimii sp. nov.

Pl. 2, Figs. 58-60

Holotype — Pl. 2, Fig. 58. Size 60×54 μ. Slide no. 3377.

Type Locality — Bore-core no. 13, Depth 30′, Laki Series, Kutch, India.

No. of specimens studied — 47.

Diagnosis — Pollen grains triangular-subtriangular, 58-75×55-70 μ. 3 colporate, brevicolpate, pore lalongate with thickened margin. Exine thick, tegillate, bacula forming negative reticulum in surface view.

Description — Pollen grains generally triangular, interapertural margin convex. Colpi distinct, sometimes indistinct, funnel shaped. Pore prominent. Exine 3-6 μ thick, sexine as thick as nexine or slightly thicker, baculate, bacula closely placed, uniformly distributed forming generally pseudoreticulate pattern, in some specimens they may also look like punctoid or scrobiculoid pits.

Derivation of name — After Prof. J. H. Langenheim, Botany Dept., Harvard University, U.S.A.

Genus — *Meliapollis* gen. nov.

Type Species — Meliapollis ramanujamii sp. nov.

Diagnosis — Pollen grains circular-subcircular. 3-5 colporate, brevicolpate. Pore distinct with thickened margin, circular-lalongate. Exine laevigate-weakly intrastructured.

Description — Pollen grains mostly circular in polar view, sometimes subcircular or rarely quadrangular grains are also met with. Size range 36-75×27-70 μ. Generally 4 colporate grains are found but some 3 or 5 colporate condition are also observed. Colpi small, sometimes indistinct. Pore well defined, 5-10 μ in diameter, mostly ± circular, sometimes lolongate. Pollen grains with slight lolongate condition are rarely found. Margin of pore uniformly thickened. Exine 2-8 μ thick, stratification of exine obscure, generally laevigate, sometimes very weakly intrastructured.

Comparison — *Tetracolporites* Coup. (1953) is comparable to the present genus in tetracolporate condition but is distinguished by its ± polygonal shape. Moreover, the apertures in *Tetracolporites* are situated at the constricted margin while in *Meliapollis* they are not so. *Quadripollenites* Stov. (1966) resembles the present genus in circular-subcircular shape, tetracolporate nature and laevigate exine but is differentiated by its thickened margin of the colpi.

Remarks — The pollen grains described by Rao and Vimal (1950, FIGS. 9-11, PHOTO 6) as *Type* 6 closely resembles the present genus in shape, size, nature of the apertures and laevigate exine. They have, however, described them as colpate. Navale (1961) and Ramanujam (1966) have also reported pollen grains belonging to the present genus from the Miocene lignite of Madras, India.

The pollen grains of *Platonia insignis* of Guttiferae is also comparable to the present genus in possessing 3-5 colporate, ± subcircular grains. But they are easily distinguished by their considerable thickening of the nexine at the mesocolpate region.

Citrus jambhiri and *C. sinensis* of Rutaceae generally produce 4 colporate pollen with subcircular shape; but the ornamentation pattern of these pollen are quite distinct from *Meliapollis* (BAMZAI AND RANDHWA, 1965; ERDTMAN, 1952).

The pollen grains of *Cyclanthera naudiniana* of Cucurbitaceae are also differentiated from the present genus in the ornamentational pattern.

Meliapollis closely resembles the pollen grains of Meliaceae, particularly that of *Melia azedarach* in which the pollen grains are generally circular-subcircular in shape, tetracolporate, pore with thickened margin and the exine is laevigate. The size range is also very much similar to that of the present genus.

Meliapollis ramanujamii sp. nov.

Pl. 2, Figs. 62-64

Holotype — Pl. 2, Fig. 62. Size 60×56 μ. Slide no. 3378.

Type Locality — Bore-core no. 15, Depth 45′, Laki Series, Kutch, India.

No. of specimens studied — 34.

Diagnosis — Pollen grains circular-subcircular, 50-65×48-62 μ. 4 colporate, brevicolpate, pore circular-lalongate, margin thickened. Exine 1·5-2·5 μ, laevigate.

Description — Pollen grains mostly circular in polar view. Colpi ill-developed, in some specimens hardly discernible. Pores distinct, equatorially-subequatorially placed, margin considerably thickened. Exine laevigate, in some specimens weakly intrastructured.

Derivation of name — After Dr. C. G. K. Ramanujam, Botany Dept., Osmania University, India.

Meliapollis raoi sp. nov.

Pl. 2, Fig. 67

Holotype — Pl. 2, Fig. 67. Size 58×56 μ. Slide no. 3380.

Type Locality — Bore-core no. 15, Depth 45′, Laki Series, Kutch, India.

No. of specimens studied — 18.

Diagnosis — Pollen grains circular-subcircular, 50-60×50-58 μ. 3 colporate, brevicolpate, pore distinct with thickened margin, lalongate-circular. Exine 1·5-2·5 μ thick, laevigate.

Description — Pollen grains mostly circular in polar view. Colpi funnel shaped, sometimes indistinct. Pores well developed, margin appreciably thickened, mostly lalongate. Exine rarely intrastructured.

Comparison — *Meliapollis ramanujamii* closely resembles the present species in size, shape, and laevigate exine, but is distinguished by its 4 colporate condition.

Derivation of name — After Prof. A. R. Rao, Botany Dept., Lucknow University, India.

Meliapollis navalei sp. nov.

Pl. 2, Fig. 65

Holotype — Pl. 2, Fig. 65. Size 70×62 μ. Slide no. 3379.

Type Locality — Bore-core no. 15, Depth 50′, Laki Series, Kutch, India.

No. of specimens studied — 22.

Diagnosis — Pollen grains subcircular-circular, 60-75×57-70 μ. 5 colporate, brevicolpate, pore distinct with thickened margin. Exine 1·5-3·5 μ thick, laevigate or weakly intrastructured.

Description — Pollen grains mostly subcircular in polar view. Colpi short, sometimes not traceable at ends. Pore

distinct, circular-lolongate, margin thickened considerably. Exine generally laevigate, sometimes weakly intrastructured.

Comparison — *Meliapollis navalei* is distinguished from *M. ramanujamii* and *M. raoi* by its bigger size and 5 colporate condition.

Derivation of name — After Dr. G. K. B. Navale, Birbal Sahni Institute of Palaeobotany, Lucknow.

Meliapollis quadrangularis (Raman.) comb. nov.

Pl. 2, Fig. 66

Synonym — *Tetracolporites quadrangularis* Raman., 1966.

Holotype — Ramanujam, 1966, Pl. 5, Fig. 82.

Diagnosis — Ramanujam, 1966, pp. 178-180.

Remarks — *Tetracolporites* Couper (1953) is polygonal in shape and apertures are placed in the markedly constricted sides.

Meliapollis melioides (Raman.) comb. nov.

Synonym — *Tetracolporites melioides* Raman., 1966.

Holotype — Ramanujam, 1966; Pl. 5, Fig. 84.

Diagnosis — Ramanujam, 1966, p. 180.

Genus — *Striacolporites* gen. nov.

Type Species — *Striacolporites striatus* sp. nov.

Diagnosis — Pollen grains tricolporate, oval in equatorial and subcircular in polar view. Exine striato-reticulate.

Description — Pollen grains in equatorial view 50-80×35-50 μ, in polar view 50-80×40-75 μ. Colpi long, extending more than two-thirds along longer axis in equatorial view, funnel shaped in polar view. Colpi membrane faintly granular. Pore distinct, lolongate. Exine 2-4 μ thick, sexine thicker than nexine, distinctly striato-reticulate.

Comparison — *Striatopollis* Krutz. (1959) resembles the present genus in shape and striato-reticulate pattern but is distinguished by its tricolpate condition.

Mention may be made here that v.d. Hamm. (1956) proposed two genera, viz. *Striatricolpites* and *Striatricolporites* for the striate, tricolpate and tricolporate pollen respectively. But he selected the subgenotype for both the genera from the recent pollen grains. Ramanujam (1966) apparently emended the genus *Striatricolporites* but wrote this as *Striatocolporites* (RAMANUJAM, 1966, p. 170). *Striatricolporites* v.d. Hamm. (1956) has not been considered here as it is based on extant pollen (POTONIÉ, 1960, p. 153).

Remarks — *Striacolporites* resembles closely the pollen grains of Solanaceae, Nolanaceae and Scrophulariaceae.

The pollen grains of *Atropa lutea, Cestrum smithii* and *Datura suaveolens* belonging to the family Solanaceae are tricolporate and distinctly striato-reticulate, but they differ from the present genus in the presence of lalongate condition (ERDTMAN, 1952).

The pollen grains of *Alona carnosa* and *Nolana atriplicifolia* of Nolanaceae are also tricolporate and the exine is striato-reticulate but the pores in both the species are lalongate.

Tricolporate pollen grains with more or less striato-reticulate pattern are also found in *Alonsoa acutifolia* and *Aptosimum depressum* of Scrophulariaceae (ERDTMAN, 1952) but they are much smaller in size than the present genus and the striation in *A. depressum* is arranged ± at right angles to the colpi. The pollen grains of *Cneorum pulverulentum* of Cenoraceae are tricolporate, subprolate and distinctly striato-reticulate; but they are much smaller in size (35×29 μ) than the present specimens and the pores are also lalongate. *Striacolporites* instituted here is quite distinct from all those above mentioned species by its lolongate condition and well developed striato-reticulate ornamentation.

Striacolporites striatus sp. nov

Pl. 2, Fig. 54

Holotype — Pl. 2, Figs 54. Size 52×32 μ. Slide no. 3362.

Type Locality — Bore-core no. 15, Depth 20′, Laki Series, Kutch, India.

No. of specimens studied — 13.

Diagnosis — Pollen grains oval in equatorial view, 45-57×30-48 μ. Tricolporate, lolongate. Exine 2-3 μ thick, sexine thicker than nexine. Striato-reticulate.

Description — Pollen grains with equally broad lateral ends. Colpi long, distinct, extending more than two-thirds along longer

axis. Pore well recognizable, 4-6×2-3 μ. Striato-reticulate pattern well developed.

Striacolporites ovatus sp. nov.

Pl. 2, Figs. 56-57

Holotype — Pl. 2, Fig. 56. Size 74×48 μ. Slide no. 3372.

Type Locality — Bore-core no. 15, Depth 23′, Laki Series, Kutch, India.

No. of specimens studied — 16.

Diagnosis — Pollen grains oval in equatorial view, 70-80×40-52 μ. Tricolporate, apertures ill-developed. Sexine thicker than nexine, striato-reticulate.

Description — Pollen grains with equally broad lateral ends. Colpi ill-defined, extending more than two-thirds along longer axis, pore lalongate, not distinct. Exine 2-3 μ thick, striato-reticulate pattern well-built.

Comparison — *Striacolporites striatus* resembles the species in general organization but is distinguished by its smaller size-range.

Striacolporites cephalus sp. nov.

Pl. 2, Figs. 68-69

Holotype — Pl. 2, Fig. 68. Size 74×62 μ. Slide no. 3367.

Type Locality — Bore-core no. 15, Depth 33′, Laki Series, Kutch, India.

No. of specimens studied — 8.

Diagnosis — Pollen grains subcircular in polar view, 70-75×58-65 μ. Tricolporate, colpi membrane faintly granular. Sexine thicker than nexine, striato-reticulate.

Description — Pollen grains mostly found in polar view. Colpi funnel shaped, mesocolpia broad. Pores well recognizable. Exine 2-4 μ thick, striato-reticulate pattern strongly built.

Comparison — *Striacolporites ovatus* resembles the present species in size and well built striato-reticulate element but is differentiated by its ill-developed apertures. *S. striatus* is smaller in size than the present species.

Genus — *Paleosantalaceaepites* Bis., 1962

Paleosantalaceaepites primitiva Bis., 1962

Pl. 2, Fig. 52

Remarks — The specimens studied in the present material are bigger in size (38-45 ×28-35 μ) than those described by Biswas (1962). The margin of the pores in the present specimens is also thickened.

Paleosantalaceaepites ellipticus sp. nov.

Pl. 2, Fig. 55

Holotype — Pl. 2, Fig. 55. Size 52×30 μ. Slide no. 3363.

Type Locality — Bore-core no. 15, Depth 50′, Laki Series, Kutch, India.

No. of specimens studied — 17.

Diagnosis — Pollen grains elliptical-oval in equatorial view, 46-55×25-40 μ. 3 colporate, colpi well developed, pore lalongate. Exine thick, ± laevigate-finely intrastructured.

Description — Pollen grains generally found in equatorial view with equally broad lateral ends. Colpi distinct, extending up to three-fourths along longer axis. Pore well defined, without thickened margin. Exine 2·5-4 μ thick, sexine thicker than nexine, generally ± laevigate, sometimes weakly intrastructured in some specimens.

Comparison — *Paleosantalaceaepites primitiva* Bis. (1962) is distinguished from the present species by its smaller size and ill-developed colpi. *P. miocenicus* Raman. (1966) is zonorate and has indistinct colpi.

Paleosantalaceaepites minutus sp. nov.

Pl. 2, Fig. 48

Holotype — Pl. 2, Fig. 48. Size 28×25 μ. Slide no. 3357.

Type Locality — Bore-core no. 13, Depth 60′, Laki Series, Kutch, India.

No. of specimens studied — 12.

Diagnosis — Pollen grains oval-subcircular in equatorial view, 20-28×18-25 μ. 3 colporate, colpi ill-developed. Pore well developed, bulging. Exine ± laevigate-finely scrobiculate.

Description — Pollen grains mostly found in equatorial view, sometimes pollen in polar view with subcircular-circular shape are also found. Colpi narrow, indistinct, extending up to two-thirds along longer axis. Pores well developed, subcircular, protruding at margin in equatorial view. Exine 1·5-2·5 μ thick, sexine thicker than nexine, generally laevigate, sometimes finely scrobiculate.

Comparison — *Paleosantalaceaepites primitiva* resembles the present species in shape

but is distinguished by its larger size. *P. miocenicus* is readily separated by its distinct zonorate condition. *P. ellipticus* is bigger in size and possesses well developed colpi. *P. minutus* described here is conspicuous by its bulging pores at margin which are absent in all the known species of this genus.

Remarks — Paleosantalaceaepites minutus closely resembles some extant pollen grains of *Rhizophora* of Rhizophoraceae. Langenheim, Hackner and Bartlett (1967) have described the pollen grains of various species belonging to *Rhizophora*. The pollen of *R. mangle* approximates the present species in shape, size and ornamentation. The bulging nature of the pores in equatorial view are also common in both of them.

Genus — *Stephanocolpites* (v.d. Hamm.) Pot., 1960

Stephanocolpites globatus Venkat. & Kar, 1969b

S. granulatus Venkat. & Kar, 1969b

S. flavatus Venkat. & Kar, 1969b

Genus — *Polybrevicolporites* Venkat. & Kar, 1969b

Polybrevicolporites cephalus Venkat. & Kar, 1969b

Genus — *Polycolpites* Coup., 1953

Polycolpites granulatus sp. nov.

Pl. 2, Fig. 41

Holotype — Pl. 2, Fig. 41. Size 40×38 μ. Slide no. 3372.

Type Locality — Bore-core no. 15, Depth 23′, Laki Series, Kutch, India.

No. of specimens studied — 31.

Diagnosis — Pollen grains circular-subcircular in polar view, 35-45×32-44 μ. Septa-octacolpate. Exine thin, granulose.

Description — Pollen grains always found in polar view. Colpi well developed, funnel shaped. Mesocolpium narrow. Exine up to 2·5 μ thick, granulose, grana ± up to 1 μ in size, not closely placed.

Comparison — Polycolpites clavatus Coup. (1953) is distinguished from the present species by its smaller size range and clavate-baculate exine. *P. obscurus* Sah & Dutta (1966) is also smaller in size and has 5-6 colpi. *P. cooksonii* Sah & Dutta (1966) is comparable to the present species in granulose exine but is distinguished by its polycolpoidate condition. *P. vimalii* Sah & Dutta (1966) is also granulose but the exine is very thick (up to 6 μ) and apertures are colpoid in nature.

Remarks — Octacolpites spm. 1 described by Vimal (1952), *Octacolpites brevicolpa* Baksi (1962) and 8 zonicolporate grain described by Bose & Sah (1964) are different from the present species. *Octacolpites type* C. described by Ghosh *et al.* (1964) seems to belong to this species.

Polycolpites flavatus sp. nov.

Pl. 2, Figs. 42, 47

Holotype — Pl. 2, Fig. 47. Size 32×30 μ. Slide no. 3373.

Type Locality — Bore-core no. 15, Depth 10′, Laki Series, Kutch, India.

No. of specimens studied — 25.

Diagnosis — Pollen grains subcircular-circular, 30-40×29-38 μ. Nona-decacolpate, brevicolpate. Exine 2-4 μ thick, finely scrobiculate.

Description — Pollen grains always found in polar view. Colpi mostly closed, sometimes open, colpi margin not thickened. Sexine as thick as nexine, in some specimens it is thicker than nexine. Scrobiculate structure well developed in most specimens.

Comparison — Polycolpites globatus is comparable to the present species in shape and size but is distinguished by its septa-octacolpate condition and granulose exine. *P. vimalii* Sah & Dutta (1966) resembles the present species in size but is distinguished by its thick, granulose exine. *P. obscurus* and *P. cooksonii* also described by Sah & Dutta (*l.c.*) are penta-hexacolpate and possess granulose exine.

Genus — *Ghoshiacolpites* gen. nov.

Type Species — Ghoshiacolpites globatus sp. nov.

Diagnosis — Pollen grains circular-subcircular. Polycolpate, colpi 5-9, mesocolpia broad, ridged in middle. Exine laevigate-finely scrobiculate.

Description — Pollen grains mostly circular in polar view, 30-40×28-36 μ. Mostly hexacolpate, but may be penta to nonacolpate in some specimens. Brevicolpate, colpi distinct, margin not thickened. Ridge of mesocolpia well developed, joining each other in middle region to form a star fish-

like appearance. Exine 1·5-2·5 μ thick, sexine as thick as nexine or slightly thicker, generally laevigate, sometimes weakly developed, fine, scrobiculate structure is also observed in some specimens.

Comparison — *Polycolpites* Coup. (1953) resembles the present genus in shape, size and polycolpate condition but is distinguished by its absence of thickened, radiating processes in central and mesocolpate region. *Stephanocolpites* (v.d. Hamm.) Pot. (1960) is also polycolpate but is differentiated by its reticulate-foveolate exine. *Polybrevicolporites* Venkat. & Kar (1969b) is polycolporate. *Ghoshiacolpites* proposed here is conspicuous by its presence of thickened radiating processes which has not been recorded in any known fossil polycolpate genera so far.

Derivation of Name — After Prof. A. K. Ghosh, Botany Dept., Calcutta University.

Remarks — Polycolpate pollen grains are found in Acanthaceae, Didiereaceae, Euphorbiaceae, Scrophulariaceae, Labiatae and number of other families. The polycolpate pollen grains have been investigated by Bhaduri (1944), Vishnu-Mittre and Gupta (1966). Rao and Vimal (1952), Vimal (1952, 1953), Ghosh, Srivastava and Sen (1964), Ramanujam (1966) and Venkatachala and Kar (1969b) have recorded fossil polycolpate pollen from the various Tertiary formations of India and Pakistan. The thickened plate like structure in the middle region with radiating processes in the mesocolpate region has, however, not reported by any of them.

Some pollen grains of Didiereaceae (ERDTMAN, 1948), however, produce polycolpate pollen grains with differential thickening in the middle region. The pollen grains of *Alluaudia ascendens, A. comosa, A. dumosa* and *A. humberti* of Didiereaceae produce penta-septacolpate pollen with thickened mesocolpate region. They are also circular-subcircular in shape but are easily distinguished by their larger size, thicker and spinuliferous exine.

The pollen grains of *Utricularia* very closely resembles the present species (NAIR, 1968).

Ghoshiacolpites globatus sp. nov.

Pl. 2, Figs. 43-46

Holotype — Pl. 2, Fig. 43. Size 34×33 μ. Slide no. 3365.

Type Locality — Bore-core no. 15, Depth 23′, Laki Series, Kutch, India.

No. of specimens studied — 47.

Diagnosis — Pollen grains circular-subcircular in polar view, 30-40×28-36 μ. Polycolpate, mostly hexacolpate. Mesocolpia thickened to form star shaped appearance. Exine ± laevigate.

Description — Pollen grains mostly found in polar view, sometimes partially tilted specimens are also met with. Colpi distinct, generally six but number varies from 5 to 9. Mesocolpia thickened as a ridge in middle which join in central region to form star fish like appearance. Exine 1·5-2·5 μ thick, sexine as thick as nexine, sometimes slightly thicker, generally laevigate, sometimes finely scrobiculate.

Genus — *Diporites* v.d. Hamm., 1954

Diporitus sp.

Pl. 2, Fig. 39

Description — Pollen grain oval, 36×26 μ. 2 porate, pores placed at lateral ends opposite to each other, without any thickened margin. Exine about 1·5 μ thick, laevigate.

Comparison — *Diporites grandiporus* v.d. Hamm. (1954) is smaller in size than the present species.

Genus — *Sonneratiopollis* Venkat. & Kar, 1969b

Sonneratiopollis bellus Venkat. & Kar, 1969

Genus — *Trilatiporites* Raman., 1966

Trilatiporites kutchensis Venkat. & Kar, 1969b

Trilatiporites minutus sp. nov.

Pl. 2, Fig. 40

Holotype — Pl. 2, Fig. 40. Size 30×26 μ. Slide no. 3370.

Type Locality — Bore-core no. 15, Depth 49′, Laki Series, Kutch, India.

No. of specimens studied — 14.

Diagnosis — Pollen grains roundly triangular, 26-32×24-27 μ. Triporate, pores subequatorially placed, margin not thickened, exine thin, scrobiculate.

Description — Pollen grains mostly roundly triangular, sometimes subcircular. Pore distinct, 4-6 μ in diameter. Exine

about 2 μ thick, sexine and nexine equally thick, finely scrobiculate.

Comparison — Trilatiporites kutchensis Venkat. & Kar (1969b) closely resembles the present species in shape and nature of the pores but is distinguished by its larger size range and thicker exine (3-5 μ thick). *T. erdtmani, T. noremi, T. sellingi, T. cooksoni* all described by Raman. (1966) are differentiated by their larger size range.

Genus — *Proteacidites* Cook., 1950

Proteacidites protrudus sp. nov.

Pl. 2, Fig. 61

Holotype — Pl. 2, Fig. 61. Size 56×50 μ. Slide no. 3365.

Type Locality — Bore-core no. 15, Depth 23′, Laki Series, Kutch, India.

No. of specimens studied — 10.

Diagnosis — Pollen grains, triangular, 50-60×48-55 μ. 3 porate, pore distinct. Exine finely scrobiculate.

Description — Pollen grains mostly triangular, sometimes sub-triangular in polar view. Pore well marked, slightly protruding, interporal margin ± straight. Exine up to 3 μ thick, sexine thicker than nexine, scrobiculate.

Comparison — Proteacidites adenanthoides Cook. (1950) resembles the present species in shape but is distinguished by its smaller size and clavate-tuberculate exine.

Genus — *Triorites* (Erdt.) Coup., 1953

Triorites triangulus sp. nov.

Pl. 2, Fig. 53

Holotype — Pl. 2, Fig. 53. Size 40×38 μ. Slide no. 3358.

Type Locality — Bore-core no. 13, Depth 165′, Laki Series, Kutch, India.

No. of specimens studied — 11.

Diagnosis — Pollen grains triangular, 32-45×28-40 μ. 3 orate, ora very big. Exine pilate-baculate, closely placed.

Description — Pollen grains mosty triangular, sometimes subtriangular, ora distinct without any thickened margin, interoral margin ± laevigate. Exine 1·5-2·5 μ thick, tegillate, pila mixed with bacula, closely placed, uniformly distributed, forming negative reticulum in surface view.

Comparison — Triorites communis Sah & Dutta (1966) is comparable to the present species in size but is distinguished by its smaller size, protruding ora and finely granular exine.

Triorites minutus sp. nov.

Pl. 2, Fig. 51

Holotype — Pl. 2, Fig. 51. Size 54×50 μ. Slide no. 3374.

Type Locality — Bore-core no. 15, Depth 40′, Laki Series, Kutch, India.

No. of specimens studied — 12.

Diagnosis — Pollen grains triangular with protruding ora, 45-58×40-55 μ. 3 orate, ora with circular opening. Exine finely scrobiculate.

Description — Pollen grains generally triangular with ± straight interoral margin. Ora distinct without thickened margin. Exine 1·5-3 μ thick, sexine thicker than nexine, scrobiculate well developed in most specimens.

Comparison — T. communis Sah & Dutta (1966) is comparable to the present species in size and protruding ora; but the latter is easily distinguished by its more protruding ora and scrobiculate structure.

Triorites bellus sp. nov.

Pl. 2, Fig. 70

Holotype — Pl. 2, Fig. 70. Size 70×69 μ. Slide no. 3352.

Type Locality — Bore-core no. 13, Depth 48′, Laki Series, Kutch, India.

No. of specimens studied — 15.

Diagnosis — Pollen grains triangular with much protruding ora, 65-75×60-73 μ. 3 orate, interoral margin convex. Exine granulose.

Description — Pollen grains triangular with triradiating arms due to projected ora. Ora distinct, 8-15 μ in diameter without any thickened margin. Exine 1·5-2·5 μ thick, granulose, grana closely placed, uniformly distributed.

Comparison — Triorites minutus resembles the present species in shape and protruding ora but is distinguished by its smaller size range and scrobiculate exine. *T. communis* Sah & Dutta (1966) resembles the present species in granulose exine but is differentiated by its smaller size and less protruding ora.

Triorites dermatus sp. nov.

Pl. 2, Figs. 49-50

Holotype — Pl. 2, Fig. 49. Size 34×33 μ. Slide no. 3365.

Type Locality — Bore-core no. 15, Depth 23′, Laki Series, Kutch, India.

No. of specimens studied — 9.

Diagnosis — Pollen grains subtriangular-subcircular, 30-38×28-35 μ. 3 orate, ora with thickened margin. Exine thick, ± laevigate-finely intrastructured.

Description — Pollen grains mostly subtriangular with convex interoral margin. Ora well developed. Exine 2·5-4 μ thick, generally laevigate, sometimes scrobiculate.

Comparison — *T. triangulus* is comparable to the present species in shape but is distinguished by its larger ora without thickened margin and pilate-baculate exine. *T. minutus* and *T. bellus* possess protruding ora.

Genus — *Pseudonathofagidites* Venkat. & Kar, 1969b

Pseudonathofagidites cerebrus Venkat. & Kar, 1969b

Genus — *Cryptopolyporites* Venkat. & Kar, 1969b

Cryptopolyporites cryptus Venkat. & Kar, 1969b

Genus — *Thymelaepollis* gen. nov.

Type Species — *Thymelaepollis crotonoidis* sp. nov.

Diagnosis — Pollen grains circular-subcircular. Polyporate, pores uniformly distributed. Exine thick, baculate-spinose, sometimes with excrescences on top.

Description — Pollen grains mostly circular, 40-60×36-56 μ. Pores distinct-indistinct, generally masked by sculptural elements, 4-10 μ in diameter, without any thickened margin. Exine 2-5 μ thick, mostly baculate, sometimes mixed with spines; sculptural elements bear excrescences on top in some cases.

Comparison — *Polyporina* (Naum.) Pot. (1960) is comparable to the present genus in shape and panporate condition, but is distinguished by its granulose exine. *Liquidambarpollenites* Raatz (1937) has 8-12 pores and laevigate to finely intramicroreticulate exine. *Multiporopollenites* (Pf.) Pot. (1960) approximates the present genus in shape and polyporate nature but is differentiated by its laevigate exine. *Cryptopolyporites* Venkat. & Kar (1969b) is distinguishable from the present genus by its pores being concealed by the baculate ornamentation of the exine.

Remarks — The pollen grains of Thymelaeaceae closely resemble the present genus in circular-subcircular shape, polyporate condition and thick exine provided with excrescences on bacular-spinose processes. This type of ornamentation has been termed as " croton-pattern " by Erdtman (1952, p. 173). This consists of well defined, regularly arranged processes with triangular-circular shape in sectional view supported by sculptured or spongy layer. In *Crotonoideae*, however, most of them are non-aperturate. Since the present genus is distinctly polyporate with " croton-pattern " so it closely resembles Thymelaeaceae than any other families. The pollen grains of *Pimelia longifolia* illustrated by Cranwell (1953, Pl. 2, Fig. 11) approximates the present genus in shape, size, aperture and ornamentation.

Thymelaepollis crotonoidis sp. nov.

Pl. 2, Fig. 71

Holotype – Pl. 2, Fig. 71. Size 48×42 μ. Slide no. 3372.

Type Locality — Bore-core no. 15, Depth 23′, Laki Series, Kutch, India.

No. of specimens studied — 13.

Diagnosis — Pollen grains circular-subcircular, 42-54×40-53 μ. Polyporate. Exine 2-4 μ thick, mostly baculate, sometimes with excrescences at top.

Description — Pollen grains mostly circular, panporate, pore subcircular-oval in shape without thickened margin. Exine heavily sculptured, bacula 3-6 μ long, sometimes mixed with spinules, excrescences are frequently found on sculptural elements.

ACKNOWLEDGEMENT

Sincere appreciation is expressed to the Directorate of Geology & Mining, Government of Gujarat, for very kindly supplying the present material. The authors are also thankful to Messers B. S. Nadhamuni, A. Venkatappaih and the staff of the Kutch Lignite Scheme of the same directorate for helping in collection of the samples.

REFERENCES

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

BAMZAI, R. D. & RANDHAWA, G. S. (1965). Palynological studies in *Citrus*. *J. Palynol.* **1**: 111-121.

BHADURI, S. (1944). A contribution to the morphology of pollen grains of Acanthaceae and its bearing on taxonomy. *Calcutta Univ. J. Dept. Sci. New Series* **1**(4): 25-58.

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

BOSE, M. N. & SAH, S. C. D. (1964). Fossil plant remains from the Laitryngew, Assam. *Palaeobotanist.* **12**(3): 220-222.

COOKSON, I. C. (1947). Plant microfossils from the lignites of Kerguelen Archipelago. *Rep. B.A.N.Z. antarct. Exped. Ser. A.* **2**: 127-142.

Idem (1950). Fossil pollen grains of Proteaceous type from Tertiary deposits in Australia. *Aust. J. Sci. Res. Ser. B. biol. Sci.* **3**(2): 166-177.

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

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

CRANWELL, L. M. (1953). New Zealand pollen studies. The Monocotyledons a comparative account. *Bull. Auckland Inst. Mus.* **3**: 1-91.

DÖRING, H. (1961). Planktonartige Fossilien des Jurakreide-Grenzbereichs der Bohrungen Werle (Mecklenburg). *Geologie.* **10**(32): 110-117.

ELSIK, W. C. in STOVER, L. E., ELSIK, W. C. & FAIRCHILD, W. W. (1966). New genera and species of Early Tertiary palynomorphs from Gulf Coast. *Univ. Kansas paleont. Contr. Pap.* **5**: 1-10.

ERDTMAN, G. (1948). Pollen morphology and plant taxonomy VIII. Didiereaceae. *Bull. Mus. Ser.* **2-20**(4): 387-394.

Idem (1952). Pollen morphology and plant taxonomy. Angiosperms. 1-539. *Stockholm.*

GHOSH, A. K., SRIVASTAVA, S. K. & SEN, J. (1963). Polycolpate grains in pre-Miocene horizons of India. *Proc. natn. Inst. Sci. India.* **29**B(5): 511-519.

KRUTZSCH, W. (1959). Mikropaläontologische (Sporenpaläontologische) Untersuchungen in der Braunkohle des Geiseltales. *Geologie.* **8**(21-22): 1-425.

LANGENHEIM, J. H., HACKNER, B. L. & BARTLEIT, A. (1967). Mangrove pollen at the depositional site of Oligo-Miocene amber from Chiapas, Mexico. *Bot. Mus. Leaf. Harv. Univ.* **21**(10): 289-324.

MATHUR, Y. K. (1963). Studies in the fossil microflora of Kutch, India. 1. On the microflora and the hystrichosphaerids in the gypseous shales (Eocene) of Western Kutch, India. *Proc. natn. Inst. Sci. India.* **29B**(3): 356-371.

Idem (1966). On the microflora in the Supra Trappeans of Western Kutch, India. *Q. Jl geol. Min. metall. Soc. India.* **38**(1): 33-51.

NAIR, P. K. K. (1968). Pollen and spores from the Karewas (Quaternary) of Kashmir. *J. palaeont. Soc. India.* **10**: 14-19, 1965.

NAIR, P. K. K. & SHARMA, M. (1965). Pollen morphology of Liliaceae. *J. Palynol.* **1**: 38-61.

NAVALE, G. K. B. (1961). Pollen grains and spores from Neyveli lignite, South India. *Palaeobotanist.* **10**: 87-90, 1959.

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

POTONIÉ, R. (1951). Die bedeutung der Sporomorphen fur die Gesellschafts geschichte. *Cong. Strat. Geol. Carb. C. r.* **5**: 501-506.

Idem (1958). Synopsis der Gattungen der *Sporae dispersae*. Teil II. *Beih. Geol. J. B.* **31**: 1-114.

Idem (1960). Synopsis der Gattungen der *Sporae dispersae*. *Ibid.* Teil III. **39**: 1-189.

RAATZ, G. V. (1937). Mikrobotanisch-stratigraphische Untersuchung der Braunkohle des Muskauer Bogens. *Abh. preuss. Geol. Land.* **183**: 1-148.

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

RAO, A. R. & VIMAL, K. P. (1950). Plant microfossils from Palana lignite (Eocene ?), Bikaner. *Curr. Sci.* **19**: 82-84.

Idem (1952). Preliminary observations on the plant microfossils contents of some lignites from Warkalli in Travancore. *Ibid.* **21**: 302-305.

SAH, S. C. D. (1968). Palynology of a Neogene profile from Rusizi Valley, Congo. *Annls Mus. r. Afr. Cent. Ser.* 8º. **57**: 1-173, 1967.

SAH, S. C. D. & DUTTA, S. K. (1966). Palynostratigraphy of the sedimentary formations of Assam. 1. Stratigraphical position of the Cherra Formation. *Palaeobotanist.* **15**(1-2): 72-86.

SAH, S. C. D. & KAR, R. K. (1969). Pteridophytic spores from the Laki Series of Kutch, Gujarat state, India. *J. Sen. mem. Vol.*:109-122.

STOVER, L. E. in STOVER, L. E., ELSIK, W. C. & FAIRCHILD, W. W. (1966). New genera and species of Early Tertiary palynomorphs from Gulf Coast. *Univ. Kansas paleont. Contr. Pap.* **5**: 1-10.

THIERGART, F. (1937). Die Pollen-flora der Niedorlausitzer Braunkohle, besondern in profile der Grube Marga bei Senftenberg. *Jb. preuss. Geol. Landst.* **58**:

VAN DER HAMMEN, T. (1954). El desarrollo de la Flora colombiana en los periodos Geologicos. 1. Maestrichtiano Hasta Terciario mas inferior. *Boln. Geol. Bogota.* **11**(1): 49-106.

Idem (1956). A palynological systematic nomenclature. *Ibid.* **4**(423): 63-101.

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

Idem (1969a). Palynology of the Mesozoic sediments of Kutch, W. India. 11. Three new species of *Applanopsis* with remarks on the morphology of the genus. *J. Sen. mem. Vol.* 33-43.

Idem (1969b). Palynology of the Tertiary sediments in Kutch. 1. Spores and pollen from the bore-hole no. 14. *Palaeobotanist.* **17**(2): 157-178, 1968.

Idem (1969c). Palynology of the Laki sediments in Kutch. 2. Epiphyllous fungal remains from the bore-hole no. 14. *Ibid.* **17**(2): 178-183, 1968.

VENKATACHALA, B. S., KAR, R. K. & RAZA, S. (1969). Palynology of the Mesozoic sediments of Kutch. W. India. 10. Spores and pollen from Katrol exposures near Bhuj, Kutch district, Gujarat State. *Ibid.* **17**(2): 184-207, 1968.

VIMAL, K. P. (1952). Spores and pollen from Tertiary lignites from Dandot, West Punjab (Pakistan). *Proc. Indian Acad. Sci.* **36**: 135-147.

Idem (1953). Occurrence of *Botryococcus* in Eocene lignites of Cutch. *Curr. Sci.* **22**: 375-376.

VISHNU-MITTRE & GUPTA, H. P. (1966). Contribution to the pollen morphology of the genus *Strobilanthes* Blume, with remarks on its taxonomy. *Pollen Spores.* **8**(2): 285-307.

WILSON, T. K. (1964). Comparative morphology of the Canellaceae. III. Pollen. *Bot. Gaz.* **125**(3): 192-197.

EXPLANATION OF PLATES

(*All photomicrographs are enlarged ca.* × 500 *unless otherwise mentioned*)

PLATE 1

1-4. *Dracaenoipollis circularis* gen. et sp. nov. Slide nos. Holotype — 3346, 3347, 3360.

5-6. *Tricolpites brevis* sp. nov. Slide nos. Holotype — 3348, 3361.

7. *Tricolpites minutus* sp. nov. Slide nos. Holotype — 3350.

8-9. *Couperipollis achinatus* sp. nov. Slide nos. Holotype — 3351, 3362.

10-11. *Clavatipollenites cephalus* sp. nov. Slide no. Holotype — 3352.

12. *Couperipollis* sp. Slide no. 3363.

13. *Palmaepollenites ovatus* sp. nov. Slide no. Holotype — 3364.

14-15. *Palmaepollenites plicatus* sp. nov. Slide no. Holotype — 3365.

16. Monocolpate pollen type-1 *ca.* × 275 Slide no. 3352.

17. *Monosulcites ovatus* sp. nov. Slide no. Holotype — 3353.

18. *Palmaepollenites magnus* sp. nov. Slide no. Holotype — 3366.

19-20. *Arecipites bellus* sp. nov. Slide nos. Holotype — 3367, 3364.

21. Cf. *Liliacidites* Slide no. 3360.

22. *Callialasporites* (*Applanopsis*) *lenticularis* Dör. Slide no. 3364.

23. *Callialasporites* (*Applanopsis*) *trilobatus* (Balme) Dev. Slide no. 3368.

24. *Podocarpidites* sp. 1. Slide no. 3354.

25. *Podocarpidites* sp. 2. Slide no. 3351.

26. *Laricoidites kutchensis* Venkat. *et al.* Slide no. 3353.

27. *Araucariacites australis* Cook. Slide no. 3353.

28. *Tricolpites* sp. 2. Slide no. 3355.

29. *Tricolpites* sp. 1. Slide no. 3369.

30. *Retitricolpites robustus* sp. nov. Slide no. Holotype — 3364.

PLATE 2

31-32. *Symplocoipollenites constrictus* sp. nov. Slide nos. Holotype — 3370, 3349.

33-36. *Verrucolporites verrucus* gen. et. sp. nov. Slide nos. Holotype — 3351, 3352.

37-38. *Verrutricolpites triangulus* sp. nov. Slide nos. Holotype — 3367, 3371.

39. *Diporites* sp. Slide no. 3356.

40. *Trilatiporites minutus* sp. nov. Slide no. Holotype — 3370.

41. *Polycolpites granulatus* sp. nov. Slide no. Holotype — 3372.

42, 47. *Polycolpites flavatus* sp. nov. Slide nos. Holotype — 3373, 3363.

43-46. *Ghoshiacolpites globatus* gen. et sp. nov. Slide nos. Holotype — 3365, 3362.

48. *Paleosantalaceaepites minutus* sp. nov. Slide no. Holotype — 3357.

49-50. *Triorites dermatus* sp. nov. Slide nos. Holotype — 3365, 3371.

51. *Triorites minutus* sp. nov. Slide no. Holotype — 3374.

52. *Paleosantalaceaepites primitiva* Bis. Slide no. 3375.

53. *Triorites triangulus* sp. nov. Slide no. Holotype — 3358.

54. *Striacolporites striatus* gen. et sp. nov. Slide no. Holotype — 3362.

55. *Paleosantalaceaepites ellipticus* sp. nov. Slide no. Holotype — 3363.

56-57. *Striacolporites ovatus* sp. nov. Slide nos. Holotype — 3372, 3376.

58-60. *Pellicieroipollis langenheimii* gen. et sp. nov. Slide nos. Holotype — 3377, 3359, 3376.

61. *Proteacidites protrudus* sp. nov. Slide no. 3365.

62-64. *Meliapollis ramanujamii* gen. et sp. nov. Slide nos. Holotype — 3378, 3363, 3358.

65. *Meliapollis navalei* sp. nov. Slide no. 3379.

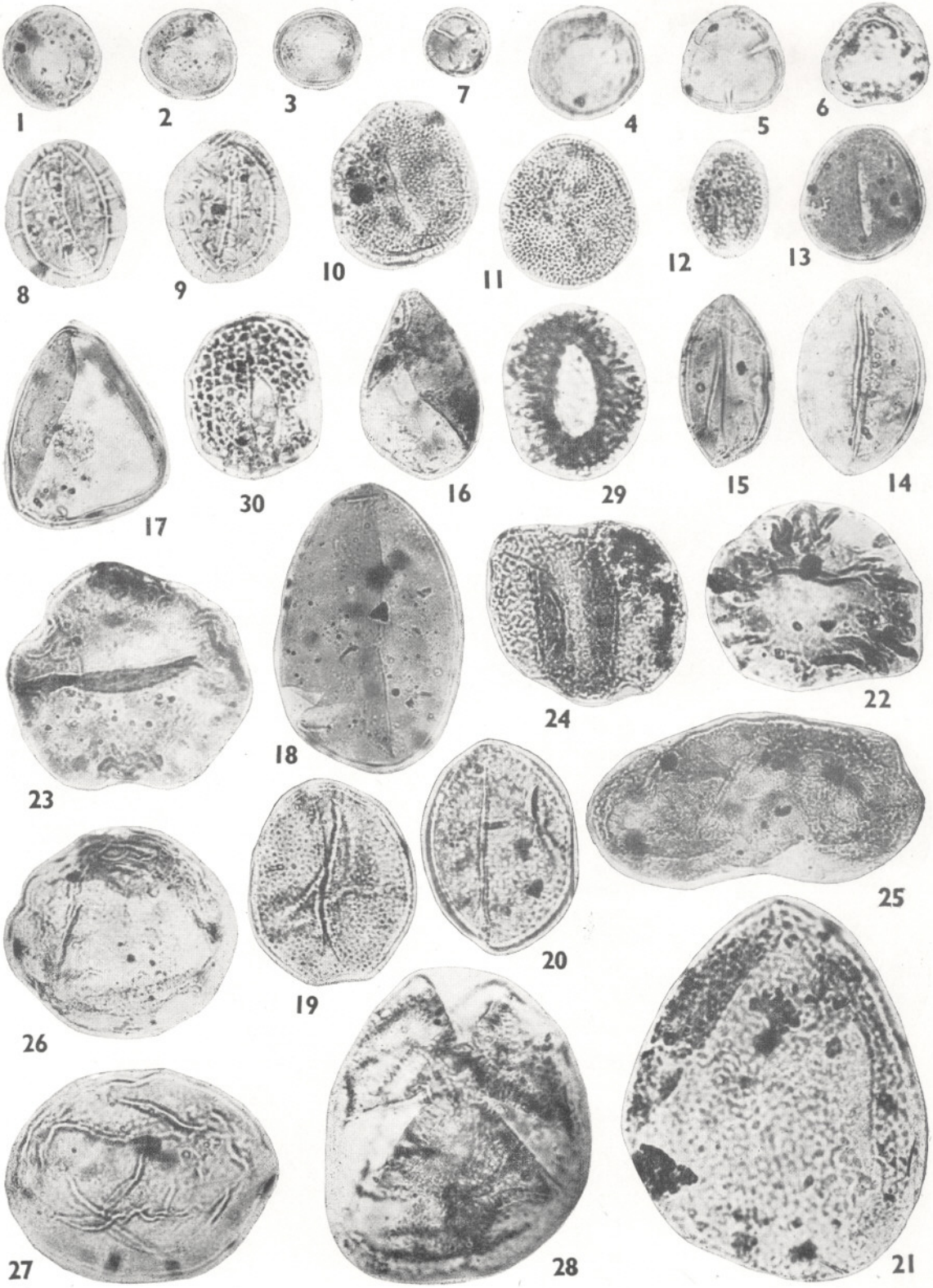
66. *Meliapollis quadrangularis* (Raman.) comb. nov. Slide no. 3361.

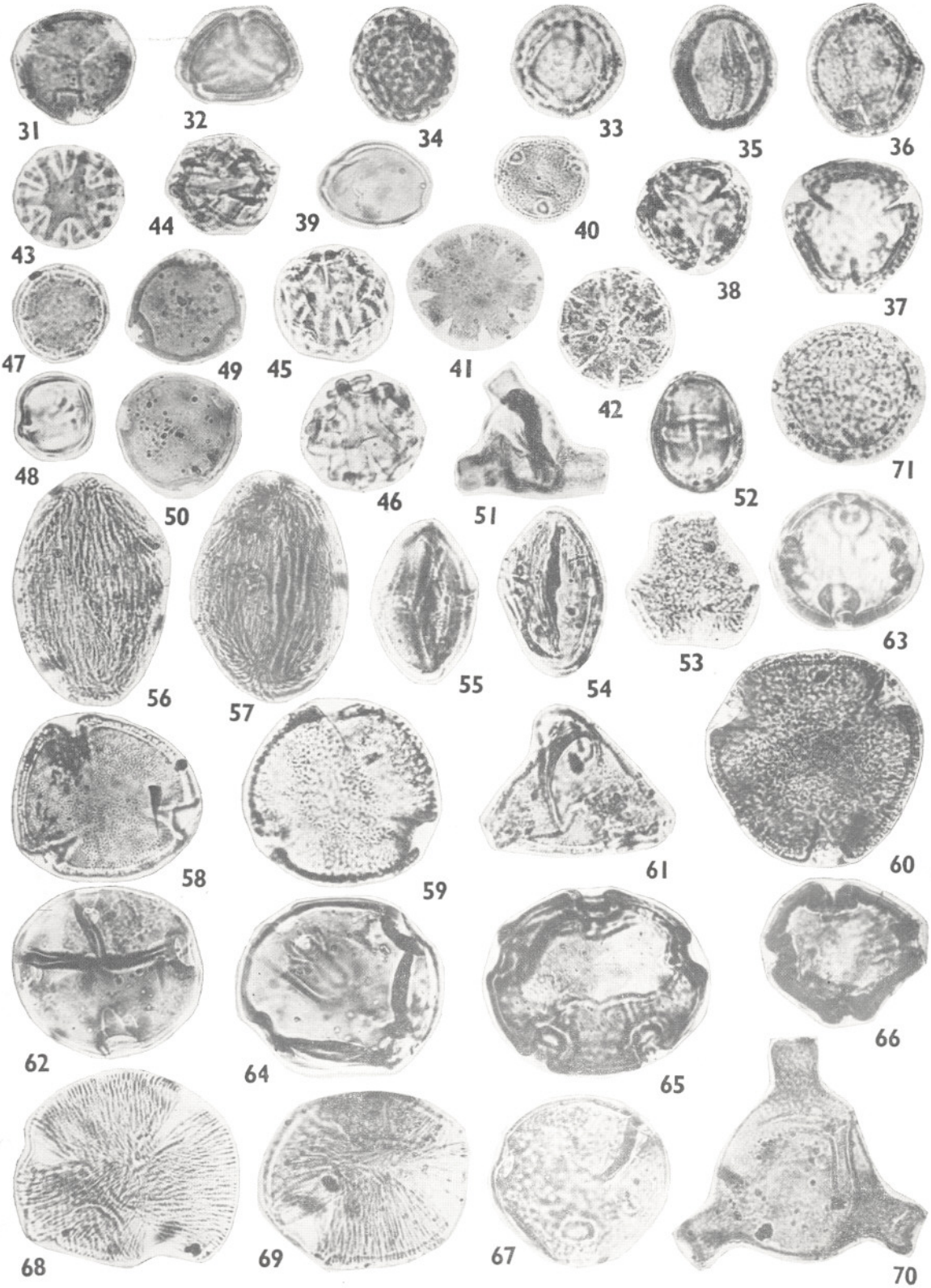
67. *Meliapollis raoi* sp. nov. Slide no. Holotype — 3380.

68-69. *Striacolporites cephalus* sp. nov. Slide nos. Holotype — 3367, 3365.

70. *Triorites bellus* sp. nov. Slide no. Holotype — 3352.

71. *Thymelaepollis crotonoidis* gen. et sp. nov. Slide no. Holotype — 3372.


1
2
3
7
4
5
6
8
9
10
11
12
13
17
30
16
29
15
14
18
24
22
23
25
19
20
26
27
28
21


31
32
34
33
35
36
43
44
39
40
38
37
47
49
45
41
42
48
50
46
51
52
71
56
57
55
54
53
63
58
59
61
60
62
64
65
66
68
69
67
70