

PALYNOLOGY OF THE MATANOMADH FORMATION IN TYPE AREA, NORTH-WESTERN KUTCH, INDIA (PART 2). SYSTEMATIC DESCRIPTION OF GYMNOSPERMOUS AND ANGIOSPERMOUS POLLEN GRAINS

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ABSTRACT

The present paper deals with the systematic description of the gymnospermous and angiospermous pollen grains recovered from the Matanomadh Formation (Palaeocene) in type area, north-western Kutch, India. The assemblage described here includes 31 genera and 59 species. The gymnospermous pollen grains are represented by 3 genera and 3 species. Of these, 1 species is new. The angiospermous pollen grains form the most dominant group in the present assemblage and are represented by 28 genera and 56 species. Of these, 1 genus and 11 species are new. Among the angiosperms, the dicotyledonous pollen grains dominate over those of monocotyledons. Six genera and 16 species belong to the monocotyledons while 22 genera and 40 species belong to the dicotyledons.

Key-words — Palaeopalynology, Palaeocene, Matanomadh Formation (India).

सारांश

उत्तर-पश्चिमी कच्छ, भारत में मातानोमध शैल-समूह के प्ररूप क्षेत्र का परागणविक अध्ययन — (भाग 2)।
आवृतबीजी एवं अनावृतबीजी परागकणों का क्रमबद्ध वर्णन — रमेश कुमार सक्सेना

प्रस्तुत शोध-पत्र में मातानोमध शैल-समूह के प्ररूप क्षेत्र, उत्तर-पश्चिमी कच्छ, भारत से प्राप्त आवृतबीजी एवं अनावृतबीजी परागकणों का क्रमबद्ध वर्णन है। वर्णित समुच्चय में 31 प्रजातियाँ व 59 जातियाँ अभिव्याप्त हैं। अनावृतबीजी परागकण 3 प्रजातियों व 3 जातियों से निरूपित हैं जिनमें से एक जाति नई है। इस समुच्चय में आवृतबीजी परागकण सर्वप्रधान समूह के रूप में विद्यमान हैं तथा 28 प्रजातियों व 56 जातियों के द्वारा निरूपित हैं। इनमें से 1 प्रजाति व 11 जातियाँ नई हैं। आवृतबीजीयों में एकबीजपत्री परागकणों की अपेक्षा द्विबीजपत्रीय परागकणों की प्रधानता है। छः प्रजातियाँ व 16 जातियाँ एकबीजपत्रीय हैं जबकि 22 प्रजातियाँ व 40 जातियाँ द्विबीजपत्रीय हैं।

INTRODUCTION

PALYNOLOGICAL investigations of the samples collected from the various levels of the Matanomadh Formation (Palaeocene) revealed the presence of a rich palynoflora. The assemblage comprises a large number of spores, pollen grains, and algal and fungal remains. The present paper includes only gymnospermous and angiospermous pollen grains. The description of algal and fungal remains has already been published by Kar and Saxena (1976) and that of pteridophytic spores by Saxena (1978). The palynological study of the

Matanomadh Formation has been carried out also by Mathur (1966).

The slides and unused material have been deposited in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC PALYNOLOGY

Anteturma — *Variegerminantes* Potonié, 1970

Turma — *Saccites* Erdtman, 1947

Subturma — *Disaccites* Cookson, 1947

Infraturma — *Podocarpoiditi* Potonié, Thomson & Thiergart, 1950

Genus — *Podocarpidites* (Cookson) Potonié, 1958

Type Species — *Podocarpidites ellipticus* Cookson, 1947.

Podocarpidites ellipticus Cookson, 1947

Pl. 1, fig. 1

Turma — *Aletes* Ibrahim, 1933

Subturma — *Azonaletes* (Luber) Potonié & Kremp, 1954

Infraturma — *Psilonapiti* Erdtman, 1947

Genus — *Laricoidites* (Potonié, Thomson & Thiergart) Potonié, 1956

Type Species — *Laricoidites magnus* (Potonié) Potonié, Thomson & Thiergart, 1950.

Laricoidites punctatus sp. nov.

Pl. 1, fig. 2

Holotype — Pl. 1, fig. 2, size $88 \times 76 \mu$. Slide no. 4936/21.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains subcircular, 40-90 μ . Germinal mark absent. Exine up to 2 μ thick, irregularly folded, intrapunctate, puncta closely placed and evenly distributed.

Comparison — The present species closely resembles *L. indicus* Singh, Srivastava & Roy (1964) in having intrapunctate exine but the latter is distinguishable by its comparatively bigger size range (90-120 μ). *L. magnus* (Potonié) Potonié, Thomson & Thiergart (1950) is laevigate.

Laricoidites sp.

Pl. 1, fig. 3

Description — Pollen grain \pm oval in shape, $220 \times 170 \mu$. Germinal mark not present. Exine 2 μ thick, irregularly folded, intrapunctate, puncta bigger in size, prominent.

Comparison — This specimen differs from all the known species of this genus by its very large size.

Infraturma — *Granulonapiti* Cookson, 1947

Genus — *Araucariacites* (Cookson) Couper, 1953

Type Species — *Araucariacites australis* Cookson, 1947.

Araucariacites australis Cookson, 1947

Pl. 1, fig. 4

Infraturma — *Subpilonapiti* (Erdtman) Vimal, 1952

Genus — *Retipilonapites* Ramanujam, 1966

Type Species — *Retipilonapites arcotense* Ramanujam, 1966.

Retipilonapites cenozoicus Sah, 1967

Pl. 1, fig. 5

Turma — *Plicates* (Naumova) Potonié, 1960

Subturma — *Monocolpates* Iversen & Troels-Smith, 1950

Infraturma — *Retectines* (Malyavkina) Potonié, 1958

Genus — *Couperipollis* Venkatachala & Kar, 1969

Type Species — *Couperipollis perspinosus* (Couper) Venkatachala & Kar, 1969.

Couperipollis wodehousei (Biswas) Venkatachala & Kar, 1969

Pl. 1, fig. 6

Couperipollis brevispinosus (Biswas) Venkatachala & Kar, 1969

Pl. 1, fig. 7

Couperipollis rarispinosus (Sah & Dutta) Venkatachala & Kar, 1969

Couperipollis kutchensis Venkatachala & Kar, 1969.

Couperipollis achinatus Sah & Kar, 1970

Couperipollis robustus sp. nov.

Pl. 1, fig. 8

Holotype — Pl. 1, fig. 8, size $49 \times 45 \mu$. Slide no. 4766/3.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains circular-oval, 16-55 μ . Monosulcate, sulcus distinct-indistinct, extending from pole to pole. Exine about 2 μ thick, sculptured with robustly built coni, verrucae, baculae and other elements.

Comparison — The present species is clearly distinguishable from *C. wodehousei* (Biswas) Venkatachala & Kar (1969), *C. brevispinosus* (Biswas) Venkatachala & Kar (1969), *C. kutchensis* Venkatachala & Kar (1969) and *C. achinatus* Sah & Kar (1970) by its exine, variously ornamented by baculae, coni and verrucae. All the other species have only spinose ornamentation.

Genus — *Liliacidites* Couper, 1953

Type Species — *Liliacidites kaitangataensis* Couper, 1953.

Liliacidites maximus sp. nov.

Pl. 1, figs 9, 10

Holotype — Pl. 1, fig. 9, size 150 \times 113 μ . Slide no. 4955/5.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains oval-elliptical, 135-205 \times 90-145 μ . Monosulcate, sulcus may be distinct or indistinct, wide, extending from pole to pole. Exine 2-3 μ thick, generally retipilate to retibaculate, pila/bacula 3-8 μ long, muri thick, raised, lumina 3-8 μ wide.

Comparison — *Liliacidites maximus* sp. nov. can be differentiated from *L. magnus* Jain, Kar & Sah (1973), *L. variegatus* Couper (1953), *L. intermedius* Couper (1953), *L. baculatus* Venkatachala & Kar (1969) and *L. ellipticus* Venkatachala & Kar (1969) by its comparatively larger size.

Liliacidites kutchensis sp. nov.

Pl. 2, fig. 11

Holotype — Pl. 2, fig. 11, size 105 \times 60 μ . Slide no. 4956/1.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains oval-elliptical, 63-100 \times 38-58 μ . Monosulcate, sulcus

mostly indistinct, wide, generally extending from pole to pole. Exine 1.5-2.5 μ thick, retipilate to retibaculate, sculptural elements 3-4 μ long, closely placed.

Comparison — *Liliacidites kutchensis* sp. nov. is closely comparable to *L. maximus* sp. nov. in having similar sculptural elements but the latter can easily be differentiated by its bigger size. *L. magnus* Jain, Kar & Sah (1973) agrees in shape and size but is intramicroreticulate. *L. intermedius* Couper (1953), *L. variegatus* Couper (1953) and *L. baculatus* Venkatachala & Kar (1969) differ in having comparatively smaller size.

Liliacidites matanomadhensis sp. nov.

Pl. 2, fig. 12

Holotype — Pl. 2, fig. 12, size 110 \times 88 μ . Slide no. 4774/3.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains oval-elliptical, 86-150 \times 58-94 μ . Monosulcate, sulcus broad, extending from one end to the other. Exine 2-3 μ thick, foveo-reticulate, foveola up to 2 μ wide, closely placed and evenly distributed.

Comparison — The present species is closely comparable to *L. maximus* sp. nov. in shape and size but is easily distinguishable by its foveo-reticulate ornamentation. *L. kutchensis* sp. nov. is smaller in size and has retipilate exine.

Liliacidites cf. *L. maximus* sp. nov.

Pl. 2, fig. 13

Description — Pollen grains triangular, 80-150 μ . Trichotomosulcate. Exine 3-8 μ thick, retipilate.

Remarks — The pollen grains are similar to *L. maximus* sp. nov. in size range and retipilate ornamentation but are differentiated by its trichotomosulcate condition.

Genus — *Palmidites* Couper, 1953

Type Species — *Palmidites maximus* Couper, 1953.

Palmidites maximus Couper, 1953

Pl. 2, fig. 14

Infraturma — *Monoptyches* (Naumova) Potonié, 1958

Genus — *Palmaepollenites* Potonié, 1951

Type Species — *Palmaepollenites tranquilus* (Potonié) Potonié, 1951.

Palmaepollenites kutchensis Venkatachala & Kar, 1969

Pl. 2, fig. 15

Palmaepollenites nadhamunii Venkatachala & Kar, 1969

Pl. 2, figs 16, 17

Remarks — Some specimens (Pl. 2, fig. 17) assignable to *P. nadhamunii* Venkatachala & Kar (1969) are bigger in size (48-56 × 30-40 μ) than those originally described by Venkatachala and Kar.

Palmaepollenites ovatus Sah & Kar, 1970

Palmaepollenites plicatus Sah & Kar, 1970

Pl. 2, fig. 18

Genus — *Dracaenopollis* Sah & Kar, 1970

Type Species — *Dracaenopollis circularis* Sah & Kar, 1970.

Dracaenopollis circularis Sah & Kar, 1970

Pl. 2, fig. 19

Infraturma — *Sphaerozonisulcates* Venkatachala & Kar, 1969

Genus — *Proxapertites* (van der Hammen) Singh, 1975

Type Species — *Proxapertites operculatus* van der Hammen, 1956.

Proxapertites microreticulatus Jain, Kar & Sah, 1973

Pl. 2, fig. 20

Proxapertites assamicus (Sah & Dutta) Singh, 1975

Pl. 2, fig. 21

Subturma — *Tryptyches* (Naumova) Potonié, 1960

Genus — *Tricolpites* (Erdtman) Potonié, 1960

Type Species — *Tricolpites reticulatus* Cookson, 1947.

Tricolpites reticulatus Cookson, 1947

Pl. 2, fig. 22

Remarks — Most of the specimens assigned here to *T. reticulatus* Cookson (1947) have retipilate to retibaculate ornamentation. Potonié (1960) mentions that the holotype is finely reticulate.

Tricolpites parvireticulatus Sah, 1967

Tricolpites crassireticulatus Dutta & Sah, 1970

Pl. 2, fig. 23

Remarks — The pollen grains found in the present preparation are comparatively larger (up to 45 μ) than those described by Dutta and Sah (1970) from South Shillong Plateau, Assam (25-37 μ).

Tricolpites brevis Sah & Kar, 1970

Pl. 2, fig. 24

Tricolpites minutus Sah & Kar, 1970

Pl. 2, fig. 25

Tricolpites baculatus Jain, Kar & Sah, 1973

Pl. 2, fig. 26

Tricolpites retibaculatus sp. nov.

Pl. 2, figs 27, 28

Holotype — Pl. 2, fig. 27, size 77 μ. Slide no. 4774/4.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains subcircular-subtriangular in polar view, 58-114 μ. Tricolpate, colpi long, well-developed, mesocolpia wide. Exine 2.5-7 μ thick, sexine thicker than nexine, retibaculate to retipilate, bacula/pila thick and strongly built, tegillate, sculptural elements provide pseudoreticulum on surface view.

Comparison — The present species is closely comparable to *T. grandis* Sah (1967)

in shape, size and tegillate exine but the latter is distinguishable by its smaller colpi and thicker exine at the apertural margin. Other species of *Tricolpites* differ either in having smaller size range or in having finer and delicate reticulum.

Tricolpites matanomadhensis sp. nov.

Pl. 2, fig. 29

Holotype — Pl. 2, fig. 29, size 82 μ . Slide no. 4953/33.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains \pm subcircular in polar view, 72-90 μ . Tricolpate, colpi well-developed, long. Exine 2-4 μ thick, retibaculate to retipilate, duplibaculate/pilate, tegillate, bacula closely placed, almost joined with each other, forming a perfect reticulum, meshes bigger in mesocolpate region.

Comparison — *T. matanomadhensis* sp. nov. is comparable to *T. retibaculatus* sp. nov. in shape and size but the former is characterized by its duplibaculate reticulum. *T. grandis* Sah (1967) has smaller colpi.

Genus — *Verrutricolpites* Pierce, 1961

Type Species — *Verrutricolpites sphaeroides* Pierce, 1961.

Verrutricolpites perverrucatus Ramanujam, 1966

Subturma — *Polyptyches* (Naumova) Potonié, 1960

Infraturma — *Stephanocolpati* (van der Hammen) Potonié, 1970

Remarks — *Stephanocolpites* was proposed by van der Hammen (1954) to accommodate "pollen grains provided with more than 3 meridional colpes" (van der Hammen, 1956, pp. 94-95). Potonié (1970, p. 110) considered it as of infraturma status and referred it as infraturma *Stephanocolpati*.

Genus — *Psilastephanocolpites* Leidelmeyer, 1966

Type Species — *Psilastephanocolpites maia* Leidelmeyer, 1966.

Psilastephanocolpites guaduensis (van der Hammen) comb. nov.

Pl. 2, fig. 30

1954 *Stephanocolpites guaduensis* B van der Hammen, pl. 7, fig. 7.

Holotype — van der Hammen, 1954, pl. 7, fig. 7.

Diagnosis — See van der Hammen, 1954, p. 92.

Remarks — *Stephanocolpites guaduensis* B van der Hammen (1954) is a 4-colpate, laevigate pollen grain and thus agrees with *Psilastephanocolpites* Leidelmeyer (1966). *Stephanocolpites* has already been raised to infraturma status by Potonié (1970, p. 110).

Genus — *Ghoshicolpites* Sah & Kar, 1970

Type Species — *Ghoshicolpites globatus* Sah & Kar, 1970.

Ghoshicolpites globatus Sah & Kar, 1970

Pl. 2, fig. 31

Genus — *Retistephanocolpites* Leidelmeyer, 1966

Type Species — *Retistephanocolpites angeli* Leidelmeyer, 1966.

Retistephanocolpites flavatus (Sah & Kar) comb. nov.

Pl. 2, fig. 32

1970 *Polycolpites flavatus* Sah & Kar, pl. 2, figs 42, 47.

Holotype — Sah and Kar, 1970, pl. 2, fig. 47.

Diagnosis — See Sah and Kar, 1970, p. 137.

Remarks — *Polycolpites flavatus* Sah & Kar (1970) is a 9-10-colpate, scrobiculate pollen. Since *Polycolpites* Couper (1953) has clavate-baculate exine, *Polycolpites flavatus* has been transferred to *Retistephanocolpites* Leidelmeyer (1966).

Retistephanocolpites kutchensis sp. nov.

Pl. 2, figs 33, 34

Holotype — Pl. 2, fig. 33, size 33 μ . Slide no. 4772/2.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains pentagonal-subcircular in polar view, 22-34 μ . Pentacolpate, colpi long, mesocolpia broad.

Exine 1.5-3.5 μ thick, foveo-reticulate, muri very thin.

Comparison — The present species is closely comparable to *Retistephanocolpites angeli* Leidekmeyer (1966) in having 5 colpi but the latter is distinguished by its brevicolpate condition. In *R. flavatus* (Sah & Kar) comb. nov. the colpi are more (9-10) than those in the present species.

Genus — *Granustephanocolpites* gen. nov.

Type Species — *Granustephanocolpites granulatus* (Venkatachala & Kar) comb. nov.

Generic Diagnosis — Pollen grains circular-subcircular in polar view. Polycolpate, colpi meridional. Exine granulose.

Comparison — *Granustephanocolpites* gen. nov. differs from other polycolpate genera in having a granulose exine. None of the existing polycolpate genera has granulose exine.

Granustephanocolpites sahilii sp. nov.

Pl. 2, fig. 35

1970 *Polycolpites granulatus* Sah & Kar, pl. 2, fig. 41.

Holotype — Sah and Kar, 1970, pl. 2, fig. 41.

Diagnosis — See Sah and Kar, 1970, p. 137.

Remarks — Sah and Kar (1970) instituted *Polycolpites granulatus* to include septa-colpate pollen grains having granulose exine. This species, however, does not fit into *Polycolpites*, because the latter is clavate-baculate. *Polycolpites granulatus* Sah & Kar (1970) should therefore be shifted to *Granustephanocolpites* gen. nov. Earlier, Venkatachala and Kar (1969) proposed *Stephanocolpites granulatus* for 4-colpate, granulose grains. This species has also been shifted to *Granustephanocolpites*. Consequently, latter species will become a junior homonym of the former. *Polycolpites granulatus* Sah & Kar (1970) is therefore described here as *Granustephanocolpites sahilii* sp. nov.

Subturma — *Ptychotriporines* (Naumova) Potonié, 1960

Infraturma — *Prolati* Erdtman, 1943

Genus — *Platoniapollenites* Sah & Kar, 1974

Type Species — *Platoniapollenites iratus* Sah & Kar, 1974.

Platoniapollenites sp.

Pl. 2, fig. 36

Description — Pollen grain subtriangular in polar view, 36 μ . Tricolpate, colpi long, distinct. Exine 2 μ thick, laevigate, uneven, very thin along apertural margin.

Comparison — *Platoniapollenites iratus* Sah & Kar (1974) differs from the present specimen in having 4 colpi and being bigger in size.

Genus — *Lakiapollis* Venkatachala & Kar, 1969

Type Species — *Lakiapollis ovatus* Venkatachala & Kar, 1969.

Lakiapollis ovatus Venkatachala & Kar, 1969

Pl. 2, fig. 37

Remarks — The pollen grains of *Lakiapollis ovatus* described by Venkatachala and Kar (1969) have a size range of 40-50 μ while pollen grains in the present preparation range up to 75 μ .

Lakiapollis matanamadhensis Venkatachala & Kar, 1969

Pl. 3, figs 38, 39

Remarks — Pollen grains assignable to this species exhibit a wide range of variation. The pollen grains described by Venkatachala and Kar (1969) have a size range of 28-40 μ while in present material, pollen grains measure up to 78 μ . The size range of this species may therefore be extended. Some difference in the ornamentation pattern has also been noticed. Few specimens (Pl. 3, fig. 38) have very fine scrobiculate pattern while others (Pl. 3, fig. 39) have a comparatively coarser texture.

Lakiapollis spinosus sp. nov.

Pl. 3, figs 40, 40a

Holotype — Pl. 3, figs 40, 40a, size 38 μ . Slide no. 4769/14.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains subcircular in polar view, 36-48 μ . Tricolporate, colpi

small, pore margin thickened. Exine up to $3\ \mu$ thick, retibaculate, tegillate and sparsely spinose.

Comparison — *Lakiapollis ovatus* and *L. matanamadhensis* both described by Venkatachala and Kar (1969) resemble the present species in subcircular shape and size range but the latter can easily be distinguished by its spinose sculptural elements.

Genus — *Paleosantalaceae*pites (Biswas) Dutta & Sah, 1970

Type Species — *Paleosantalaceae*pites *dinoflagellatus* (Biswas) Dutta & Sah, 1970.

*Paleosantalaceae*pites *ellipticus* Sah & Kar, 1970

Pl. 3, fig. 41

Remarks — Although otherwise similar, the present specimens are smaller in size ($28\text{--}48 \times 16\text{--}38\ \mu$) and possess thinner exine than those described by Sah and Kar (1970) which have a size range of $45\text{--}55 \times 25\text{--}40\ \mu$.

*Paleosantalaceae*pites *minutus* Sah & Kar, 1970

Pl. 3, fig. 42

Genus — *Verrucolporites* Sah & Kar, 1970

Type Species — *Verrucolporites verrucus* Sah & Kar, 1970.

Verrucolporites verrucus Sah & Kar, 1970

Pl. 3, fig. 43

Remarks — Pollen grains are generally found in equatorial view. The size of verrucae in the present material is smaller ($2\text{--}6\ \mu$) than that ($4\text{--}8\ \mu$) found in the specimens described by Sah and Kar (1970).

Genus — *Striacolporites* Sah & Kar, 1970

Type Species — *Striacolporites striatus* Sah & Kar, 1970.

Striacolporites cephalus Sah & Kar, 1970

Pl. 3, fig. 44

Striacolporites ovatus Sah & Kar, 1970

Pl. 3, fig. 45

Genus — *Favitricolporites* Sah, 1967

Type Species — *Favitricolporites, eminens* Sah, 1967.

Favitricolporites retiformis Sah, 1967

Infraturma — *Oblati* Erdtman, 1943

Genus — *Palaeocoprosmadites* Ramanujam, 1966

Type Species — *Palaeocoprosmadites arcotense* Ramanujam, 1966.

Palaeocoprosmadites arcotense Ramanujam, 1966

Pl. 3, fig. 46

Subturma — *Ptychopolyporines* (Naumova) Potonić, 1960

Genus — *Meliapollis* Sah & Kar, 1970

Type Species — *Meliapollis ramanujamii* Sah & Kar, 1970.

Meliapollis ramanujamii Sah & Kar, 1970

Pl. 3, fig. 47

Remarks — Sah and Kar (1970), while instituting this species, gave its size range as $48\text{--}55\ \mu$, but in the present assemblage, pollen grains having size range of $40\text{--}78\ \mu$ are also found. Therefore, the size range for the species is extended accordingly. Besides, some of the pollen grains are also \pm quadrangular in shape.

Meliapollis navalei Sah & Kar, 1970

Meliapollis quadrangularis (Ramanujam) Sah & Kar, 1970

Pl. 3, fig. 48

Meliapollis melioides (Ramanujam) Sah & Kar, 1970

Pl. 3, fig. 49

Meliapollis triangulus sp. nov.

Pl. 3, figs 50, 51

Holotype — Pl. 3, fig. 50, size $58\ \mu$. Slide no. 4767/15.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains triangular-subtriangular in polar view, 40-60 μ . Tricolporate, brevicolpate, pores distinct, pore margin thickened. Exine up to 4 μ thick, laevigate to finely intrastriated.

Comparison — The present species is closely comparable to *Meliapollis raoi* Sah & Kar (1970) in size and apertural characters but differs in having a triangular shape. Other species of *Meliapollis* differ in being tetra- or pentacolporate.

cf. *Meliapollis* sp.

Pl. 3, fig. 52

Description — Pollen grain subcircular, 64 \times 58 μ . Nine colporate, pores distinct, margin thickened. Exine about 2 μ thick, \pm laevigate.

Remarks — The present pollen approximates *Meliapollis* Sah & Kar (1970) in shape, size and nature of the apertures but differs from all the known species of this genus in having 9 colpi. Since only a single specimen of this kind has been found, so it has tentatively been described under the genus *Meliapollis*.

Turma — *Porosus* (Naumova) Potonié, 1960

Subturma — *Triporines* (Naumova) Potonié, 1960

Infraturma — *Zoniporiti* Ramanujam, 1966

Genus — *Triorites* (Erdtman) Couper, 1953

Type Species — *Triorites magnificus* Cookson, 1950.

Triorites bellus Sah & Kar, 1970

Pl. 3, fig. 53

Remarks — The original diagnosis of the species prescribed the size range as 60-75 μ . In the present assemblage, pollen as small as 40 μ have also been recorded.

Triorites triradiatus sp. nov.

Pl. 3, fig. 54

Holotype — Pl. 3, fig. 54, size 55 μ . Slide no. 4959/1.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Pollen grains triangular in polar view with pronounced protuberances, 48-57 μ . Triorate, ora distinct. Exine 2-3 μ thick, sexine thinner than nexine, finely scrobiculate to granulose.

Comparison — *Triorites bellus* Sah & Kar (1970) is comparable to the present species in general organization of the pollen and its sculptural pattern. The latter can, however, be distinguished by its pronounced oral protuberances. *T. hirsutus* Sah & Kar (1974) is pilate-baculate and hence is easily separable from the present one.

Genus — *Proteacidites* Cookson, 1950

Type Species — *Proteacidites adenanthoides* Cookson, 1950.

Proteacidites protrudus Sah & Kar, 1970

Pl. 3, fig. 55

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

Type Species — *Triporopollenites coryloides* (Pflug) Thomson & Pflug, 1953.

Triporopollenites minutiformis (Ramanujam) comb. nov.

Pl. 3, fig. 56

1966 *Engelhardtoidites minutiformis* Ramanujam, pl. 5, fig. 94.

Holotype — Ramanujam, 1966, pl. 5, fig. 94.

Diagnosis — See Ramanujam, 1966, p. 183.

Remarks — In the diagnosis of *Engelhardtoidites minutiformis*, Ramanujam (1966) remarked that the pollen grains have distinctly thickened pore margins (annulus). Potonié (1960) clearly mentions that *Engelhardtoidites* does not have thickened apertural margins. *Triporopollenites*, on the other hand, has distinct thickening around the pore margin. Hence, *Engelhardtoidites minutiformis* Ramanujam (1966), in fact, comes within the circumscription of the

genus *Triporopollenites* and therefore, Ramanujam's species is transferred to this genus.

Infraturma — *Trilatiporiti* Ramanujam, 1966

Genus — *Trilatiporites* Ramanujam, 1966

Type Species — *Trilatiporites erdtmani* Ramanujam, 1966.

Trilatiporites cooksoni Ramanujam, 1966

Trilatiporites kutchensis Venkatachala & Kar, 1969

Pl. 3, fig. 57

Genus — *Sonneratioipollis* Venkatachala & Kar, 1969

Type Species — *Sonneratioipollis bellus* Venkatachala & Kar, 1969.

Sonneratioipollis bellus Venkatachala & Kar, 1969

Pl. 3, fig. 58

Subturma — *Polyporines* (Naumova) Potonié, 1960

Infraturma — *Stephanoporiti* (van der Hammen) Potonié, 1960

Genus — *Pseudonothofagidites* Venkatachala & Kar, 1969

Type Species — *Pseudonothofagidites kutchensis* Venkatachala & Kar, 1969.

Pseudonothofagidites kutchensis Venkatachala & Kar, 1969

Pl. 3, fig. 59

Turma — *Jugates* Potonié, 1960

Subturma — *Tetradites* Cookson, 1947

Genus — *Kielmeyerapollenites* Sah & Kar, 1974

Type Species — *Kielmeyerapollenites eocenicus* Sah & Kar, 1974.

Kielmeyerapollenites eocenicus Sah & Kar, 1974

Pl. 3, fig. 60

INCERTAE SEDIS

POLLEN TYPE-1

Pl. 3, fig. 61

Description — Pollen grains oval, 92-110 × 58-88 μ. Inaperturate. Exine up to 2.5 μ thick, spinose, spines hair-like up to 6 μ long.

POLLEN TYPE-2

Pl. 3, fig. 62

Description — Pollen elliptical in equatorial view, 58 × 38 μ. Tricolpate, colpi long, narrow, extending almost one end to other. Exine about 3 μ thick, nexine scrobiculate, thicker than sexine. A few spines are also observed on outer surface.

SPONGE SPICULES

Pl. 3, fig. 63

Description — Spicules monoaxon, 25-115 μ long, generally isolated, but sometimes found in flower-shaped clusters. The specimens while treated with hydrochloric acid are dissolved. Their calcareous nature shows that they belong to class Calcaria.

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EXPLANATION OF PLATES

(All photomicrographs are enlarged ca. $\times 500$)

PLATE 1

1. *Podocarpidites ellipticus* Cookson; Slide no. 4935/18.
2. *Laricoidites punctatus* sp. nov.; Slide no. 4936/21 (Holotype).
3. *Laricoidites* sp., Slide no.; 4954/3.
4. *Araucariacites australis* Cookson; Slide no. 4781/7.
5. *Retipilonapites cenozoicus* Sah; Slide no. 4780/9.
6. *Couperipollis wodehousei* (Biswas) Venkatachala & Kar; Slide no. 4767/30.
7. *Couperipollis brevispinosus* (Biswas) Venkatachala & Kar; Slide no. 4796/7.
8. *Couperipollis robustus* sp. nov.; Slide no. 4766/3 (Holotype).
- 9,10. *Liliacidites maximus* sp. nov.; Slide nos. 4955/5 (Holotype), 4800/9.

PLATE 2

11. *Liliacidites kutchensis* sp. nov.; Slide no. 4956/1 (Holotype).
12. *Liliacidites matanomadhensis* sp. nov.; Slide no. 4774/3 (Holotype).
13. *Liliacidites* cf. *L. maximus* sp. nov.; Slide no. 4773/13.
14. *Palmidites maximus* Couper; Slide no. 4796/10.
15. *Palmaepollenites kutchensis* Venkatachala & Kar; Slide no. 4957/2.
- 16,17. *Palmaepollenites nadhamunii* Venkatachala & Kar; Slide nos. 4958/7, 4940/19.
18. *Palmaepollenites plicatus* Sah & Kar; Slide no. 4792/3.
19. *Dracaenopollis circularis* Sah & Kar; Slide no. 4959/6.

20. *Proxapertites microreticulatus* Jain, Kar & Sah; Slide no. 4780/7.
 21. *Proxapertites assamicus* (Sah & Dutta) Singh; Slide no. 4938/22.
 22. *Tricolpites reticulatus* Cookson; Slide no. 4767/12.
 23. *Tricolpites crassireticulatus* Dutta & Sah; Slide no. 4960/26.
 24. *Tricolpites brevis* Sah & Kar; Slide no. 4788/7.
 25. *Tricolpites minutus* Sah & Kar; Slide no. 4938/10.
 26. *Tricolpites baculatus* Jain, Kar & Sah; Slide no. 4792/11.
 27, 28. *Tricolpites retibaculatus* sp. nov.; Slide nos. 4774/4 (Holotype), 4961/28.
 29. *Tricolpites matanomadhensis* sp. nov.; Slide no. 4953/33 (Holotype).
 30. *Psilastephanocolpites guaduensis* (van der Hammen) comb. nov.; Slide no. 4957/14.
 31. *Ghoshicolpites globatus* Sah & Kar; Slide no. 4794/20.
 32. *Retistephanocolpites flavatus* (Sah & Kar) comb. nov.; Slide no. 4775/3.
 33,34. *Retistephanocolpites kutchensis* sp. nov.; Slide nos. 4772/2 (Holotype), 4766/18.
 35. *Granustephanocolpites sahhii* sp. nov.; Slide no. 4779/8.
 36. *Platoniapollenites* sp.; Slide no. 4962/1.
 37. *Lakiapollis ovatus* Venkatachala & Kar; Slide no. 4767/2.
41. *Paleosantalaceaepites ellipticus* Sah & Kar; Slide no. 4964/4.
 42. *Paleosantalaceaepites minutus* Sah & Kar; Slide no. 4965/4.
 43. *Verrucolporites verrucus* Sah & Kar; Slide no. 4966/1.
 44. *Striacolporites cephalus* Sah & Kar; Slide no. 4967/10.
 45. *Striacolporites ovatus* Sah & Kar; Slide no. 4968/8.
 46. *Palaeocoprosmadites arcotense* Ramanujam; Slide no. 4788/9.
 47. *Meliapollis ramanujamii* Sah & Kar; Slide no. 4771/2.
 48. *Meliapollis quadrangularis* (Ramanujam) Sah & Kar; Slide no. 4969/8.
 49. *Meliapollis melioides* (Ramanujam) Sah & Kar; Slide no. 4970/2.
 50,51. *Meliapollis triangulus* sp. nov.; Slide nos. 4767/15 (Holotype), 4938/7.
 52. cf. *Meliapollis* sp., Slide no. 4769/22.
 53. *Triorites bellus* Sah & Kar; Slide no. 4780/10.
 54. *Triorites triradiatus* sp. nov.; Slide no. 4959/1 (Holotype).
 55. *Proteacidites protrudus* Sah & Kar; Slide no. 4791/7.
 56. *Tripoporollenites minutiformis* (Ramanujam) comb. nov.; Slide no. 4971/7.
 57. *Trilatiporites kutchensis* Venkatachala & Kar; Slide no. 4780/5.
 58. *Sonneratioipollis bellus* Venkatachala & Kar; Slide no. 4791/1.
 59. *Pseudonothofagidites kutchensis* Venkatachala & Kar; Slide no. 4962/11.
 60. *Kielmeyerapollenites eocenicus* Sah & Kar; Slide no. 4950/12.
 61. Pollen type 1; Slide no. 4972/1.
 62. Pollen type 2; Slide no. 4772/1.
 63. Sponge spicule; Slide no. 4973/1.

PLATE 3

- 38,39. *Lakiapollis matanomadhensis* Venkatachala & Kar; Slide nos. 4775/3, 4963/5.
 40. *Lakiapollis spinosus* sp. nov.; Slide no. 4769/14 (Holotype). 40a. $\times 1000$ of the holotype to show spinose ornamentation.

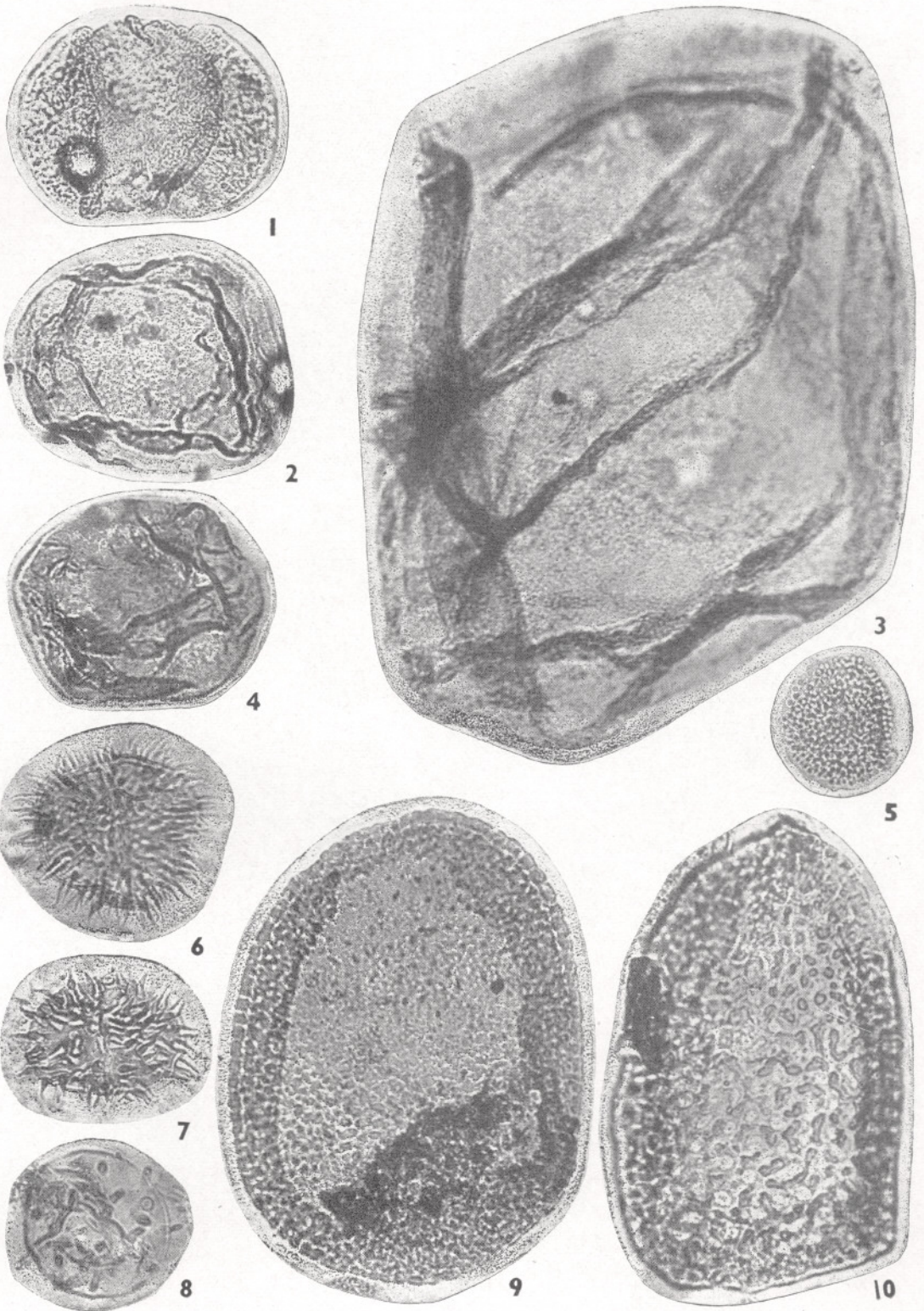


PLATE 1

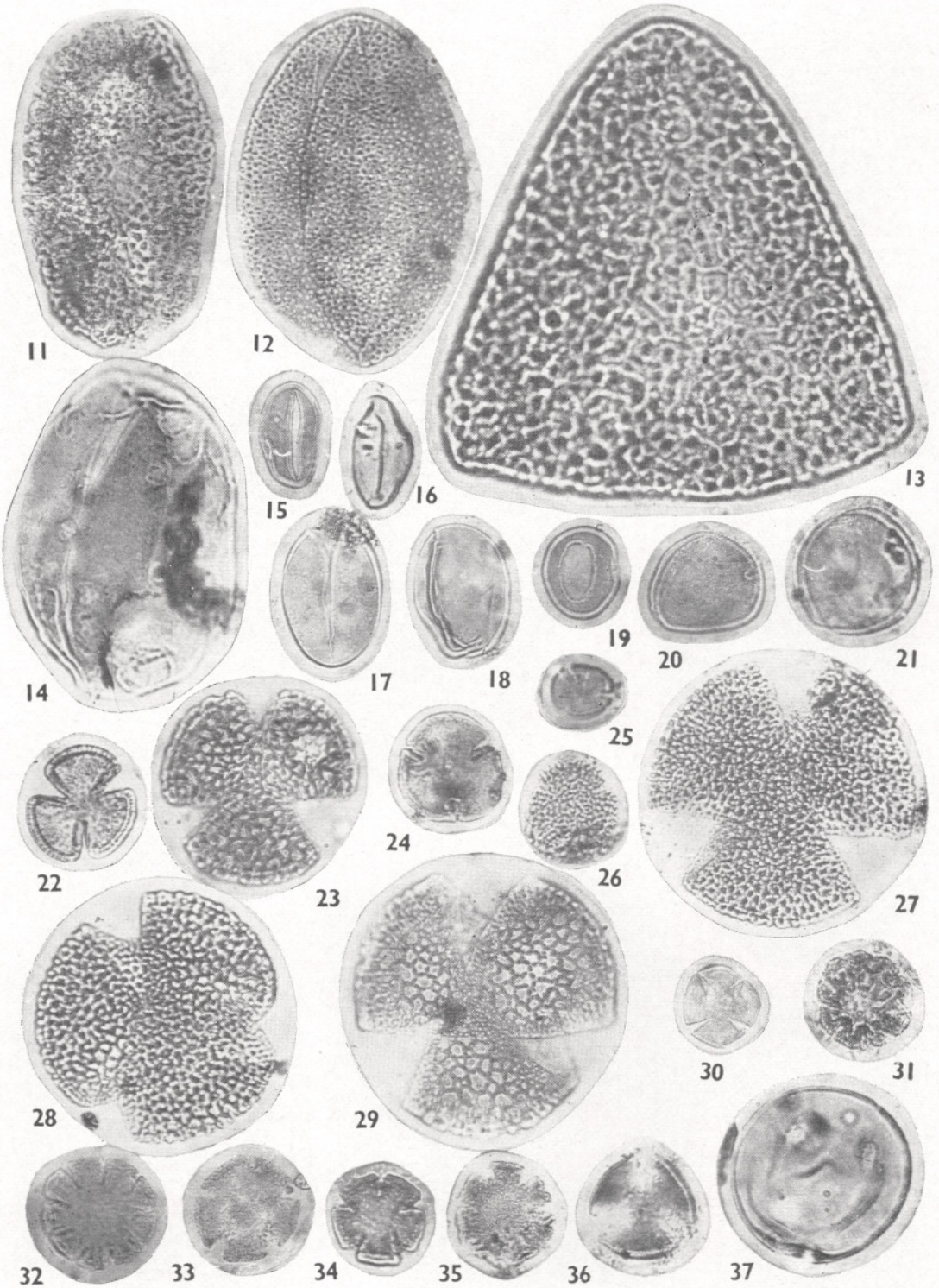


PLATE 2

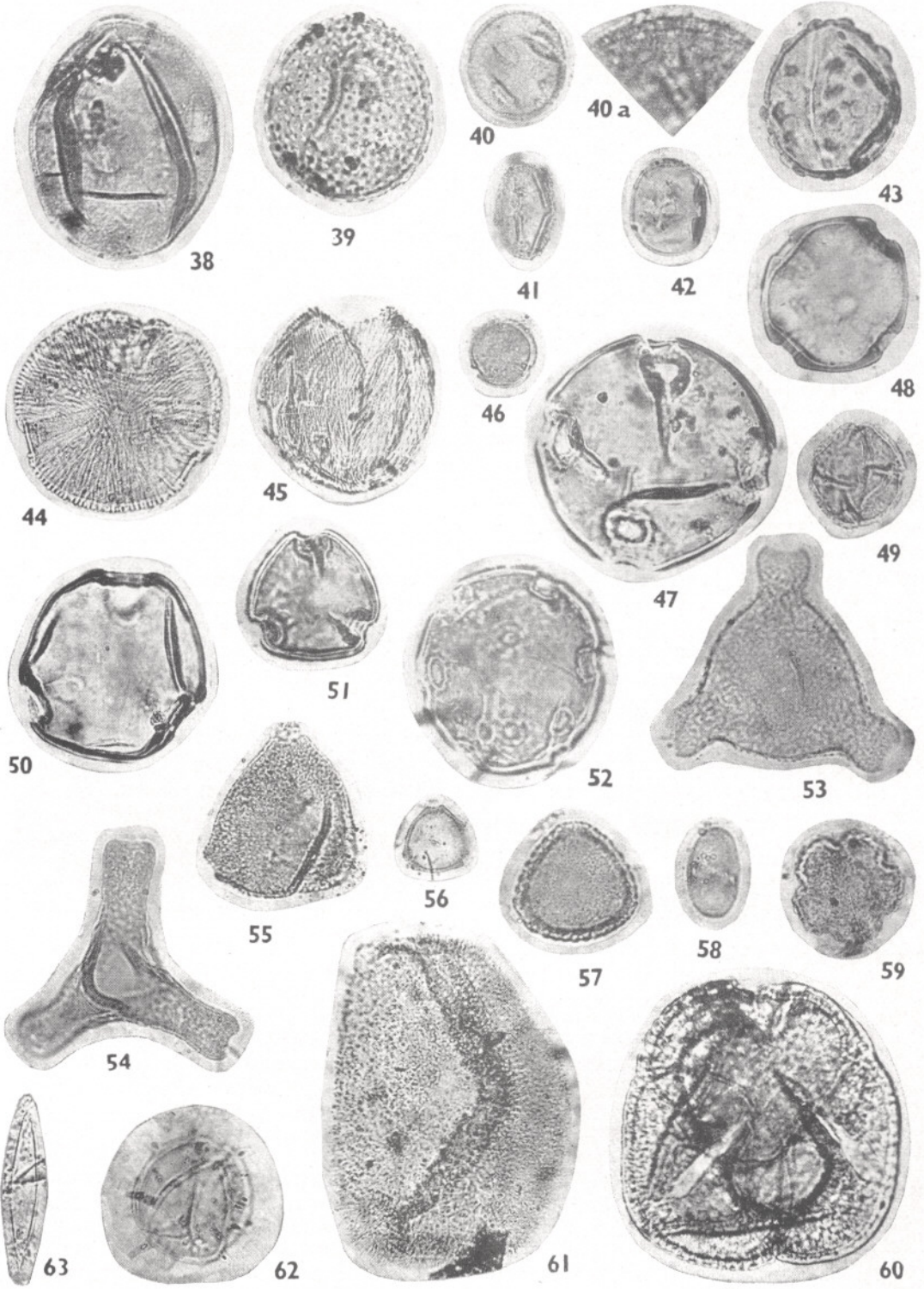


PLATE 3