SOME NEW POLLEN GRAINS FROM NEYVELI LIGNITE, TAMIL NADU, INDIA

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ABSTRACT

The palynoforms described here belong to 11 genera and 21 species of fossil angiospermic pollen grains from the Neyveli lignite assemblage. Out of the 11 genera and 21 species, 4 genera and 16 species are new.

The 11 genera recorded are referable to following families—Cruciferae, Plumbaginaceae, Icacinaceae, Ctenolophonaceae, Alangiaceae, Meliaceae, Leguminosae (Papilionatae), Droseraceae, Malvaceae and Thymeliaceae. The record of pollen grains referable to Ctenolophonaceae and Alangiaceae is noteworthy because *Ctenolophon* like pollen have not been recorded so far from East Coast of South India and pollen referable to *Alangium* happens to be the first record in India.

INTRODUCTION

Mioflora of the Neyveli lignite remained practically unknown until the detailed investigation by RAMANUJAM (1966). Lately, however some new forms have been reported here and there and the age of the fuel deposit has also been discussed. Yet, palynological information is still not fully known as more and more forms are being described. The present study enumerates some new pollen taxa and additional information on the already known forms.

The Neyveli deposit is believed to be of Upper Miocene or Pliocene age [KRISHNAN (1968), LAKHANPAL (1970), RAMANUJAM (1966), NAVALE (1973)]. However, recently VENKATACHALA (1973) infers from palynological studies of Cauvery basin that the lower age limit of the lignite may extend to Eocene.

Anteturma	POLLENITES Potonié, 1960
Turma	PLICATES (Naumova) Potonié, 1960
Subturma	TRIPTYCHES (Naumova) Potonié, 1969.

Genus—**Cruciferoipollenites** gen. nov.

Type Species—Cruciferoipollenites elongatus gen. et sp. nov.

Generic Diagnosis—Pollen grain isopolar, prolate, size range 47—120×33—110 μm. Tricolpate to tricolporoidate, colpi long, generally uneven, distinct and extending almost up to the poles. Exine 3-4 μm thick, sexine thicker than nexine. Surface tegillate, granulate to microreticulate, grana comparatively denser at the poles.

Comparison—The present form differs from like genus *Aceripollenites* (NAGY, 1969) described from Mecsek Mountains, Hungary in the nature of colpi and exine structure. It shows close similarities with the cruciferous pollen—*Lepidium oahuense* described by SELLING (1947, Pl. 4, Figs. 71-72).

Cruciferoipollenites elongatus sp. nov.

Pl. 1, Figs. 1-3

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Holotype—Pl. 1, Fig. 1. Size 51×37 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Isopolar pollen grain, prolate, mostly seen in equatorial compression while in polar compression they are seldom intact. Size range 47—56×33—54 μm. Tricolpate to tricolporoidate, colpi quite long, margins generally uneven, distinct, extending up to the pole, mesocolpi convex towards periphery. Exine 3.5-4 μm thick, thinning gradually towards colpi, sexine nearly double the thickness of nexine, tegillate, surface structure finely microreticulate, lumina of varying shapes.

Comparison—*Cruciferoipollenites elongatus* differs from *Aceripollenites elongatus* (NAGY, 1969) in the nature of colpi and quite thick exine. From *Retitrescolpites oblongus* (SAH, 1967), it is distinguished by smaller size range and comparatively finer surface structure. *Tricolpites congoensis* and *T. triangulatus* (SAH, 1967) resemble the present species in few characters but they have smaller size range and are distinctly brevicolpate. *T. lucidus* (SAH, 1967) differs from *Cruciferoipollenites elongatus* in possessing smaller size range, comparatively shallower colpi and circular lumina of the surface reticulation.

Genus—**Plumbaginacipites** gen. nov.

Type Species—*Plumbaginacipites neyvelii* gen. et sp. nov.

Generic Diagnosis—Pollen grain isopolar, oblate, suboblate to spheroidal. Size ranges from 60—95×60—70 μm. Tricolpate, colpi simple, long and deep, do not reach the poles, mesocolpi rounded. Exine always thick (5-7 μm), sexine thicker than nexine, sexine with distinct rod layer, rods are long, papillate to clavate showing a granular to microreticulate surface pattern.

Comparison—This form does not resemble with the grains of *Retitrescolpites* recorded by SAH (1967) from Rusizi Valley, Africa in having a characteristic thick exine and finer surface pattern. It compares very closely with the extant pollen of Plumbaginaceae (*Plumbaginae zeylanica*, Pl. 32, Figs. 500-502) described by SELLING (1947).

Plumbaginacipites neyvelii sp. nov.

Pl. 1, Figs. 4-6

Holotype—Pl. 1, Fig. 4, Size 67×61 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Isopolar pollen, oblate to spheroidal, 60—95×60—70 μm in size. Tricolpate, colpi longicolpate, deep but do not reach the poles, mesocolpi are rounded at the periphery. Exine 5-7 μm thick, sexine thicker (2-3 times) than nexine, gradually thinning towards the colpi margins. Distinct rod layer is present in the sexine, rods are long, papillate to clavate forming a granulate to finely micro-reticulate surface structure.

Comparison—The present species shows some gross morphological features (size and nature of colpi) in common with few species of *Retitrescolpites* (SAH, 1967) but the former is distinguishable from the latter by its gradually thinning tendency of exine towards colpi margins and relatively finer surface ornamentation. It shows close morphological similarities with the extant pollen of *Plumbaginae zeylanica* (Plumbaginaceae) described by SELLING (1947).

Genus—**Icacinoipollenites** gen. nov.

Type Species—*Icacinoipollenites spinulatus* gen. et sp. nov.

Generic Diagnosis—Pollen grain isopolar, subprolate to oblate, size range 41—68×30—56 μm. Tricolpate, brevicolpate, colpi slit-like, surrounded by lip-like thickening. Exine 2.5—5.5 μm thick, crassisexinous, tegillate, spinulate, spinules very small (1 μm). Surface microgranulate.

Comparison—This genus does not compare with any other known fossil pollen genera by virtue of its lipped brevicolpate nature, sexinal character and spinulate ornamentation. It shows close resemblance with the pollen of *Desmostachys preussii* of family Icacinaceae (ERDTMAN, 1952, Fig. 126 D) excepting that the latter is tetracolpate.

Icacinacipollenites spinulatus sp. nov.

Pl. 1, Figs. 7-9

Holotype—Pl. 1, Fig. 8. Size 47×44 μm

Type Locality—Neyveli Lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Isopolar pollen grain, subprolate to oblate (in equatorial view) 41—68×38—56 μm in size. Tricolpate, brevicolpate, slit-like colpi surrounded by lip-like thickening about 2.5—3 μm thick. Exine 3.5—4.5 μm thick, crassisexinous, sexine nearly 3—4 times thicker than nexine, tegillate, spinulate, spinules very small (1 μm long) but their bases are distinctly seen in the surface view, surface microgranulate.

Comparison—This species is distinguished from various species of *Droseracidites* (COOKSON, 1947) in having slit-like, lipped brevicolpi, crassisexinous exine and spinulate ornamentation. It does not compare with any other fossil pollen genera. It resembles very closely with the extant pollen of *Desmostachys preussii* of family Icacinaceae described by ERDTMAN (1952, Fig. 126 D) but the latter is a tetracolpate form. Many living genera (plants) of this family have been described from the Malabar Coast of South India (GABMLE, 1957).

Subturma—POLYPTCHES (Naumova) Potonié, 1960

Genus—**Ctenolophonidites** Van Hoeken Klinkenberg, 1966

Type Species—Ctenolophonidites costatus Van Hoeken Klinkenberg, 1966

Ctenolophonidites stellatus sp. nov.

Pl. 1, Figs. 10-12

Holotype—Pl. 1, Fig. 11 Size 53×53 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Pollen grain isopolar, spherical (in polar view), oblate to suboblate (equatorial view), radially symmetrical; 42—57 μm polar diameter. 9 colpate, colpi 10—15 μm deep, funnel shaped with distinct incrassate margins and ring-like endexinous thickening around apocolpium of each pole, interconnected with a radial costae 2.5—4.5 μm thick, going into each mesocolpium. Additional irregular thickenings are also present inside each apocolpial ring. Polar area inside apocolpial ring smooth or minutely punctate.

Comparison—It resembles very closely with 6-8 colpate form of *Ctenolophonidites costatus* but differs in having 9 distinct colpi while other forms *C. erdtmanii* and *C. saadii* (RAMANUJAM AND RAO, 1973) are 5-7 colpate having two radial costae in each mesocolpium. RAMANUJAM AND RAO (*loc. cit.*) discussed briefly the previous data of *Ctenolophon* like pollen and recorded the occurrence of four species of this genus from Warkalli beds of Kerala on West Coast. Our report of *Ctenolophonidites* pollen from Neyveli lignite is the first record of this genus from East Coast of South India.

Remarks—According to GERMERAAD, MULLER AND HOPPING (1968) *Ctenolophon* originated during Upper Cretaceous times, probably, in Africa and there it soon differentiated into two pollen types, *engleri* and *parvifolius*. RAMANUJAM AND RAO (1973) opines that sometime during Miocene epoch it migrated eastwards to Western Coast (Warkalli deposits) of South India. He inferred from then available records of *Ctenolophonidites* that the genus existed for a short time only along West Coast of South India during Upper Miocene and became extinct.

Fossil records of *Ctenolophonidites* are from Palaeocene of Caribbean Islands, Palaeocene of Columbia (South America), Senonian (Upper Cretaceous) of Nigeria (West Africa) and Neogene of India and Borneo. While extant records of this genus are from West Africa, Malaysian archipelago and Philippine Islands in South East Asia.

Recognition of *C. costatus*, *C. erdtmanii* and *C. stellatus* in the present assemblage of the Neyveli lignite deposits extends the earlier palaeogeographical distribution of *Ctenolophonidites* (RAMANUJAM & RAO, 1973) towards East Coast and establishes that the genus not only existed in the West Coast but also in the East Coast of South India during that period. It may be inferred from this finding that genus *Ctenolophonidites* might have migrated eastwards from Africa to Indonesian archipelago via West and East coasts of South India.

Subturma PTYCHOTRIPORITES (Naumova) Potonié, 1960
Infraturma PROLATI Erdtman, 1943

Genus—**Dakshinipollenites** gen. nov.

Type Species—Dakshinipollenites tripakshi gen. et sp. nov.

Generic Diagnosis—Pollen grain isopolar, triangular to subtriangular (in polar view), subprolate to suboblate (equatorial view) ; 48—70×48—66 μm in size. Tricolporate, angulaperturate, colpi long, narrow and deep, apocolpi small. Ora faint to indistinct, lalongate, slit-like. Exine thin (1.5 μm) in the middle part of the mesocolpi where it is projected out like a hump (Pl. 1, Fig. 13), graudally thickens laterally, being thickest (3-4.5 μm) on the colpi margins. Surface microgranulate to granulate, granulation more prominent towards colpi margins.

Comparison—The present genus resembles with *Araliaceoipollenites* (RAMANUJAM, 1966—only equatorial view was described) and *Palaeoaraliaceaepites* (BISWAS, 1962) in some characters but differs in the nature of indistinct pore, typical exinal thickening towards colpi margin and surface structure.

Dakshinipollenites tripakshi sp. nov.

Pl. 1, Figs. 13-16

Holotype—Pl. 1, Fig. 13, Size 55-54 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu

Diagnosis—Isopolar pollen grain, subprolate to suboblate in equatorial view, triangular to subtriangular in polar view. Size range 48—70×48—66 μm. Tricolpate, angulaperturate, longicolpate, colpi deep and narrow, extending quite upto the poles, apocolpium small. Pore obscure, lalongate, like a slit. Exine thin (1.5-2 μm) in the middle part of the mesocolpi (clearly visible in the polar view) projecting outwards like a hump, gradually thickening laterally, being thickest (3-4.5 μm) at the colpi margins. Microgranulate to granulate, granulation becoming more prominent towards colpi margins.

Comparison—The present species differs from *Araliaceoipollenites potoniei* (RAMANUJAM, 1966) in having a bigger size range, indistinct pore, typical nature of exinal thickening and surface structure. From *Palaeoaraliaceaepites indica* (BISWAS, 1962) also this species is distinguished by the same morphological characters.

Genus—**Alangiopollis** Krutzsch, 1962

Type Species—Alangiopollis barghoornianum Krutzsch, 1962

Alangiopollis gemmatus sp. nov.

Pl. 1, Figs. 17 & 17a

Holotype—Pl. 1, Fig. 17, Size 63×60 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Pollen grain isopolar, subtriangular, size 63×60 μm. Tricolporate, angulaperturate, colpi short (?) faintly visible, pore simple distinct, pore diameter 3-3.5 μm. Exine 3-4.7 μm (including surface ornamentation) thick. Surface provided with wart like projections—gemmae, gemmae of various sizes, 1.5-3 μm irregularly distributed, exine area between gemmae microgranulate.

Comparison—The present species differs from other species of *Alangiopollis* in having warty surface ornamentation and a very faint colpus. It closely resembles with the extant African species—*Alangium chinense* type C (Pl. 5, Figs. A-D described by REITSMA, 1970).

Alangiopollis arcotense sp. nov.

Pl. 1, Figs. 18-22

Holotype—Pl. 1, Fig. 18 Size 90×90 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Pollen grain isopolar, rounded triangular, subcircular to circular in polar view, 70—120×70—120 μm in size. Tri-to tetracolporate, colpi distinct, length varying from medium to short, 20—35 μm deep, bordered by thickened margo, colpi membrane psilate, ends acute to rounded. Pore distinct, lalongate, circular or rarely lolongate, pore margin thinned. Exine 2.5-5 μm thick, sexine thicker than or equal to nexine, surface tegillate, reticulate, retipilate, simplicolumellate, capita more or less rounded, columellae short and thin, lumina small of varying shapes, smaller near colpi margins.

Comparison—The present species though has similar reticulate ornamentation and pore character of various species of *Margocolporites* (RAMANUJAM, 1966) but lacks the typical "margocolporate" nature and has bigger size range than the latter. *Alangiopollis gemmatus* has smaller size range and a typical gemmate surface ornamentation. *A. barghoornianum* (KRUTZSCH, 1962) has a similar size range as *A. arcotense* but possesses slightly thicker exine and relatively coarser reticulate or striate pattern. *Alangiopollis simplex* (NAGY, 1969) differs from the present species in having finer striate surface ornamentation. It shows close resemblance with extant pollen species of *Alangium barbatum* type described by REITSMA (1970).

Remarks—Fossil pollen of *Alangium* (*Alangiopollis*) has been recorded, from the present assemblage, for the first time in India although fossil wood *Alangioxylon scariforme* has been described by AWASTHI (1968) in the Neogene deposits (Cuddalore Formation) of Tamil Nadu (South India). REITSMA (1970) critically reviewed the description of *Margocolporites* (RAMANUJAM, 1966) and concluded that "*Margocolporites complexum and Margocolporites dubius, do not show a "margocolporus" at all. In my opinion these grains are certainly*

not ralated to those of the Caesalpiniaceae". He considered that the two species of *Margocolporites—dubius* and *complexum* show relationship to *Alangium* section of *Marlea* and are closely comparable to extant pollen species of *Alangium chinense* type A and type B, respectively. Thus, the present assemblage includes four species of *Alangiopollis—A. gemmatus* (=*Alangium chinense* type C, restricted to Africa), *A. arcotense* (=*A. barbatum* type), *A.* (*Margocolporites*) *dubius* (RAMANUJAM, 1966) (=*A. chinense* type A, India and eastern Asia) and *A.* (*Margocolporites*) *complexum* (RAMANUJAM, 1966) (=*A. chinense* type B, restricted to India).

From the available data on the evolutionary trends and present day phytogeographical distribution of *Alangium*, REITSMA (1970) considers that among the four types of *A. chinense*, type A is the most primitive and it originated somewhere in India, migrated westwards to Africa via Lemurian land bridge or western Asia and eastwards via Asiatic main land. Presence of *Alangiopollis gemmatus* (*A. chinense* type C) indicates that either this type differentiated in India from the primitive stock, then migrated to Africa or differentiation took place in Africa and later migrated back to India.

Subturma PTYCHOPOLYPORINES (Naumova) Potonié, 1960

Genus—**Meliapollis** (Sah & Kar, 1970) emended

Types Species—Meliapollis ramanujamii Sah & Kar, 1970

Emended diagnosis—Pollen grain isopolar, triangular, quadrangular, pentagonal to subcircular in polar view while suboblate to subprolate in equatorial view, 36—140× 27—140 μm, tri-tetra-and pentacolporate but tetracolporate condition is most common. Longicolpate to brevicolpate, colpi tenuimarginate, generally faintly visible, pore mostly well defined, 5—18 μm in diameter, more or less circular, lalongate, rarely lolongate, surrounded by thickened rim. Mostly in case of grains with thin exine, colpi membrane dissolves rendering excessive deepening of colpi and pore untraceable. Such grains look like a cross. Exine thin to very thick (2—14 μm), sexine is generally thinner (1—2.5 μm, 2-4 times) than nexine, nexine is continuous throughout the pollen via thickening of the pore. In case of pollen with very thick nexine, the nexine makes 1-2 bulges inwards. This is probably to accommodate thickened nexinal part of the pores and mesocolpi. These bulges are mostly seen, clearly, in tetra- and pentacolporate grains. Surface laevigate, sometimes weakly intrastructured, at least in this assemblage most of the grains bear scars of biological degradation.

Comparison—Tetracolporites (COUPER, 1953) is comparable to the present genus but the former is distinguished by its more or less polygonal shape and situation of pores at constricted margins. *Quadripollenites* (STOVER, 1966) is a laevigate, tetracolporate form but has characteristically thickened colpi margins which *Meliapollis* does not possess. NAVALE (1961) and RAMANUJAM (1966) have also reported pollen grains belonging to the present genus from this locality.

Pollen of extant species of *Platonia insignis* of Guttiferae resembles the present genus in shape, size and 3-5 colporate nature but differs in possessing distinct equatorially elongated, unthickened pore and considerably thickened nexine in the mesocolpial and polar region. Tetracolporate pollen grains of *Citrus jambhiri* and *C. sinensis* (BAMZAI & RANDHAWA, 1965 ; ERDTMAN, 1952) of Rutaceeae and *Cyclanthera naudiniana* of Cucurbitaceae differ from *Meliapollis* by their typical ornamentational pattern. *Meliapollis* shows many morphological characters, viz., shape, size, thickened pore, tenuimarginate colpi, thicker nexine (or sexine=nexine) and laevigate exine, in common with pollen grains of Meliaceae, particularly with that of *Melia azadirachta*.

Remarks—It has been observed, in the present assemblage, that grains generally with thin exine are prone to dissolution of tenuimarginate colpi (Pl. 2, Figs. 30, 34, 37, 39, 41 & 42). This dissolution produces funnel-shaped 'pseudocolpi' (Pl. 2, Figs. 34, 37 & 42) in which pores, although previously present (traces visible), are not clearly seen (Pl. 2, Figs. 30, 37, 39 & 42) and exine on the sides of the pores are detached from them looking slightly thinned towards colpi margins (Pl. 2, Figs. 30 & 42). All these latter changes cause, apparently, slight increase in the thickness of exine in the mesocolpial region and in the depth of the colpi as well, due to which pollen appears like a cross. These later developed secondary characters are super-imposed on the original characters of the grain and thus influence the observation and interpretation.

SAH AND KAR (1974, pp. 171-172 ; Pl. 2, Figs. 57-59) instituted a genus *Platoniapollenites* as 3-4 colporate grains having "colpi conspicuous, funnel shaped reaching up to the polar region, colpi margin mostly dissolved, due to its thinness providing cross-like appearance. Pore generally indistinct and not traceable in polar view because colpi margin mostly dissolve, *while traceable, pore seems to be lalongate, margin sometimes appreciably thickened.... sexine generally thinner than nexine,* nexine more thickened in the mesocolpial region".

The genus *Platoniapollenites* appears to be based mainly on secondary characters while primary characters (parts italicized in the preceding paragraph) very well conform with the characters of *Meliapollis* (SAH & KAR, 1970). In our opinion while showing similarities of *Platoniapollenites* with extant pollen of *Platonia insignis* (ERDTMAN, 1952, p. 196; Fig. 116 D) of Guttiferae, the characteristic features, of the latter (equatorially elongated, unthickened pore and thickening of exine in the middle of the mesocolpial and polar regions) were not critically considered. In comparing *Meliapollis* with *Platoniapollenites* the authors (*loc. cit.*) differentiated the former with the latter on the basis of "its short colpi and uniformly thickened exine". These criteria of differentiation do not seem tenable because the genus *Platoniapollenites* shows many secondary characters and in none of the photographs (*loc. cit.*) exine shows the typical mesocolpial thickening. Hence, it is opined to maintain the genus *Meliapollis* and merge *Platoniapollenites* into the former.

Meliapollis (*Tetracolporites*) *quadratus* (Sah, 1967) comb. nov.
Meliapollis (*Platoniapollenites*) *kivuensis* (Sah & Kar, 1974) comb. nov.
Meliapollis (*Tetracolporites*) *levis* (Sah, 1967) comb. nov.
Meliapollis (*Tetracolporites*) *rotundoides* (Sah, 1967) comb. nov.
Meliapollis (*Tetracolporites*) *africanus* (Sah, 1967) comb. nov.

Remarks—Above mentioned species of *Tetracolporites* described by SAH (1967) from Neogene sediments of Rusizi Valley (Burundi), Congo, Africa, very well conform with the emended genus *Meliapollis*. Most of the grains described, lack distinct pores and colpi (dissolution of the colpi membrane obliterated the pores and produced pseudocolpi) and show positive signs of biological degradation which has effected exinal pattern.

Meliapollis (Tetracolporites) firmus (Sah, 1967) comb. nov.

Pl. 2, Fig. 36

Remarks—Isopolar, quadrangular pollen, 82—82 μm in size. Tetracolporate, brevicolpate, colpi faint, pores distinct, lalongate, margins appreciably thickened. Exine 7.5-10 μm thick, sexine (2-2.5 μm) 2-3 times thinner than nexine (5.5-7.5 μm), internal surfaces of the nexine in the mesocolpi bulges out at places which appears to be due to thickened and sunken pore margins. Surface of the exine laevigate.

Meliapollis (Platoniapollenites) iratus (Sah & Kar, 1974) comb. nov.

Pl. 2, Figs. 34 & 37

Remarks—Isopolar, quadrangular pollen, 66-90×64-90 μm in size. Tetracolporate, colpi (membrane dissolved) appearing long, rendering the grain cross-like appearance, pores distinct (but all pores are not intact), 9-11 μm in diameter, margins thickened. Exine 3-4 μm thick, sexine thinner than or equal to nexine, surface laevigate.

Meliapollis ramanujamii Sah & Kar, 1970

Pl. 2, Figs. 32 & 33

Remarks—Subcircular to quadrangular grains with slightly larger size (52—70× 51—70 μm) than described by SAH AND KAR (1970). Tetracolporate, colpi distinctly to faintly visible, medium to brevicolpate, tenuimarginate, pores distinct,lalongate, margins thickened. Exine laevigate, 1.5-3 μm thick, sexine equal to nexine.

Meliapollis raoi Sah & Kar, 1970

Pl. 2, Figs. 29, 30

Remarks—Subtriangular to subcircular pollen, 63—90×62—90 μm in size (larger pollen of the present assemblage have been included in the present species). Tricolporate, medium to brevicolpate, pores distinct to obscure (in grains with dissolved colpi margins), lalongate. Exine 1.5-2.5 μm thick, sexine equal to nexine, surface laevigate.

Meliapollis navalei Sah & Kar, 1970

Pl. 2, Fig. 42.

Remarks—Subcircular to pentagonal pollen with slightly larger size (86×84 μm) than described by SAH AND KAR (1970). Pentacolporate, colpi long due to dissolution as is indicated by thinned exinal margins bordering colpi, pores not traceable. Exine 1.5-2 μm thick, surface laevigate.

Meliapollis pachydermis sp. nov.

Pl. 2, Fig. 31

Holotype—Pl. 2, Fig. 31, Size 95×95 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Isopolar, subtriangular pollen grain, 95×95 μm in size. Tricolporate, brevicolpate, colpi faintly visible, grandiporate, crassimarginate, pores 17 μm in diameter. Exine 10 μm thick, sexine is thinner than nexine, surface laevigate.

Comparison—Meliapollis raoi Sah & Kar (1970) differs from the present species in possessing smaller size, pore and comparatively thinner exine. Tricolporate form of the *M. (Tetracolporites) africanus* (SAH, 1967) comb. nov. compares very closely with the *M. pachydermis* but the latter has slightly larger size and thicker exine while the former has tetracolporate form also.

Meliapollis magnus sp. nov.

Pl. 2, Fig. 40

Holotype—Pl. 2, Fig. 40. Size 115×110 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Isopolar, subcircular to pentagonal pollen, 100—115×100—110 μm in size. Pentacolporate, medium to longicolpate, colpi distinct, pore distinct, 10-12 μm in diameter, lalongate but thickening around pores is less conspicuous than in other species of *Meliapollis*. Exine 5-6 μm thick, nexine thicker than sexine (1.5-2 μm), surface laevigate.

Comparison—This species differs from all other pentacolporate species of the genus *Meliapollis* in having the largest size, medium to longicolpate nature and comparatively less conspicuous pore thickening.

Meliapollis tamilii sp. nov.

Pl. 2, Figs. 39, 41

Holotype—Pl. 2, Fig. 41, Size 100×95 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Isopolar, subcircular to pentagonal pollen, 85—100×85—95 μm in size. Pentacolporate, brevicolpate, colpi faint to distinct, some colpi margins are dissolved appearing deeper than others. Pore distinct, 11-14 μm in diameter, lalongate, with thickened margins. Exine 3-5.5 μm thick, sexine equal to or slightly thinner than nexine, surface laevigate.

Comparison—*Meliapollis navalei* (Sah & Kar, 1970) differs from the present species by its relatively smaller size range and thicker exine. *M. simplex* is comparatively very small in size, has a thicker exine and its colpi are faint. From *M. magnus*, *M. tamilii* is differentiated by having smaller size range, thinner exine and faint to distinct brevicolpate nature.

Meliapollis simplex sp. nov.

Pl. 2, Fig. 38

Holotype—Pl. 2, Fig. 38, Size 53×52 μm

Type Locality—Neyveli Lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Isopolar, subcircular to pentagonal pollen grain, 53×52 μm in size. Pentacolporate, brevicolpate, colpi faint to indistinct, grandiporate, lalongate, 7-8 μm in diameter with appreciably thickened margins. Exine 7-8 μm, thick, sexine (1.5 μm) 3-4 times thinner than nexine (6-6.5 μm). Internal margin of the mesocolpial nexine has bulged out at places due to accommodation of very thickened pore margins. Surface laevigate.

Comparison—It resembles with *Meliapollis navalei* (Sah & Kar, 1970), *M. tamilii* and *M. magnus* in having 5 colporate and brevicolpate nature but differs in possessing comparatively smaller size and thicker exine. Other species of *Meliapollis* are distinguished from *M. simplex* by being either tri- or tetracolporate.

Turma Poroses (Naumova) Potonié, 1960
Subturma Triporines (Naumova) Potonié, 1960
Infraturma Trilatiporiti (Ramanujam, 1966) Extended

Pollen heteropolar, pores (2—) 3 (—4) more ro less circular, grandiporate, latiporate, non-equatorial all in one hemisphere.

Remarks—Apart from common 3-porate, 2- and 4-porate pollen grains have also been observed in the present assemblage. To incorporate, forms possessing this kind of apertural distribution Norem (1958) in his artificial key for identification of fossil pollen

grains instituted a subgroup "latiporate". NAIR (1965) described extant pollen species of *Dumasia villosa* of Papilionatae having 3 non-equatorial, heteropolar pores. A study of pollen slides of *Dumasia villosa* indicate that the number of aperture varies from 3 to 4, where 3-porate condition is most frequent and hence it is deemed necessary to extend the infraturmal diagnosis.

Genus—**Dorreenipites** (Biswas, 1962) Emended

Type Species—Dorreenipites platydesma Biswas, 1962

Emended diagnosis—Pollen grain heteropolar, mostly seen in polar view, occasionally folded and crumpled grains have also been observed. Rounded to triangular in shape, 35—64×29—58 μm in size. Pores (2-) 3 (-4), latiporate, generally grandiporate, 3.3—7 μm in diameter, more or less circular surrounded by 2—2.5 μm thick annulus, non-equatorial—all in one hemisphere. Exine 2.5-5 μm thick, sexine equal to or slightly thicker than nexine, tegillate, pila distinct, surface finely to very coarsely granulate to microreticulate.

Comparison—These pollen grains apparently resemble the triporate, heteropolar pollen of *Carya* (ERDTMAN, 1952 ; STACHURSKA, 1961) but marked heteropolarity and position of distinctly large pores placed away from the equatorial margin differentiate the former from the latter. Pollen of *Anacolosidites* (POTONIÉ, 1960) though has markedly non-equatorial pores but is 3-dupliforate. *Tricolata riedeli*, described by THIERGART AND FRANTZ (1962) from Neyveli lignite, is differentiated from *Dorreenipites* by being a 3-dupliforate form. BISWAS (1962) tried to affiliate this pollen with *Platydesma* of Rutaceae which is actually tricolpate. *Triporites* spm. 2 described by VIMAL (1953) from Warkalli lignite, belongs to the *Dorreenipites*. The present pollen closely compares with the living pollen of *Dumasia villosa* (NAIR, 1965) of Papilionatae in surface structure and latiporate condition.

Remarks—BISWAS (1962) instituted the genus *Dorreenipites*. He described the genus which lacks range of variation of morphological characters, and the disposition of three pores on the grain is also wanting. RAMANUJAM (1966) established a genus *Trilatiporites* resembling almost with the *Dorreenipites*, but did not designate its type species. Moreover, *Dorreenipites*, described by BISWAS (1962) by virtue of its priority over *Trilatiporites*, is maintained here and the latter is considered as a junior synonym of the former

Dorreenipites (*Trilatiporites*) *erdtmani* (Ramanujam, 1966) comb. nov.
Dorreenipites (*Trilatiporites*) *noremi* (Ramanujam, 1966) comb. nov.
Dorreenipites (*Trilatiporites*) *sellengi* (Ramanujam, 1966) comb. nov.
Dorreenipites (*Trilatiporites*) *cooksoni* (Ramanujam, 1966) comb. nov.

Dorreenipites distinctus sp. nov.

Pl. 1, Figs. 23-26, 26a

Holotype—Pl. 1, Figs. 26 & 26a. Size 28×54 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Pollen heteropolar, amb rounded triangular to subcircular, 44—58× 48—54 μm in size. 2-4 grandiporate, latiporate, pore more or less circular, 5—7 μm in diameter (one or two pores may be of smaller size), surrounded by 2—2.5 μm thick annulus, non-equatorial all in one hemisphere. Exine 4—4.5 μm thick, sexine equal to or slightly thicker than nexine, tegillate, pila distinct, surface evenly granulate to microreticulate.

Comparison—This species can be distinguished from all other species of *Dorreenipites* by virtue of its 2-and 4-porate nature.

Dorreenipites medius sp. nov.

Pl. 1, Figs. 27, 28

Holotype—Pl. 1, Fig. 28, Size 64×58 μm

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Heteropolar pollen grains, amb rounded triangular to subcircular 55—64 ×55—58 μm in size. Tri-latiporate, pores large 6—7 μm in diameter, circular to elliptical, surrounded by approximately 2 μm thick rim, non-equatorial to prominently nonequatorial, all in one hemisphere. Exine 3.5—4.5 μm thick, sexine thicker or equal to nexine, surface tegillate, pila distinct, granulate to microgranulate.

Comparison—The present species is distinguished from *Dorreenipites* (*Trilatiporites*) *sellengi* (RAMANUJAM, 1966) in having bigger size and coarser exine structure. *D.* (*Trilatiporites*) *cooksoni* (*loc. cit.*) is smaller in size, pore annulus thinner and columellae fainter giving pollen a smoother look when compared to *D. medius*, *D. platydesma* (BISWAS, 1962) and other species described by RAMANUJAM (*loc. cit.*) differ in size, exine and in having smaller pore.

Subturma POLYPORINES (Naumova) Potonié, 1960
Infraturma PERIPORITI (Van der Hammen) Potonié, 1960

Genus—**Clavaperiporites** Ramanujam, 1966

Type species—Clavaperiporites jacobi Ramanujam, 1966

Clavaperiporites clavatus sp. nov.

Pl. 2, Figs. 45, 45a

Holotype—Pl. 2, Figs. 45 & 45a. Size 48×45 μm.

Type Locality—Neyveli Lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Pollen grain prolate or circular, 40—48×40—46 μm. Pore 5-10, panporate, faintly visible due to ornamentation, each pore 2—3 μm in diameter, tenuimarginate, margins often irregular. Exine 5—6.5 μm thick (including sculptural elements), sexine thicker than nexine, surface ornamented with densely packed clavae, clavae heads generally triangular, occasionally polygonal, arranged in somewhat crotonoid pattern, forming a loose reticulum, meshes polygonal, lumina smooth.

Comparison—The present species differs from the *Clavaperiporites jacobi* (RAMANUJAM, 1966) in having a bigger size range and thicker exine.

Genus—**Malvacearumpollis** Nagy, 1962

Type Species—Malvacearumpollis bakonyensis Nagy, 1962

Malvacearumpollis minutus sp. nov

Pl. 2, Figs. 43, 43a, 44

Holotype—Pl. 2, Figs. 43 & 43a. Size 62.5×62.5 μm.

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Pollen grains spheroidal to subspheroidal, size range 47—63 μm. Tricolporate (?) colpi and pores are not distinctly observed. Exine 3—3.5 μm thick, sexine microgranulate, spinose, spines few to many, suprategillar with bulbous bases, 4—7 μm high and 3—4 μm thick at the base, bases of the spines are encircled by fused suprategillar elements.

Comparison—This species does not resemble other species of the genus by virtue of its smaller size range and lack of polyforate condition although it resembles very closely with *M. africus* (SAH, 1967) in other morphological details.

Turma JUGATES (Erdtman) Potonié, 1960
Subturma TETRADITES Cookson, 1947

Genus—**Droseracidites** Cookson, 1947

Type species—Droseracidites spinosa Cookson, 1947

Droseracidites medius sp. nov.

Pl. 2, Figs. 46 & 47

Holotype—Pl. 2, Fig. 46, Size (Tetrad) 54×47 μm.

Type Locality—Neyveli lignite field, South Arcot District, Tamil Nadu.

Diagnosis—Pollen in tetrahedral tetrad ; tetrad diameter 51—56×40—50 μm individual grains (without spines) 35—39×25—28 μm in size. Dorsal side of the grains arched, proximal side somewhat conical, folds visible at contact lines of grains. Exine 2—2.5 μm thick, structureless, provided with numerous, short, acuminate, 2.5—3.5 μm long spines.

Comparison—The present species differs from *D. parvus* of DUTTA AND SAH (1970) in having a comparatively bigger spines and tetrad size. *D. spinosa* (COOKSON, 1947) and *D. spinulosus* (MANUM, 1962) have bigger spines and tetrad size with comparatively thicker exine.

Apart from the above new pollen forms, some microplanktonic forms (*Psilasphaera, Tetraporina, Octaplata* and few new types) hitherto not reported from the Neyveli area have been also recognised.

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EXPLANATION OF PLATES

(All photomicrographs × 500 except when mentioned)

PLATE 1

1 & 2. *Cruciferoipollenites elongatus* gen. et. sp. nov., polar view.

3. *C. elongatus*, oblique view.

4 & 5. *Plumbaginacipites neyvelii* gen. et. sp. nov., polar view.

6. *P. neyvelii*, equatorial view.

7 & 9. *Icacinoipollenites spinulatus* gen. et. sp. nov., oblique view.

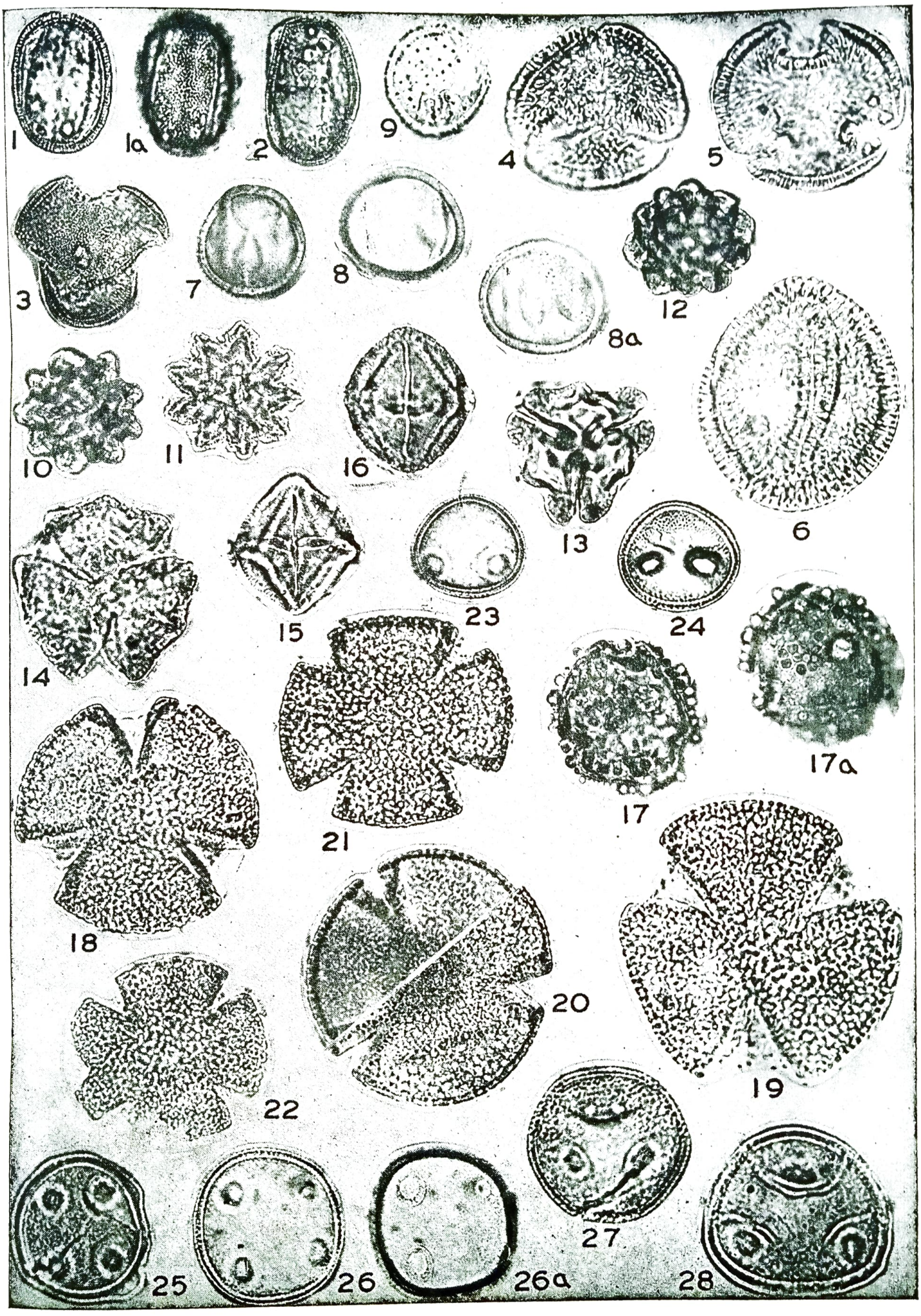
8 & 8a. *I. spinulatus*, equatorial view. Note the uniformly thick (lip like) colpi margins.

10-12. *Ctenolophonidites stellatus* sp. nov., polar view.

13. *Dakshinipollenites tripakshi* gen. et. sp. nov., (Holotype), polar view. Note the thinned exine projection (hump) in the middle of mesocolpi and thickened exine at the colpi margins.

14. *D. tripakshi*, polar view.

15 & 16. *D. tripakshi*, equatorial view.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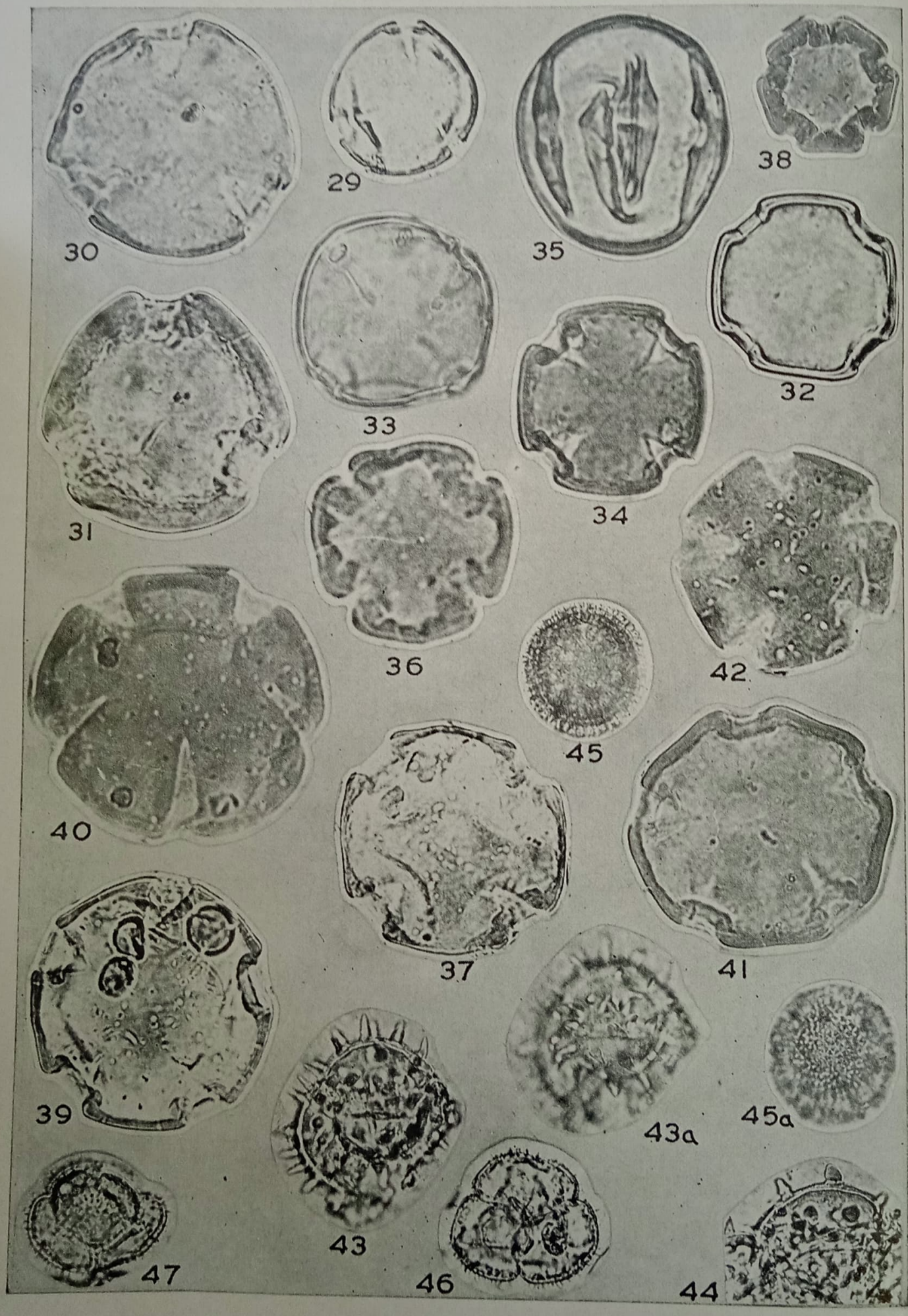

Navale & Misra—Plate 2

17 & 17a. *Alangiopollis gemmatus* sp. nov. (Holotype), polar view.
18-20. *A. arcotense*, polar view, tricolporate forms.
21 & 22. *A. arcotense*, polar view, tetracolporate forms.
23 & 24. *Dorreenipites distinctus* sp. nov., polar view, disporate forms.
25. *D. distinctus* polar view, tetraporate form. Note the loosening of sexine.
26 & 26a. *D. distinctus* (Holotype), polar view, tetraporate forms.
27 & 28. *D. medius* sp. nov., polar view, triporate forms.

PLATE 2

29 & 30. *Meliapollis raoi*, polar view.
31. *M. pachydermis* sp. nov. (Holotype), polar view.
32 & 33. *M. ramanujamii*, polar view (Fig. 33 × 750)
34 & 37. *M.* (*Platoniapollenites*) *iratus* comb. nov., polar view. Note the dissolution of colpi membrane due to which pores are also ruptured.
35. *Meliapollis* sp., equatorial view.
36. *M.* (*Tetracolporites*) *firmus* comb. nov., polar view. Note the bulges on the internal margin of the nexine in the mesocolpi.
38. *M. simplex* sp. nov. (Holotype), polar view. Note the bulges on the internal margin of the nexine in the mesocolpi.
39 & 41. *M. tamilii* sp. nov., polar view. Note differential dissolution of some of the colpi and pores.
40. *M. magnus* sp. nov. (Holotype), polar view.
42. *M. navalei*, polar view.
43 & 43a. *Malvacearumpollis minutus* sp. nov. (Holotype). Same grain in different focus showing exine pattern.
44. *M. minutus*, a magnified grain showing spine characters.
45 & 45a. *Clavaperiporites clavatus* sp. nov. (Holotype), polar view. (Fig. 45a—same in different focus to show crotonoid pattern on the surface of the grain).
46 & 47. *Droseracidites medius* sp. nov., tetrad, showing three grains in focus.