PALYNOLOGY OF DALMIAPURAM GREY SHALE, DALMIAPURAM FORMATION, DISTRICT TRICHINOPOLY, SOUTH INDIA—1. TAXONOMY

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ABSTRACT

The present account incorporates palynological results obtained from the Grey Shale samples collected from the north limestone quarry, Kallakkudi at Dalmiapuram, South India. The assemblage is rich both in miospores and microplanktonic remains. Conspicuous components of the present assemblage are, *Cyatheacidites*, *Contignisporites*, *Appendicisporites*, *Coptospora*, *Converrucosisporites* in trilete spores; *Podocarpidites* and *Spheripollenites* in gymnosperms pollen grains and *Gonyaulacysta*, *Cyclonephelium*, *Hexagonifera*, *Spiniferites*, *Ovoidinium* and *Oligosphaeridium* in microplankton.

INTRODUCTION

The geological age and stratigraphic position of reef lime stone and associated rocks in Cauvery basin has been a long existing controversy. The reef lime stone is best exposed around Dalmiapuram, a township (10° 58′ 30″: 78° 57′ 00″)in Trichinopoly district, Tamil Nadu.

BLANFORD (1865) made the first elaborate survey of the area concluding that the reef limestone constitutes the basal part of the Oottatur Group (=Uttatur Formation). STOLICZKA (1866-73) considered it as upper Albian. KOSSMAT (1897) correlated the limestone with the Valudavur Group of Pondicherry (Senonian) whereas NARAYAN RAO (1947) thought it to be Jurassic in age.

Within the last decade a considerable amount of geological and palaeontological work in this area has been done. SUBBARAMAN (1968) has described the surface and subsurface geology of the area around Dalmiapuram in great detail. He places the coralline limestone at the base of Uttatur Formation and describes the occurrence of grey shale which unconformably underlies the coralline limestone in the northern limestone quarry, Kallakkudi, as pre-Uttatur in age. RAMANATHAN (1968, table-1) assigns Neocomian-Albian age to the lower part of Uttatur Formation including the greyshale but JAIN and SUBBARAMAN (1969) on palynological basis proposed an Aptian age for the grey-shale.

Recently, BHATIA and JAIN (1969) have confirmed the observations of SUBBARAMAN (1968) that there is an angular unconformity between the basal member of Uttatur Formation (Coral reef limestone) and the underlying greyshale. They also supported their contention by analysing the ecological conditions that the greyshales were deposited under anaerobic reducing environment and the Coral limestone in a warm tropical, oxidising environment. Taking into consideration the stratigraphic gap between the basal member of Uttatur and greyshale along with their different depositional environment, they assigned the grey shale a distinct status of a Formation "Dalmiapuram Formation". BHATIA and JAIN (1969) are of the opinion that the Formation is Aptian-Lower Albian in age.

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In a latest publication BANERJI (1972) has also proposed the same status but include limestone and associated rocks as its two members; the upper limestone member and the lower shale member. On the basis of palaeontological grounds BANERJI (1972) considers the formation to be of Lower-Middle Albian in age. RAO and VENKATACHALA (1971) have assigned a lower Albian age on the basis of their palynological findings.

The detailed palynological account presented here indicates a significant presence of *Appendicisporites erdtmanii* and *A. cristatus* which are so far recorded from Albian sediments elsewhere. The Dalmiapuram grey shale palynological assemblage shows a total absence of *Deflandrea* spp. and angiospermic pollengrains. This evidence though negative precludes the possibility of its being Albian in age. But on the contrary the occurrence of *Hexagonifera* in abundance does reflect upon its Albian association (DAVEY, 1970, p. 349). A comparison with well known Albian microplankton assemblage (see DAVEY & VERDIER, 1971) shows very little similarity. RAO and VENKATACHALA (1971)have analysed the stratigraphic position of other Lower Cretaceous palynological assemblages (spore and pollen grains) described from different parts of India. The Dalmiapuram formation appears to be youngest. Unfortunately, the microplankton evidence has not been seriously taken up. The age of Dalmiapuram grey shale is now concluded to be Lower Cretaceous (Probably Aptian to lower early Albian).

The material for the present analysis was collected from the northern limestone quarry II, Kallakkudi (Dalmiapuram) at different surface levels. A preliminary analysis of the samples collected along the fault has already been published by JAIN and SUBBARAMAN (1969).

A total of 36 genera and 44 species of fossil spores, pollen grains and microplankton are recovered from the analysis of greyshale samples.

The morphographic system of classification proposed by POTONIE (1956, 1958, 1960) for the dispersed spores and pollen grains; and by SARJEANT and DOWNIE (1966) for the microplankton have been followed here.

Repository: Museum, Birbal Sahni Institute of Palaeobotany, Lucknow, India.

SYSTEMATIC DESCRIPTION

PART I—SPORES AND POLLEN GRAINS

Genus—**Cyathidites** Couper, 1953

Cyathidites minor Couper, 1953

Pl. 1, Fig. 1

Distribution—Jurassic—Cretaceous (DETTMANN, 1963; COUPER, 1953; BALME, 1957)

Genus—**Biretisporites** (Delcourt & Sprumont) Delcourt, *et al.*, 1963.

Biretisporites minutus sp. nov.

Pl. 2, Fig. 5, 22

Holotype—Pl. 2, Fig. 5 ; Slide No. 3952-20.
Type Locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.
Horizon—Lower Cretaceous.

Diagnosis—Miospores trilete, amb convexly triangular to sub-triangular, 25-45 μ in size; Y-mark distinct, laesurae straight, reaching up to equator, lips raised. Exine 2-2.5 μ thick, smooth.

Comparison—*Biretisporites minutus* sp. nov. compares best with *B. psilatus* (Groot & Penny) Dettman (1963) in having almost similar morphological features but differs mainly in having smaller size and thinner exine. *B. potoniei* Delcourt & Sprumont (1955) differs in having median fold in the distal exine.

Genus—**Matonisporites** Couper, 1958

?Matonisporites sp.

Pl. 2, Fig. 7

Description—Miospore trilete, amb triangular, 35μ in size, sides convex, apices obtusely rounded; Y-mark distinct, rays reacting up to equator. Exin psilate, 4 μ thick, uniform.

Remarks—Only a single spore of this type has been recovered. It is not very well preserved. The exact identification is therefore doubtful.

Genus—**Ceratosporites** Cookson & Dettmann, 1958

Ceratosporites equalis Cookson & Dettmann, 1958

Pl. 2, Figs. 3-4

Distribution—Upper Jurassic onwards.

Ceratosporites sp.

Pl. 1, Fig. 11

Description—Miospore trilete, amb subtriangular, 25-30 μ in size, sides convex, apices obtusely rounded; Y-mark distinct, ray extending up to equator. Exine thin, distally sculptured with 1-1.5 μ long processes, apex blunt, proximally smooth.

Genus—**Osmundacidites** Couper, 1953

Osmundacidites wellmanii Couper, 1953

Pl. 2, Figs. 8-9

Distribution—Jurassic onwards.

Genus—**Converrucosisporites** Potonié & Kremp, 1954

Converrucosisporites distinctus sp. nov.

Pl. 1, Fig. 23; Pl. 2, Fig. 1

Holotype—Pl. 2, Fig. 1; Slide No. 3938-55.

Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.

Horizon—Lower Cretaceous.

Diagnosis—Miospore trilete, 55-65 μ in size, amb broadly triangular, angles obtusely rounded, sides straight to convex, Y-mark very prominent, rays reaching up to equator,

labra thick, flanked by margo. Exine moderately thick, verrucate, verrucae crowded both proximally and distally, compact, varied in shape, 1-2 μ high, top flat to rounded.

Comparison—*Converrucosisporites distinctus* sp. nov. compares very well with *Converrucosisporites* sp. (REINHARDT, 1963, p. 49, pl. 2, fig. 7, 9). But differs mainly in its bigger size and much raised verrucae. *C. saskatchewensis* Pocock (1962, p. 47, pl. 5, fig. 59) compares well with the present species but differs mainly in having low verrucae. The present species is distinct from all the known species of the genus in its characteristic compact, flat and low verrucae.

Genus—**Verrucosisporites** (Ibrahim) Potonié & Kremp, 1954

Verrucosisporites sp. cf. **V. obscurilaesuratus** Pocock, 1962

Pl. 2, Fig. 2

Description—Miospore trilete, 40 μ in size, laesurae indistinct, outline irregular, subcircular, both proximal and distal surfaces ornamented with prominent verrucae, verrucae 4 μ across and 2 μ high, flat topped, never fusing.

Remarks—In most of the morphological features it resembles with *V. obscurilaesuratus* Pocock (1962) but differs in its smaller size and never fusing verrucate nature.

Verrucosisporites sp.

Pl. 1, Fig. 9

Description—Miospore trilete, amb triangular, 28 μ in size, sides straight; Y-mark distinct, rays reaching up to equator. Exine 1-1.5 μ thick, verrucate, verrucae 0.5-1 μ high, top rounded.

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

Lycopodiumsporites reticulumsporites (Rouse) Dettmann, 1963

Pl. 1, Fig. 20

Distribution—Jurassic onwards.

?Lycopodiumsporites sp.

Pl. 1, Fig. 10

Description—Miospores trilete, amb circular, 45-50 μ in size; Y-mark distinct, rays extending up to equator, labra thin. Exine 3 μ thick, two layered, intine thin, exoexine thick, ornamented with mixed sculpture, granulose-reticulate, grana coarse, compact, reticulum muri thicker along lacunae corners, lacunae penta to hexagonal, up to 14 μ in diameter, muri 3 μ high.

Remarks—The present specimens compare best with *Retitrilites sernoensis* Krutzsch. No specific identification has been attempted due to lack of many specimens.

Genus—**Cicatricosisporites** Potonié & Gelletich, 1933

Cicatricosisporites pseudotripartitus (Bolkhovitina) Dettmann, 1963

Pl. 2, Fig. 6

Distribution—Cretaceous.

Cicatricosisporites sp. cf. **C. minor** (Bolkhovitina) Pocock, 1962

Pl. 1, Fig. 12

Description—Miospores trilete, amb triangular, 32 μ in size; Y-mark distinct, rays extending 3/4 radial distance. Exine 1.5 μ thick, uniform, distally and equatorially sculptured with very low and thin muri crust; distal muri terminate along apices bisectors.

Remarks—*C. minor* is known from Albian of Canada.

Cicatricosisporites sp.

Pl. 1, Fig. 21

Description—Miospore trilete, amb triangular, 60 × 48 μ in size; Y-mark not distinct. Exine 2 μ thick, distally and equatorially sculptured with two series of muri, several in each series, arranged parallel to inter-radial sides.

Remarks—Only a few specimens have been recovered and therefore no specific identification has been attempted.

Genus—**Trilites** (Erdtman *ex* Couper) Dettmann, 1963

Trilites tuberculiformis Cookson, 1947

Pl. 1, Figs. 7-8

Distribution—Cretaceous onwards.

Genus—**Trilobosporites** Pant *ex* Potonié, 1956

Trilobosporites indicus sp. nov.

Pl. 1, Fig. 19; Pl. 2, Fig. 16; Pl. 4, Fig. 10

Holotype—Pl. 1, Fig. 9; Slide No. 3950-1.

Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.

Horizon—Lower Cretaceous.

Diagnosis—Miospores trilete, valvate, 25-30 μ in size, amb triangular, sides straight, apices broadly rounded; Y-mark distinct, rays reaching 3/4 of radius, lips thin and narrow. Exine valvate, with one homogeneous layer of verrucae; verrucae closely placed, 2-4 μ high near valvate region, valvae verrucate, forming a sort of ring at apices.

Comparison—*T. indicus* sp. nov. differs from all the known species of the genus in having ring like valvae with verrucae and smaller size.

Genus—**Appendicisporites** Weyland & Krieger, 1953

Appendicisporites erdtmanii Pocock, 1964

Pl. 1, Fig. 16

Distribution—Lower Cretaceous (Albian).

Appendicisporites cristatus (Markova) Pocock, 1962.

Pl. 1, Fig. 17

Distribution—Lower Cretaceous (Albian).

Appendicisporites sp. A

Pl. 1, Fig. 15

Description—Miospore trilete, 40 μ in size, amb triangular, sides convex, ends rounded; Y-mark not distinct. Exine ornamented with prominent ridges, 3 μ wide and 5 μ high, irregular, angular, spaced ±2-4 μ apart, few in number, coalesce at the ends, appendices 5.5 μ long and 3 μ wide (One specimen).

Appendicisporites sp. B

Pl. 2, Fig. 13

Description—Miospore trilete, Y-mark not distinct, triangular, 100-75 μ in size, not well preserved, sides slightly concave. Exine ornamented with ridges, 3μ wide, few in number (5-6). Appendices 10-12 μ high, surface spongeous and granulose (one specimen).

Genus—**Contignisporites** Dettmann, 1963

Contignisporites glebulentus Dettmann, 1963

Pl. 1, Fig. 13

Distribution—Lower Cretaceous.

Contignisporites dettmannii Singh & Kumar, 1966

Pl. 1, Fig. 14

Distribution—Lower Cretaceous.

Contignisporites novus sp. nov.

Pl. 2, Figs. 10-11

Holotype—Pl. 2, Figs. 10-11, Slide No. 3936-22
Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.
Horizon—Lower Cretaceous.
Diagnosis—Miospore cingulate, cingulum 4-5μ thick, subtriangular, 30-35 ×40-45μ in size, sides convex, angles broadly rounded. Central body distinct, Y-mark prominent, lips thin, arms reaching 2/3 radial distance. Exine proximally and equatorially spongeous in structure, distally ornamented with 10-12, 2-3 μ wide, parallel, bifurcating stripes with rounded edges.

Comparison—Contignisporites novus sp. nov. differs from the so far known species of the genus in having spongeous proximal and equatorial exine.

Genus—**Kraeuselisporites** (Leschik) Jansonius, 1962

Kraeuselisporites sp.

Pl. 1, Fig. 18

Description—Miospore trilete, 32μ in size, zonate, amb subtriangular, sides convex Y-mark distinct, ± reaching equator. Exine 1-1.5 μ thick, distally ornamented with muri forming complete to incomplete lacunae having spinose crest; spines small 1.5-2 μ long. Zona 5-7 μ wide, smooth, margin serrate.

Remarks—The present spore specimen compares best with *Kraeuselisporites jubatus* Dettmann & Playford (1968) in having muri with spinose crust on the distal exine surface, but differs mainly due to less wide and smooth zona.

Genus—**Cyatheacidites** (Cookson) Potonié, 1954

Cyatheacidites dalmiapuramensis sp. nov.

Pl. 1, Figs. 3-4

Holotype—Pl. 1, Fig. 3; Slide No. 3999-5.
Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.
Horizon—Lower Cretaceous.

Diagnosis—Miospore trilete, 30-40 μ in size, amb triangular, sides slightly convex, apices rounded. Y-mark distinct, rays extending up to equator, labra thin. Exine 3 μ thick, equatorial flange or cingulum 3 μ wide, granulose, distally verrucate, verrucae 2-3 μ high, irregular, bases broad, sometimes fused, forming irregular lacunae.

Comparison—*Cyatheacidites dalmiapuramensis* sp. nov. differs from the other known species of the genus in having distal and proximal verrucate ornamentation.

Cyatheacidites sp. cf. **C. tectifera** Archangelsky & Gamerro, 1967

Pl. 1, Fig. 2

Description—Miospore trilete, 24-30 μ in size, amb triangular, sides straight to slightly convex, apices broadly rounded; Y-mark distinct, labra open, thin, rays reaching equator. Equatorial flange prominent, 3 μ wide, scabrate. Exine 1.5 μ thick, ornamented with irregular protuberances on distal side, proximal thickenings only along contact faces, forming three separate thickened areas.

Remarks—The present specimen differs from *C. tectifera* and the type species in its smaller size and characteristic flange with prominent distal exinal ornamentation.

Distribution—Lower Cretaceous (Barremian-Aptian).

Cyatheacidites sp.

Pl. 2, Fig. 12

Description—Miospore trilete, 52 × 45 μ in size, amb triangular, sides straight to slightly convex, apices broadly rounded; Y-mark distinct, rays reaching up to margin. Equatorial flange prominent, 1.5-2 μ thick. Exine 1.5 μ thick, granulose distally, verrucate proximally, along the contact area verrucae fused forming three separate thickened areas.

Remarks—No specific identification has been attempted as only one spore of this type has been recorded.

Genus—**Taurocusporites** Stover, 1962

Taurocusporites sp. cf. **T. reduncus** Stover, 1962

Pl. 1, Fig. 24

Description—Miospore trilete, 60 μ in size, circular, margin crenate. Distal surface unornamented, divided into three concentric zones separated from each other by two narrow rings, 1.5-2 μ wide; proximal surface scabrate, Y-mark distinct, rays extending upto equator. Exine thin, 4 μ thick.

Distribution—Lower Cretaceous.

Genus—**Hymenozonotriletes** Naumova, 1937

Hymenozonotriletes mesozoicus Pocock, 1962

Pl. 1, Figs. 5-6

Distribution—Lower Cretaceous onwards.

Genus—**Coptospora** Dettmann, 1963

Coptospora micropunctata sp. nov.

Pl. 2, Fig. 18

Holotype—Pl. 2, Fig. 18; Slide No. 3936-16.

Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.

Horizon—Lower Cretaceous.

Diagnosis—Sporomorph inaperturate, biconvex; amb oval to sub-circular, 70-50 μ in size. Exine smooth, 2.5-3 μ thick equatorially, surface of both distal and proximal hemispheres micropunctate, fractured in a longer than broad area at and about the pole (?proximal). Fractured margins rolled.

Comparison—*Coptospora micropunctata* sp. nov. differs from all the known species of the genus in having micropunctate polar exine.

Coptospora psilata sp. nov.

Pl. 2, Figs. 19-20

Holotype—Pl. 2, Fig. 19; Slide No. 3938-60.

Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.

Horizon—Lower Cretaceous.

Diagnosis—Sporomorph inaperturate, biconvex, amb circular to subcircular, 45-55 × 60-65 μ in size. Exine 2.5-3 μ thick, smooth fractured at and about the pole (?proximal), fractures delimit triangular to rectangular areas 30-50 μ in size, both proximal and distal hemisphere exine smooth.

Comparison—The present species differs from all the known species of the genus *Coptospora* in having psilate exine.

?Coptospora sp.

Pl. 2, Fig. 21

Description—Sporomorph inaperturate, biconvex, amb subcircular, 46 × 60 μ in size. Exine 1.5 μ thick, granulate, fractures delimit triangular area.

Genus—**Podocarpidites** (Cookson) Potonié, 1956

Podocarpidites sp. A

Pl. 1, Fig. 26

Description—Miospore bisaccate, 38 × 52 μ in size, longer than broad, central body distinct, 32 μ in diameter, marginal crest not well defined, exine microreticulate; bladders well developed, 40 × 52 μ in size, attached proximally, surface reticulate, reticulum even throughout, furrow narrow, 6 μ wide.

Podocarpidites sp. B

Pl. 1, Figs. 27-28

Description—Miospores bisaccate, 60-70 × 40-50μ in size, longer than broad, central body circular, 36-45 μ in size, marginal crest prominent, fril like, 4 μ wide, surface scabrate bladder attachment distinct, expanded, 40-55 × 20-30 μ in size, reticulate, reticulum wider towards outer margin, finer near attachment.

Genus—**Spheripollenites** Couper, 1958

Spheripollenites subgranulosus Couper, 1958

Pl. 1, Fig. 22, 29

Distribution—Lower Cretaceous.

Genus—**Callialasporites** Sukh-Dev, 1961

Callialasporites trilobatus (Balme) Sukh-Dev, 1961

Pl. 1, Fig. 25

Distribution—Jurassic onwards.

Incertae Sedis

Spore type A

Pl. 1, Fig. 30

Description—Sporomorph non-aperturate, circular to oval in shape, 35-40 μ in diameter, inner body conspicuous, outer flange distinct, 8 μ wide beyond the margin of central body, surface reticulate, muri high.

Spore type B

Pl. 1, Figs. 31-32

Description—Miospore monosulcate (?), 24 μ in diameter, circular in outline; exine tectate, 2.5 μ thick, carrying closely placed clavate projections, 2 μ long in surface view, sculpture microreticulate.

Remarks—Only one specimen of this type has been recovered, and therefore, no comment is possible at present, though such grains have been described from Wealden Aptian (Couper, 1959, p. 159) under the genus *Clavatipollenites*.

Genus—**Spiniferites** Mantell, 1850

Spiniferites ramosus (Ebrenberg) Mantell, var. *ramosus* Davey & Williams, 1966.

Pl. 3, Figs. 14-15.

Distribution—Oxfordian to Post Pleistocene (DAVEY *et al.*, 1966, p. 32).

Spiniferites ramosus (Ehrenberg) Mantell, var. *granosus* Davey & William,1966.

Pl. 3, Fig. 4

Distribution—London clay of England.

Spiniferites sp.

Pl. 3, Fig. 13

Description—Central body spherical, 38 μ in size; periphragm smooth, forming crest and processes; crest well developed with bifid processes, 6-10 μ long and 1-2 μ broad. Archaeopyle precingular. Some processes connected with developed membrane.

Remarks—The present specimen compares very closely with *Hystrichosphaera* sp. described by DAVEY and WILLIAMS (in DAVEY *et al.* 1966, pl. 9, fig. 9; p. 46). But differs mainly in having smooth periphragm. It also shows remarkable similarity in process terminations of *Baltispharidium* sp. cf. *B. neptuni* Eisenack, described by SINGH (1964, pl. 19, figs. 6-7) from Aptian of Clear Water Formation, Canada.

Genus—**Oligosphaeridium** Davey & Williams, 1966

Oligosphaeridium complex (White) Davey & Williams, 1966

Pl. 3, Figs. 1-2

Distribution—Neocomian to Ypresian (DAVEY *et al.*, 1966, p. 73).

Oligosphaeridium albertense (Pocock) Davey & Williams, 1966

Pl. 3, Fig. 3

Distribution—Lower Cretaceous (POCOCK, 1962).

Genus—**Cordosphaeridium** (Eisenack) Davey & Williams, 1966

Cordosphaeridium sp.

Pl. 2, Fig. 17

Description—Subspherical central body bearing very small number of processes. Processes short, 12 μ in length, cylindrical, hollow, erect, simple, digitate, 8-10 in number. Archaeopyle apical, haplo-tabular, reflected tabutation not clear.

Dimensions—Body 60×48 μ, Processes 12×8 μ, Archaeopyle 22×14 μ in size.

Genus—**Tenua** Eisenack, 1958

Tenua hystricella Eisenack, 1958

Pl. 3, Fig. 11, 16

Distribution—Upper Aptian (Eisenack, 1958, p. 411).

Genus—**Gonyaulacysta** Deflandre, 1954

Gonyaulacysta sp. cf. **G. orthoceras** (Eisenack) Sarjeant, 1966.

Pl. 4, Fig. 5

Description—Shell large 105 ×85 μ in size, ovoidal to sub-spherical, thick walled, walls 3 μ thick; apical horn tapering, 25 μ long, broader at base. Tabulation not very clear. Surface densely granular.

Remarks—The present specimens resemble in most of the morphological features with *G. orthoceras* (Eisenack) Sarjeant (1966). But due to the lack of complete tabulation it has been described as comparable species.

Distribution—Upper Valanginian onwards.

Gonyaulacysta helicoidea (Cookson & Eisenack) Sarjeant, 1966

Pl. 4, Fig. 7

Distribution—Lower Cretaceous.

Gonyaulacysta aichmetes Sarjeant, 1966

Pl. 4, Fig. 6

Distribution—Lower Cretaceous.

Gonyaulacysta serrata Cookson & Eisenack, 1958

Pl. 2, Figs. 14-15

Distribution—Upper Jurassic to probably Lower Cretaceous (Neocomian) (Cookson & Eisenack, 1958, p. 34).

Gonyaulacysta sp.

Pl. 4, Fig. 4

Description—Cyst ovoidal, wall moderately thick, over all length 128 μ, breadth 68 μ horn strong, tapering, 40 μ long, 4 μ broad at base. Horn about one-tenth of the total length. Tabulation probably 4', oa?, 2'', ?4c, 5''', Ip, 1''''. Plate boundaries outlined by low crests. Cingulum 3 μ wide, spiral. Shell surface granular with tubercles. Archaeopyle precingular.

Remarks—The present specimen has been placed under the genus *Gonyaulacysta* essentially due to the presence of an apical horn, with lack of antapical or median horns and the presence of precingular archaeopyle and granular shell surface. As the tabulation is uncertain no specific identification has been attempted.

Genus—**Exochosphaeridium** Davey *et al.*, 1966

Exochosphaeridium indicum sp. nov.

Pl. 3, Fig. 7

Holotype—Pl. 3, Fig. 7, Sl. No. 3952-17.
Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.
Horizon—Lower Cretaceous.
Diagnosis—Central body spherical, surface granular, bearing numerous acuminate processes; processes solid, broad based, bases of adjacent processes confluent, irregularly arranged, unequal in size. Apex of the process is not distinctly branched. Archaeopyle precingular.
Dimensions—Central body 40-50 μ in diameter, length of processes up to 15 μ.
Comparison—*E. indicum* sp. nov. differs from all the known species in having granulate surface and simple acuminate rarely branched processes.

Genus—**Prolixosphaeridium** Davey *et al.*, 1966

Prolixosphaeridium sp. cf. **P. granulosum** (Deflandre) Davey *et al.*, 1966.

Pl. 3, Fig. 5

Description—Central body elongate having about 35 processes. Processes simple, closed, curved, 8-12 μ, long, central body wall 1.5 μ thick, granular. Apical archaeopyle prominent.
Remarks—The present specimens have been placed under the above genus due to its elongate-ovoidal shell, apical archaeopyle and the placement of processes in rows.

Genus—**Baltisphaeridium** Eisenack, 1958

Baltisphaeridium lumectum Sarjeant, 1960

Pl. 3, Fig. 6, 8, 9

Distribution—Upper Jurassic onwards.

Baltisphaeridium sp.

Pl. 3, Fig. 10

Description—Vesicle circular, 30 μ in diameter, thin walled, processes short (10-15 μ long) numerous, thin, repeatedly and irregularly branched; distributed all over body.
Remarks—It is comparable with *B.* sp. described by Singh (1964, p. 141; pl. 19, fig. 8).

Genus—**Cyclonephelium** Deflandre & Cookson, 1955

Cyclonephelium distinctum Deflandre & Cookson, 1955

Pl. 3, Fig. 12

Distribution—Neocomian to Senonian (Gocht, 1959; Alberti, 1961); Cenomanian (Davey, 1969)

Genus—**Hexagonifera** (Cookson & Eisenack) Cookson & Eisenack, 1962

Hexagonifera scabrata sp. nov.

Pl. 4, Figs. 11-12

Holotype—Pl. 4, Fig. 11; Slide No. 3938-40
Type locality—North lime-stone quarry, Dalmiapuram, Distt. Trichinopoly.
Horizon—Lower Cretaceous.
Diagnosis—Shell globular, 50-80 μ diameter, without any horn or appendages, enclosed in a spongeous, fibre-like covering extending 4-6 μ beyond shell. Shell wall 4-5 μ thick, inner surface scabrate. Archaeopyle apical, apical operculum distinct, line of separation six sided, notches deep, 6 in number.
Comparison—*Hexagonifera scabrata* sp. nov. differs from all the known species of the genus in having deeply notched separation line and very thick, scabrate shell wall with spongeous-fibrous outer covering.
Remarks—DAVEY (1970 p. 349) remarks that the genus *Hexagonifera* appears to be restricted in stratigraphic range being recorded only from the Albian and Upper Cretaceous and is therefore of stratigraphic importance.

Genus—**Ovoidinium** Davey, 1970

Ovoidinium indicum sp. nov.

Pl. 4, Figs. 1-2.

Holotype—Pl. 4, Fig. 1; Slide No. 3941-1.
Type locality—North lime stone quarry, Dalmiapuram, Distt. Trichinopoly.
Horizon—Lower Cretaceous.
Diagnosis—Shell longer than broad, sides convex, girdle indistinct, longitudinal furrow absent, double walled; periphragm thin, microgranulate, extending apically to form a conical apical horn, antapically extending flatly without demarcating two separate horns with one to three-openings. Periphragm also shows lateral extension along girdle region; girdle mark decernible in a few specimens at outer margin of lateral periphragm extensions (Pl. 4, Fig. 2); endophragm thick, microgranulate, capsule oval, almost completely filling periphragm laterally. Archaeopyle apical, both endo- and periphragmused in archaeopyle formation, line of detachment circular to angular.

Holotype—Overall Size 95 × 87.5 μ; Capsule Size 80 × 70 μ.

Observed range—Overall size 80-95 × 70-90 μ; Capsule size 60-80 × 55-70 μ.

Comparison—*Ovoidinium indicum* sp. nov. compares best with *Ovoidinium ostium* Davey (1970) in having granular periphragm and sub-rectangular opening on the ventral side of the posterior pericoel membrane (position of opening in the present forms could not be ascertained). But differs due to the presence of lateral periphragm extensions, non-tuberculate granulate periphragm and its larger size.

Genus—**Odontochitina** Deflandre emend. Davey, 1970

Odontochitina subbaramana sp. nov.

Pl. 4, Fig. 3

Holotype—Pl. 4, Fig. 3; Slide No.. 3942-8.

Type locality—North lime stone quarry, Dalmiapuram, Distt. Trichinopoly.

Horizon—Lower Cretaceous.

Diagnosis—Shell oblong, apical part detached, capsule completing filling pericoel except along horn contact. Periphragm thick, extending apically and antapically forming single apical and two antapical horns. Apical horn long with slight expansion in middle. Antapical horns unequal, pointed, one out of two has typical expansion at 1/3 distance from point of origin. Perforations develops longitudinally from free pointed end to expanded region. Second antapical horn comparatively small and narrow with slight expansion at 1/3 distance from point of origin. Peri- and endophragm smooth.

Dimension—Over all size—150-180 μ×50-70 μ (excluding apical part).

Periphragm—1.5 μ thick.

Antapical Horns – 105×20 μ and 80×10 μ.

Apical Horn—80×10 μ in size.

Comparison—*Odontochitina subbaramana* sp. nov. compares only with *O. costata* Alberti (1961) and *O. striatoperforata* Cookson & Eisenack (1962) in having common perforations along the length of the antapical horns. But differs in not possessing any striations. It also differs in having characteristic expansion of one antapical horn at 1/3 distance from the point of origin.

Derivation of specific name—After Mr. J. V. Subbaraman, Geologist, Dalmia Cement Company, Dalmiapuram, Tamil Nadu.

Genus—**Palaeoperidinium** Deflandre, 1934

Palaeoperidinium spinosum Cookson & Hughes, 1964

Pl. 4, Fig. 8

Distribution—Lower Cretaceous.

INCERTAE SEDIS

Genus—**Chlamydophorella** Cookson & Eisenack, 1958

?Chlamydophorella sp.

Pl. 4, Fig. 9

Description—Shell outline oval, 64×48 μ in size, wall 6 μ thick, bearing widely placed rod-like processes, 5.5 μ long, 1.5 μ broad, expanding at their ends supporting a thin outer membrane. Apical archaeopyle present.

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EXPLANATION OF PLATES

(All magnifications × 500)

Plate 1

1. *Cyathidites minor* Couper, Sl. No. 3948-4.
2. *Cyatheacidites* sp. cf. *C. tectifera* Archangelsky & Gamerro; Sl. No. 3934-3.
3. *Cyatheacidites dalmiapuramensis* sp. nov., Sl. No.; 3949-5.
4. *Cyatheacidites dalmianpuramensis* sp. nov.; Sl. No. 3945-11.
5. *Hymenozonotriletes mesozoicus* Pocock; Sl. No. 3935-10.
6. *Hymenozonotriletes mesozoicus* Pocock; Sl. No. 3932-4.
7. *Trilites tuberculiformis* Cookson; Sl. No. 3950-2.
8. *Triletes tuberculiformis* Cookson; Sl. No. 3936-9.
9. *Verrucosisporites* sp.; Sl. No. 3937-7.
10. *?Lycopodiumsporites* sp.; Sl. No. 3932-25.
11. *Ceratosporites* sp.; Sl. No. 3948-7.
12. *Cicatricosisporites* sp. cf. *C. minor;* Sl. No. 3936-6.
13. *Contignisporites glebulentus* Dettmnan; Sl. No. 3932-21.
14. *Contignisporites dettmannii* Singh & Kumar; Sl. No. 3949-2.
15. *Appendicisporites* sp. A. Sl. No. 3934-8.
16. *Appendicisporites erdtmanii* Pocock; Sl. No. 3934-9.
17. *Appendicisporites cristatus* (Markova) Pocock; Sl. No. 3941-2.
18. *Kraeuselisporites* sp.; Sl. No. 3932-24.
19. *Trilobosporites indicus* sp. nov.; Sl. No. 3950-1.
20. *Lycopodiumsporites reticulumsporites* (Rouse) Dettmann; Sl. No. 3942-14.
21. *Cicatricosisporites* sp.; Sl. No. 3938-2.
22. *Spheripollenites subgranulosus* Couper; Sl. No. 3930-5.
23. *Converrucosisporites distinctus* sp. nov.; Sl. No. 3952-9.
24. *Taurocusporites* sp. cf. *T. reduncus* Stover; Sl. No. 3940-1.
25. *Callialasporites trilobatus* (Balme) Dev.; Sl. No. 3940-7.
26. *Podocarpidites* sp. A. Sl. No. 3933-2.
27. *Podocarpidites* sp. B. Sl. No. 3945-12.
28. *Podocarpidites* sp. B. Sl. No. 3945-8.
29. *Spheripollenites subgranulosus* Couper; Sl. No. 3940-6.
30. Spore type A; Sl. No. 3940-4.
31. Spore type B; Sl. No. 3937-2.
32. Spore type B under different focus.

PLATE 2

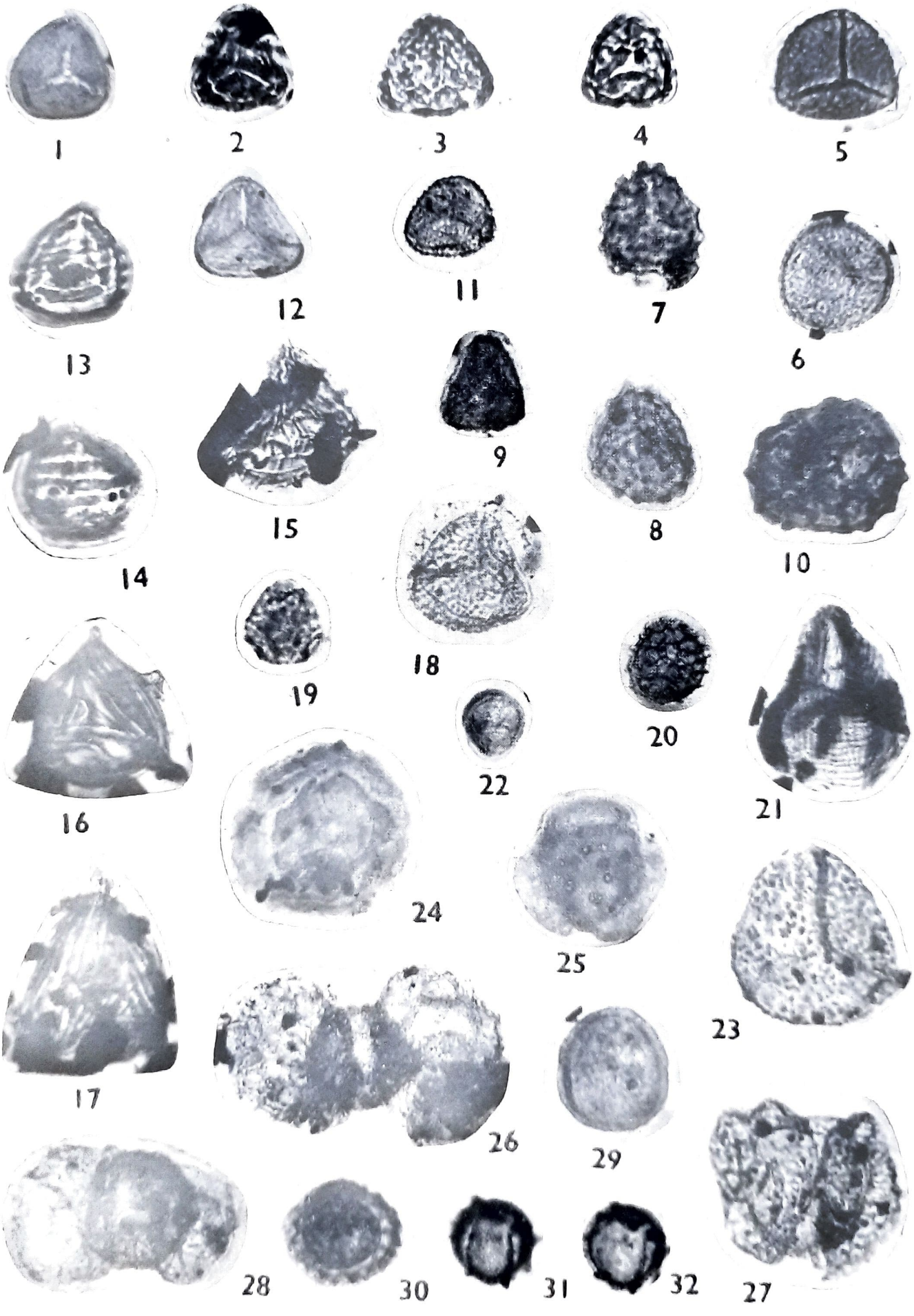
1. *Converrucosisporites distinctus* sp. nov.; Sl. No. 3938-55.
2. *Verrucosisporites* sp. cf. *V. obscurilaesuratus* Pocock; Sl. No. 3933-7.
3. *Ceratosporites equalis* Cookson & Dettmann; Sl. No. 3936-4.
4. Same in distal view.
5. *Biretisporites minutus* sp. nov.; Sl. No. 3952-20.
6. *Cicatricosisporites pseudotripartitus* (Bolk.) Dettmann; Sl. No. 3931-18.
7. *Matonisporites* sp.; Sl. No. 3952-18.
8–9. *Osmundacidites wellmanii* Couper; Sl. Nos. 3938-50 & 3938-63.
10. *Contignisporites novus* sp. nov.; Sl. No. 3936-22.
11. Same in distal view.
12. *Cyatheacidites* sp.; Sl. No. 3938-60.
13. *Appendicisporites* sp. B.; Sl. No. 3938-62.
14. *Gonyaulacystaerrata* Cookson & Eisenack; Sl. No. 3930-12.
15. *Gonyaulacysta serrata* Cookson & Eisenack; Sl. No. 3936-25.
16. *Trilobosporites indicus* sp. nov. No. 3950-1. × 1250 (Distal view).
17. *Cordosphaeridium* sp.; Sl. No. 3930-8.
18. *Coptospora micropunctata* sp. nov.; Sl. No. 3936-16.
19. *Coptospora psilata* sp. nov.; Sl. No. 3938-60.
20. *Coptospora psilata* sp. nov. Sl. No. 3952-25.
21. *Coptospora* sp.; Sl. No. 3938-47.
22. *Biretisporites minutus* sp.; nov. Sl. No. 3952-8.

PLATE 3

1. *Oligosphaeridium complex* (White) Davey *et al.*; Sl. No. 3932-24.
2. *Oligosphaeridium complex* (White) Davey *et al.*; Sl. No. 3952-6.
3. *Oligosphaeridium albertense* (Pocock) Davey *et al.*; Sl. No. 3952-5.
4. *Spiniferites ramosa* var. *granosa* Davey & Williams; Sl. No. 3933-5.
5. *Prolixosphaeridium* sp. cf. *P. granulosus* Davey *et al.*; Sl. No. 3934-2.
6. *Baltisphaeridium lumectum* Sarjeant; Sl. No. 3952-13.
7. *Exochosphaeridium indicum* sp. nov.; Sl. No. 3952-17.
8. *Baltisphaeridium lumectum* Sarjeant; Sl. No. 3935-4.
9. *Baltisphaeridium lumectum* Sarjeant, ; Sl. No. 3935-17.
10. *Baltisphaeridium* sp.; Sl. No. 3931-4.
11. *Tenua hystricella* Eisenback; Sl. No. 3938-20.
12. *Cyclonephelium distinctum* Deflandre & Cookson; Sl. No. 3948-5.
13. *Spiniferites* sp.; Sl. No. 3931-10.
14. *Spiniferites ramosa* var. *ramosa* Davey & Williams; Sl. No. 3931-3.
15. *Spiniferites ramosa* var. *ramosa* Davey & Williams; Sl. No. 3945-13.
16. *Tenua hystricella* Eisenack; Sl. No. 3937-7.

PLATE 4

1–2. *Ovoidinium indicum* sp. nov.; Sl. Nos. 3941-1 & 3940-8.
3. *Odontochitina subbaramana* sp. nov.; Sl. No. 3942-8.
4. *Gonyaulacysta* sp.; Sl. No. 3933-3.
5. *Gonyaulacysta* sp. cf. *orthoceras* (Eisenack) Davey *et al.*; Sl. No. 3937-4.
6. *Gonyaulacysta aichmetes* Davey *et al.*; Sl. No. 3934-7.
7. *Gonyaulacysta helicoidea* (Eisenack & Cookson) Davey *et al.*; Sl. No. 3945-10.
8. *Palaeoperidinium spinosum* Cookson & Hughes; Sl. No. 3952-72.
9. *?Chlamydophorella* sp.; Sl. No. 3933-1.
10. *Trilobosporites indicus* sp. nov.; Sl. No. 3950-1 (Proximal view ×1250).
11–12. *Hexagonifera scabrata* sp. nov.; Sl. Nos. 3938-40 & 3936-1.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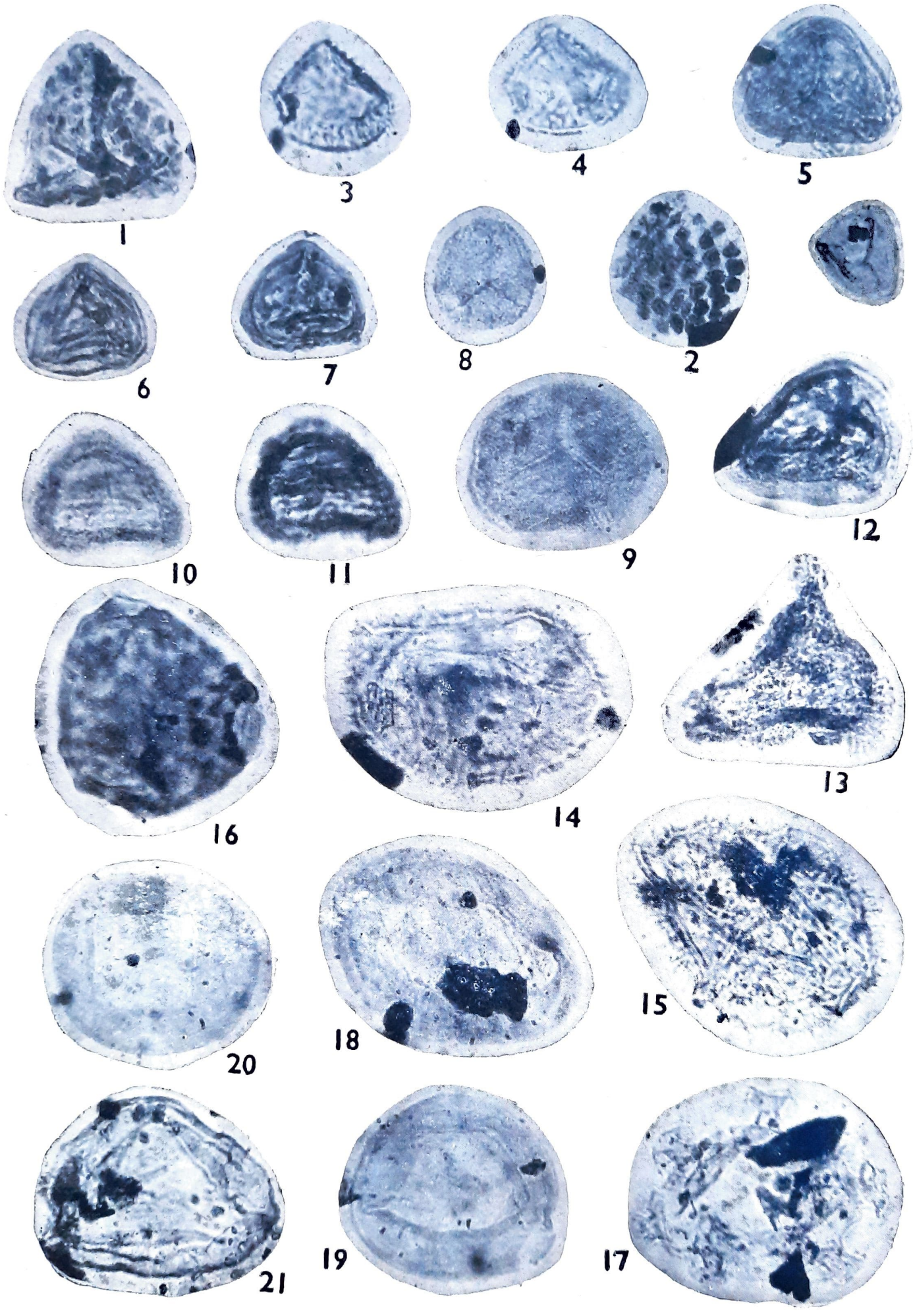
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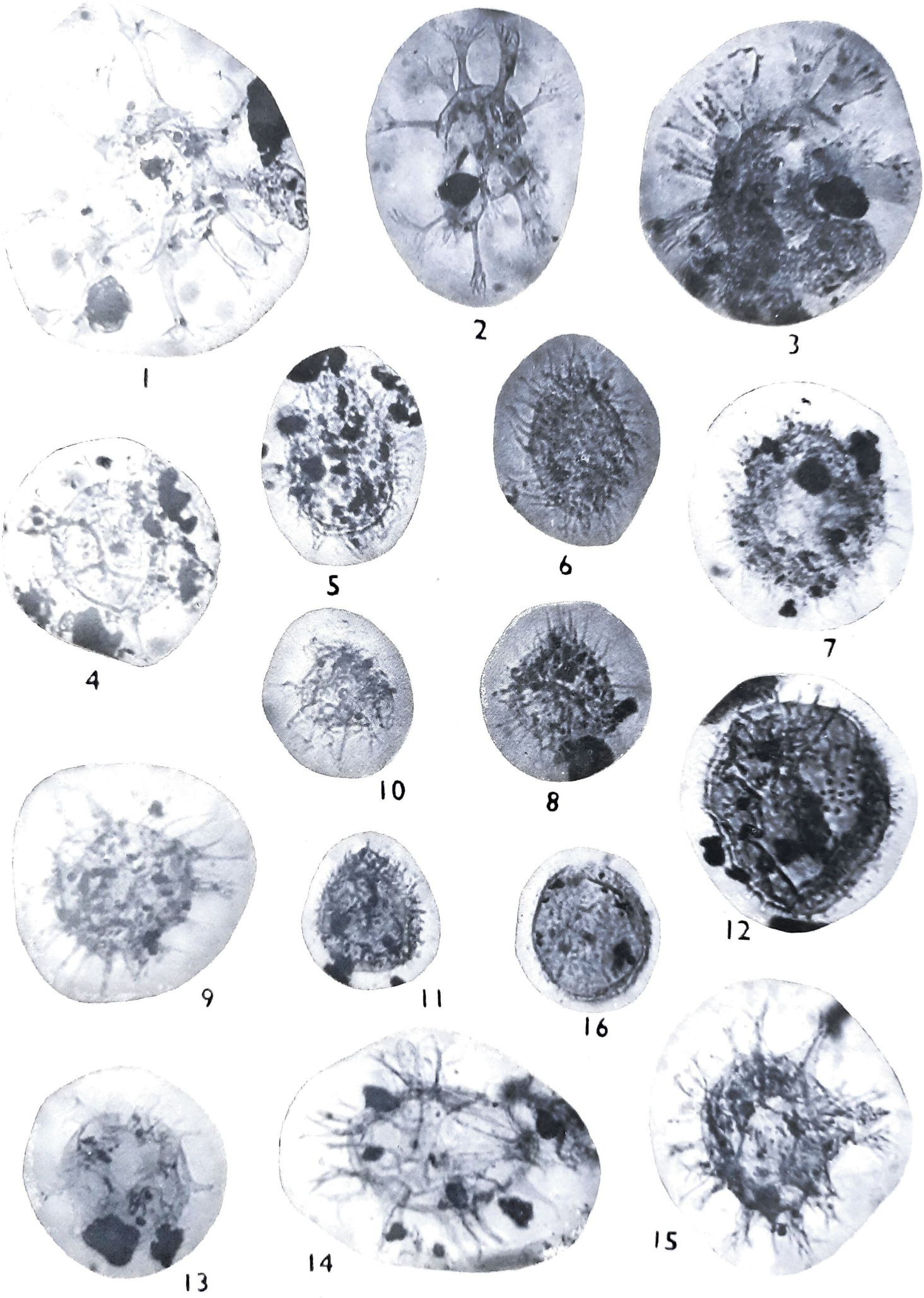
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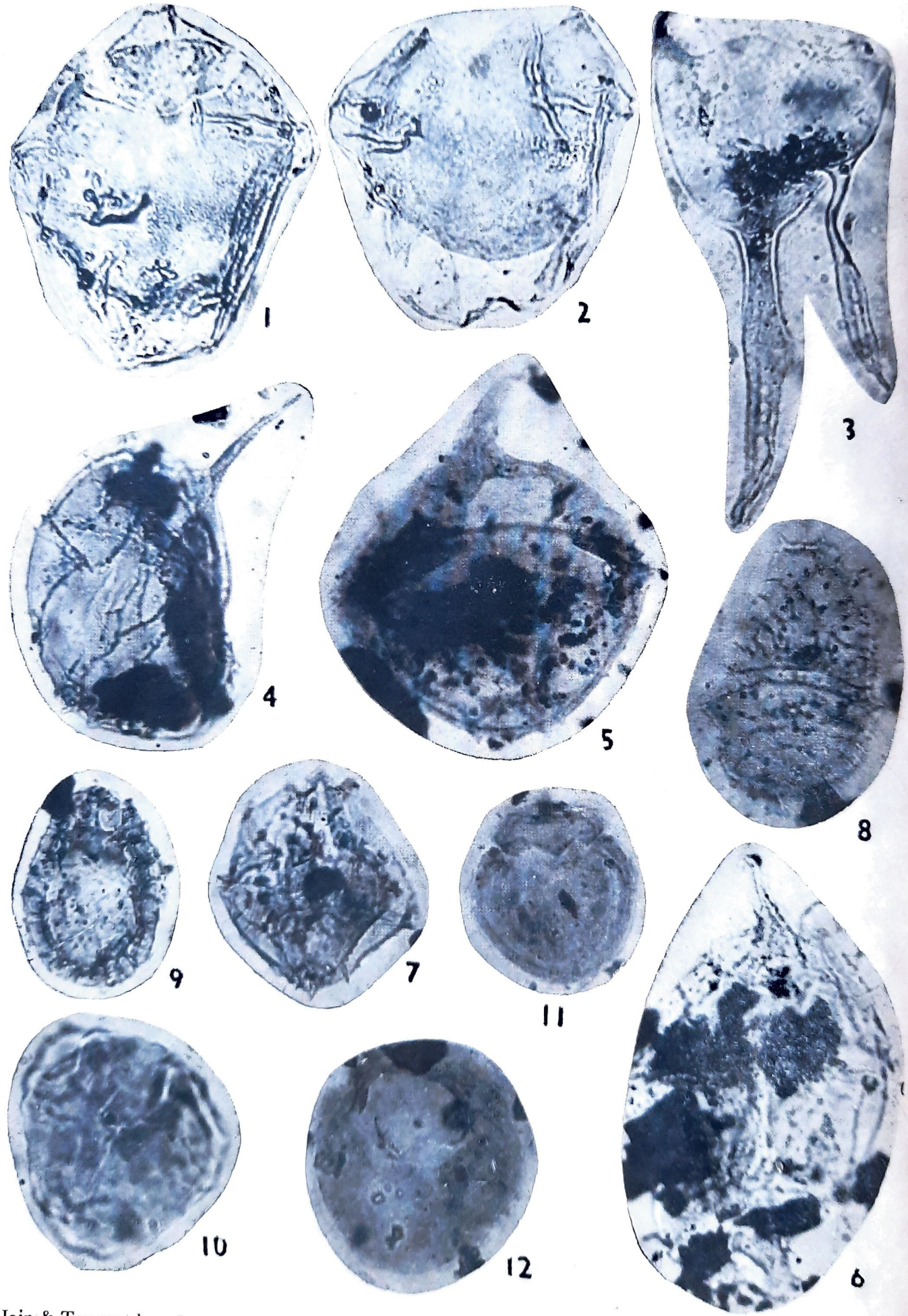

Jain & Taugourdeau-Lantz—Plate 4