STUDIES ON THE UPPER GONDWANA OF CUTCH — 1. MIO- AND MACROSPORES*

H. P. SINGH, S. K. SRIVASTAVA & S. K. ROY

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The present paper describes mio- and macrospores obtained from the Umia-beds (Uppermost Gondwana horizon) in Cutch (W. India). They are referred to 48 genera and 82 species, of which four genera viz. *Bacularetículosporis*, *Crassimonoletes*, *Umiaspora*, *Auriculozonospora*, and 40 species are new. The spore-flora is rich in pteridophytic spores and coniferous pollen grains. It has been compared with the other known assemblages from comparable strata. Finally a discussion on the probable age of Umia-beds, based on the study of *Sporae dispersae*, has been given indicating that these beds closely correspond to the Wealden (Lower Cretaceous) age.

INTRODUCTION

THE stratigraphical position and the age of Umia-beds, in Cutch (West India), considered as the Uppermost limit of the Gondwana formations, has been studied by earlier workers with the help of animal and plant fossils. Important workers in this field have been Blanford (1867), Wynne (1869, 1872), Grant (1840) and Feistmantel (1876). Among these, the work of Feistmantel (*loc. cit.*) on the Oolitic flora of Cutch is very comprehensive. The other works relating to the palaeontological and geological aspects of Umia-beds and other related formations have been chiefly done by Oldham (1869), Blanford (1869), Waagen (1873-76), Kitchin (1900, 1903), Spath (1924) and Rajnath (1942, 1952). Out of these, the work of Rajnath (*loc. cit.*) on the geology of Cutch is quite significant. Feistmantel (1876), on the records of the plant megafossils, has concluded that the age of Umia-beds is Lower Oolitic (Bathonian). Later on, Spath (1924) and Rajnath (1952), on the basis of comparative study of the fauna and flora of Cutch, have shown that the age of Umia-plant-beds (Bhuj Series) extends up to Post-Aptian or Middle Cretaceous. Sahni (1932, p. 322) has reported the occurrence of *Palmoxylon mathuri* in the Umia-beds and has supported the same view. Rajnath (1952) believes that the Bhuj Series has got at least three horizons, viz., *Zamia*-beds at the bottom, *Ptilophyllum*-beds in the middle and *Palmoxylon*-beds at the top. The present study on the dispersed spores in the Umia-beds has been carried out with a view to throw light on the geological age of these beds.

Spores from the other Upper Mesozoic formations in India have been described by Vishnu-Mittre (1954), Sah (1955), Ramanujam (1959), and Dev (1961). Balme (1957) and Cookson & Dettmann (1957, 1958 & 1959) have given an elaborate account of dispersed spores and pollen grains from the Upper Mesozoic deposits of Australia. Some of the notable contributions dealing with the dispersed spores in the Mesozoic strata, from the northern hemisphere, have been made by Bolchovitina (1956), Radforth and Rouse (1954), Couper (1958), Delcourt & Sprumont (1955), Lantz (1959), Rouse (1957) and Pocock (1962).

The available literature on the fossil megaspores of the Mesozoic strata, as compared to the Palaeozoic age, is much poorer. However, workers like Harris (1926, 1945, 1946), Miner (1932, 1935), Murray (1939), Dijkstra (1949, 1951), Hughes (1955), Mädler (1954), Cookson & Dettmann (1958), Jung (1958) and others have reported the occurrence of fossil megaspores in the Mesozoic sediments. They have vividly described the morphographical details of these mega-

*PREFATORY NOTE — In the present paper, the isolation of miospores and their taxonomic study from the coal samples has been done by me. The shale samples have been investigated by one of us (ROY) for their miospore content and morphographic study. The other co-author (SRIVASTAVA) has studied the megaspores out of the shale samples. For the purpose of publicationwe (SINGH, SRIVASTAVA & ROY) have compiled the data together, as it is presented here. The finalization of this work has been done by me.— H. P. SINGH.

spores and have also laid stress upon their stratigraphical significance.

MATERIAL AND METHODS

Coal and carbonaceous shale samples, for the present sporological study, were collected by Dr. U. Prakash and one of us (Srivastava) of the Birbal Sahni Institute of Palaeobotany, Lucknow in 1958 from two localities namely Trambau and Ghuneri which lie in the Umia-beds of Cutch in India.

The Trambau coal seam is exposed along the right bank of the rocky river-cutting at a distance of about three furlongs, south-west of Trambau village. It lies above the blue clay with carbonaceous markings and is overlain by a layer of carbonaceous shale. The samples out of this coal seam as well as the overlying carbonaceous shale were taken for sporological investigation.

The second coal seam is located, lying exposed at a depth of 15′ from the ground level, along a dried stream cutting at a distance of about 400 yards, south-west of Ghuneri village. The coal samples as well as the carbonaceous shale samples out of the under- and overlying layers of this seam were taken for study.

The necessary precautions to avoid contamination were taken and the samples were packed in brown paper bags and separately stored in card-board boxes.

Coal and shale samples were treated with nitric acid for 3-7 days. The oxidized material was washed acid-free and further treated with 5 per cent solution of KOH. The resulting dark brown liquid was washed and the macerate sieved. Megaspores were picked from the macerate, while in wet condition, under the low power binocular microscope and mounted as such in the glycerine jelly medium. Slides for miospores were separately made in the glycerine jelly medium.

The coal samples from both Trambau and Ghuneri localities failed to yield any intact megaspore types, but the carbonaceous shales of these localities yielded well preserved megaspores. Miospores were abundantly found in all the coal samples as well as carbonaceous shales.

The taxonomic arrangement of the mio- and macrospores in this work has been done according to the classification suggested by Potonié (1956, 1958 and 1960).

DESCRIPTION OF SPORAE DISPERSAE

Anteturma	***Sporites* H. Pot. 1893**
Turma	***Triletes* (Reinsch) Pot. & Kr. 1954**
Subturma	***Azonotriletes* Luber 1935**
Infraturma	***Laevigati* (B. & K.) Pot. 1956**

Genus *Deltoidospora* (Miner) Pot. 1956

Deltoidospora pseudoreticulata sp. nov.

Pl. 1, Fig. 1

Holotype — Pl. 1, Fig. 1; Sl. No. 1626.

Diagnosis — Trilete miospore, size 110-120 μ, triangular contour, with ± rounded angles, sides ± straight; Y-mark extending up to the equator; exine thin, ± smooth, irregularly folded, appearing structured.

Comparison — The spore specimen described and figured here shows a close resemblance with *D. hallii* Miner (1935, Pl. 24, Fig. 7) but the latter is much smaller in size and lacks ornamented exine of the spore and hence is not comparable.

Occurrence — Trambau carbonaceous shale.

Genus *Cyathidites* Coup. 1953

Cyathidites australis Coup. 1953

Pl. 1, Figs. 2, 3

Diagnosis — See Couper 1953.

Description of our specimens — Triangular miospore, size 50-80 μ, sides ± straight; Y-mark reaching ¾ of the radius, open; angles rounded; exine laevigate to faintly infragranulose, ± 1·5 μ thick.

Occurrence — Trambau carbonaceous shale.

Cyathidites minor Coup. 1953

Pl. 1, Figs. 4, 5

Diagnosis & Description — See Couper 1953, p. 28.

Remarks — Miospores referable to *C. minor* Coup., are found quite abundantly in the present assemblage. Morphographically these spores are comparable to the spores of *Coniopteris hymenophylloides* figured by Hamshaw-Thomas (1911, Pl. 3, Fig. 6) and Couper (1958, Pl. 20, Fig. 5).

Occurrence — Trambau coal, carbonaceous shale, Ghuneri coal and underlying carbonaceous shale.

Cyathidites pseudopunctatus sp. nov.

Pl. 1, Figs. 6, 7

Holotype — Pl. 1, Fig. 6; Sl. No. 1780.

Diagnosis — Miospores 80-110 μ in size, holotype 94 μ, triangular with concave sides and broadly rounded angles; Y-rays ¾ of the radius, labra thin, ray-ends rarely bifurcating, proximal as well as distal exine densely intrapunctate, more dense at the periphery, exine ± 1 μ thick; proximal and distal faces convex.

Comparison — The exine in *C.* australis Coup., differs from *C. pseudopunctatus* by not being densely intrapunctate, while *C. minor* Coup., is much smaller in size.

Occurrence — Ghuneri coal.

Cyathidites cutchensis sp. nov.

Pl. 1, Figs. 8-9

Holotype — Pl. 1, Fig. 8; Sl. No. 1784.

Diagnosis — Miospores 80-90 μ in size, holotype 80 μ, triangular, dark brown, sides concave, corners round; Y-mark ¾ of the radius, ± undulating, apex low; exine dark brown, ± thick, proximally and distally intrapunctate; proximal surface concave and distal surface convex.

Comparison — The specimens of *C. cutchensis* differ from *C. australis* in possessing a thicker exine. *C. pseudopunctatus* has got thinner exine which is densely intrapunctate. *C. cutchensis* is much bigger in size as compared to the spores of *C. minor* Coup.

Occurrence — Ghuneri coal.

Cyathidites grandis sp. nov.

Pl. 1, Figs. 10, 11

Holotype — Pl. 1, Fig. 10; Sl. No. 1785.

Diagnosis — Miospore 90-102 μ in size, holotype 96 μ, triangular, yellowish brown, with straight to concave sides and rounded angles; Y-rays ¾ of the radius, labra thin; exine proximally ± laevigate, punctate along the Y-mark area, puncta small, sparsely arranged in two or three rows, distally laevigate; *extrema lineamenta* entire.

Comparison — The specimens referred to *C. grandis* differ from all the other known species of *Cyathidites* by the presence of puncta along the Y-mark area which are arranged in one or two rows.

Occurrence — Ghuneri coal.

Cyathidites ghuneriensis sp. nov.

Pl. 1, Figs. 12, 13

Holotype — Pl. 1, Fig. 12; Sl. No. 1787.

Diagnosis — Miospores 62-96 μ in size, holotype 80 μ, triangular with concave sides, apices usually round sometimes longish-round. Y-mark distinct, ¾ radius long, thin, usually open, ray-ends sometimes bifurcating; proximal as well as distal exine intragranulose, about 1 μ thick; *extrema lineamenta* slightly rough.

Comparison — The specimens of *C. ghuneriensis* differ from rest of the species in having concave sides and intragranulose ornamentation of the exine. Some specimens described as *Cyathidites* sp. by Dev (1959) from the Jabalpur Series of India agree very much to the diagnosis of *C. ghuneriensis*, excepting that they are much smaller in size.

Remarks — The spore type described by Sah (1953, Pl. 1, Fig. 6) under *Leiotriletes* is comparable with *C. ghuneriensis* in having intragranulose exine and deeply concave sides; and can probably be included here.

Occurrence — Trambau carbonaceous shale and Ghuneri coal.

Genus *Alsophilidites* (Cooks.) Pot. 1956

Alsophilidites densus sp. nov.

Pl. 2, Figs. 14, 15

Holotype — Pl. 2, Fig. 15; Sl. No. 1790.

Diagnosis — Miospores 60-80 μ, holotype 80 μ, subtriangular, with ± straight sides, broadly rounded angles; Y-mark distinct, trilete rays extending up to the equator, apex high, ray-vertex gradually lowering towards the equator, ray-ends sometimes bifurcating; exine thick, dark brown, intrapunctate; *extrema lineamenta* rough.

Comparison — *A. kerguelensis* Cooks., is reported from the Tertiary of Kerguelen Archipelago and possesses thinner and laevigate exine and hence it is not comparable with *A. densus*.

Occurrence — Ghuneri coal.

Genus *Gleicheniidites* (Ross) Delc. & Sprum. 1955

Gleicheniidites indicus sp. nov.

Pl. 2, Figs. 16-18

Holotype — Pl. 2, Fig. 16; Sl. No. 1792.

Diagnosis — Miospores 28-48 μ in size, triangular, sides ± concave to slightly convex, angles sharp; Y-rays reaching up to the equator, ray-vertex slightly raised; exine laevigate, prominently thickened in between the apices.

Comparison — The spore specimens described here are very much comparable to *Gleicheniidites senonicus* Ross which is, however, geographically and stratigraphically widely separated and belongs to northern hemisphere formations (DELCOURT & SPRUMONT, 1955, PL. 1, FIG. 5). Organizationally, *Gleichenia concavisporites* Rouse and *G. circinidites* Cooks are also comparable to our specimens but both these forms are different from *G. indicus* in one or more characters.

Occurrence — Trambau coal and carbonaceous shale.

Genus *Concavisporites* Pflug

Concavisporites cutchensis sp. nov.

Pl. 2, Fig. 19

Holotype — Pl. 2, Fig. 19; Sl. No. 1791.

Diagnosis — Size 50-62 μ, holotype 50 μ, triangular miospore with straight to slightly concave sides and rounded corners; Y-rays almost extending up to the equator; ray-vertex elevated bound by conspicuously thick interradial bands, curving over the ray-ends; exine laevigate.

Comparison — *Concavisporites juriensis* Balme is different by having arcuate thickenings looping over the distal side; while *C. infirmus* Balme shows a finely rugose or incipiently microreticulate exine.

Remarks — Organizationally comparable spores are figured under *Phlebopteris exornatus* Bolcho. by Bolchovitina (1956, PL. 1, FIGS. 9a & b). Reissinger (1950, PL. 12, FIG. 4) has illustrated comparable forms from the Liassic of Europe. *Sporonites neddeni* R. Pot., has been recorded by Rogalska (1954, PL. 1, FIG. 11) from the Liassic coals of Poland which compares well with *C. cutchensis*. Sahni & Sitholey (1945) have described *in situ* spores of *Phlebopteris hirsuta* Sahni & Sitholey, which are comparable to the spores of *C. cutchensis*, but they are different in having thicker exine particularly at the corners, and a 'margo' like feature flanking the Y-rays.

Occurrence — Trambau coal.

Concavisporites cf. *punctatus* Delc. & Sprum. 1955

Pl. 2, Fig. 20a

Description — Miospore ± 70 μ, triangular with rounded angles and concave sides; Y-rays extending ¾ of the radius, surrounded by a kyrtome, broader near the poles and narrower near the ends; exine appearing infragranulose to infrapunctate.

Remarks — The specimen referred here as *C.* cf. *punctatus* shows close resemblance with the specimens of *C. punctatus* figured by Delcourt & Sprumont (1955, PL. 1, FIG. 8; PL. 2, FIG. 2). As this species is reported from the Wealden of Belgium so we defer to include our specimen in one and the same species. The spores of *C.* cf. *punctatus* occur very scantily in this assemblage and, therefore, their taxonomic treatment, at present, is provisional. Delcourt, Dettmann and Hughes (1963) have reassigned *C. punctatus* to the genus *Cyathidites*.

Occurrence — Trambau carbonaceous shale.

Genus *Matonisporites* Coup. 1958

Matonisporites sp.

Pl. 2, Fig. 20b

Description — Triangular miospores, 30-44 μ in size, sides ± straight, angles narrow; Y-mark distinct, approaching the equator, flanked by a distinct margo, raised; exine ± smooth, more thickened inbetween the apices than at the apices.

Remarks — The specimens figured here does not compare much with the spore species of *M. equiexinus* Coup. and *M. phlebopteroides* Coup. as the exine in the former case is thinner in comparison to both the latter mentioned species. The spore specimen described as cf. *Leiotriletes* by Sah (1955, Type 2, PL. 1, FIG. 3) is closely comparable.

Occurrence — Trambau carbonaceous shale.

Genus *Trileites* (Erdtm.) Pot. 1956

Trileites sp. A

Pl. 2, Fig. 21

Description — Size ± 281 μ, trilete megaspore, ± globose; trilete lamellae distinct, 8-11 μ high and 6 μ broad; Y-rays extending almost up to the equator, ray-ends connected by slightly convex arcuate ridges, 5-6 μ broad and 5-6 μ high; spore wall single layered, 1·5 μ thick, translucent, finely granulose; contact facets not depressed.

Remarks — Most of the species of the genus *Trileites*, dispersed both in the Mesozoic and Palaeozoic strata, have larger size as compared to the present specimen. This specimen is the only record in this assemblage.

Occurrence — Trambau carbonaceous shale.

Trileites[1] sp. B

Pl. 2, Fig. 22

Description — Size ± 845 μ in diameter, trilete megaspore, ± rounded in shape; spore wall 30-34 μ thick, consisting of finely granular substance; proximal face marked with radially arranged and irregularly undulating ridges or thickenings, 20-28 μ broad; Y-rays sutures thin, lying among the thickenings.

Remarks — The ridges or thickenings on the proximal face of the exine do not appear to compare with the "neck" or gula of the *Lagenicula*-type of megaspores. *Trileites subdeltoides* (Dijkstra) Pot., has got similar type of folds and plications on the proximal side but along with a neck-like apical structure.

Occurrence — Underlying Ghuneri carbonaceous shale.

Infraturma *Apiculati* (B. & K.) Pot. 1956

Genus *Lycopodiacidites* (Coup.) Pot. 1956

Lycopodiacidites minor sp. nov.

Pl. 2, Figs. 23-24

Holotype — Pl. 2, Figs. 23, 24; Sl. No. 1613.

Diagnosis — Miospore 28 μ in size, ± triangular in equatorial outline, sides ± straight; Y-mark approaching the equator; proximal face smooth; distal face beset with verrucae, verrucae 2-4 μ in size, about 2 μ high, along the equator.

Comparison — As compared to other species of *Lycopodiacidites*, *L. minor* is smaller in size and has got ± triangular shape with ± straight sides.

Occurrence — Trambau carbonaceous shale.

Genus *Verrutriletes* (Van der Hammen) Pot. 1956

Verrutriletes sp. A

Pl. 2, Fig. 25

Description — Size ± 470 μ in diameter, megaspore ± circular; spore wall 15-18 μ thick; Y-mark faintly discernible; exine surface covered with thick, solid, dense and ± triangular to roundly conical protuberances all over, tubers 31-45 μ broad at the base and 15-24 μ high, at places with confluent bases; arcuate folds and contact facets not present.

Comparison — In *Triletes pemphigus* Harris, similar type of protuberances are recorded as is the case in *Verrutriletes* sp. A. They are, however, hollow and rounded. *Verrutriletes dubius* (Dijkstra) Pot., has mammaliform and hemispherical papillae which are separately placed. *V. hopeniensis* (Selling) Pot., on the other hand shows thicker and obtuse warts.

Occurrence — Trambau carbonaceous shale.

Genus *Lophotriletes* (Naum.) Pot. & Kr. 1954

Lophotriletes sp.

Pl. 2, Fig. 26

Description — ± Triangular miospore, size ± 65 μ, angles broadly rounded and ± convex sides; Y-mark apparent, $\frac{3}{4}$ of the radius long; exine covered with numerous closely placed coni or conical warts which are slightly confluent at the base.

Occurrence — Trambau carbonaceous shale.

Genus *Osmundacidites* Coup. 1953

Osmundacidites cf. *wellamanii* Coup. 1953

Pl. 2, Fig. 27

Description — ± Circular miospore in outline; Y-mark distinct, Y-rays ± $\frac{1}{2}$ of the radius long; exine surface covered with granulo-papillate ornamentation, 0·5-2 μ broad, 2-4 μ high, along the equator.

Remarks — In ornamentation pattern the present specimen closely agrees with the genotype of *Osmundacidites* but differs from

1. *Trileites* sp. b is reassigned to *Hughesisporites* Pot. It compares well with *H. variabilis* Dettmann under the **Turma Barbates** Mädler.

it in having more prominent papillate processes.

Occurrence — Trambau carbonaceous shale.

Osmundacidites indicus sp. nov.

Pl. 2, Figs. 28-29

Holotype — Pl. 2, Fig. 28; Sl. No. 1793.

Diagnosis — Miospores 30-38 μ in size, holotype 34 μ, ± subcircular to circular, Y-mark perceptible, Y-rays thin and faint, about 14 μ long, equal, appearing bright in the top focus, exine thin, often folded, granulose; grana longish, closely disposed, projecting as high as 1·5 μ along the equator.

Comparison — *O. wellmanii* is bigger in size and has more prominent granulo-papillose ornamentation as compared to *O. indicus*. *O. comaumensis* (Cooks.) Balme has also got more prominent excrescences than in *O. indicus*.

Remarks — Morphographically, spores referred to *O. wellmanii* by Couper (*loc. cit.*) and from this assemblage are comparable with the *in situ* spores of *Osmundopsis plectophora* Harris and *Todites hartzi* Harris.

Occurrence — Ghuneri coal.

Genus *Baculatisporites* Thoms. & Pflug 1953

Baculatisporites comaumensis (Cooks.) Pot. 1956

Pl. 2, Fig. 30

Description — Miospores 30-50 μ in diameter, ± circular; Y-mark thin, Y-rays extending almost up to the equator; exine thin, ornamented with closely placed small bacula, up to 1·5 μ long and 1 μ broad, usually projecting beyond the *extrema lineamenta*.

Occurrence — Trambau carbonaceous shale.

Genus *Bacutriletes* (Van der Hammen) Pot. 1956

Bacutriletes cutchensis sp. nov.

Pl. 2, Figs. 31-33

Holotype — Pl. 2, Fig. 31; Sl. No. 1717.

Diagnosis — Trilete megaspore, size 600-1,025 μ, outline rounded; spore wall 14-27 μ thick; Y-mark thick, trilete rays extending up to $\pm \frac{3}{4}$ of the radius, exine closely placed with vermiform bacula or papilla (30-60 μ long and 6-13 μ broad at the base) having rounded tops; arcuate ridges and contact facets not clear.

Comparison — *B. cutchensis* is abundantly represented in this assemblage. *B. tylotus* (Harris) Pot., is smaller in size and possesses bacula with transversely truncated ends. In *B. arnoldii* (Miner) Pot., the bacula have rounded apices, and also the size is smaller. *B. greenlandicus* (Miner) Pot., differs from *B. cutchensis* in having smaller size and finger-like appendages which are slightly longer than broad.

Occurrence — Ghuneri underlying carbonaceous shale.

Bacutriletes dijkstrae sp. nov.

Pl. 3, Figs. 34-35

Holotype — Pl. 3, Fig. 34; Sl. No. 1722.

Diagnosis — Trilete megaspores; size 720-760 μ; ± circular in shape; spore wall 12·5-20 μ thick; Y-mark conspicuous, Y-rays $\pm \frac{1}{2}$ of the radius long, labra 9-13 μ broad; proximal exine covered with finger-like bacula forming a broad expanse, bacula closely placed, 30-60 μ long and 10-12 μ broad with rounded ends; distal exine ± smooth; arcuate ridges not observed.

Comparison — The shape of bacula in *B. dijkstrae* is more finger-like to vermiform than in *B. cutchensis*. The absence of bacula on the distal side of *B. dijkstrae* distinguishes it from the other species viz., *B. arnoldii*, *B. tylotus* and *B. greenlandicus*.

Remarks — The specimens of *B. dijkstrae*, if overmacerated, tend to lose their original ornamentation.

Occurrence — Ghuneri underlying carbonaceous shale.

Infraturma *Murornati* Pot. & Kr. 1954

Genus *Bacularetículosporis* gen. nov.

Genotype — *B. cutchensis* gen. et sp. nov.

Generic Diagnosis — ± Circular miospores in equatorial outline; Y-mark not discernible; exine reticulate, meshes bearing unequal, prominent bacula at the intersections of the muri.

Generic Comparison — A clearly reticulate ornamentation of the exine along with baculate projections at the intersections of the muri in *Bacularetículosporis* are the characters which are not shared by any of the other known genera. *Baculatisporites*

Thoms. & Pflug shows a clearly defined Y-mark, and the exine lacks the type of ornamentation as it is in *Bacularetículosporis*. *Cyclobaculisporites* Bhard., differs from *Bacularetículosporis* by the presence of so closely set bacula that the intervening spaces simulate negative reticulum. In the case of *Bacularetículosporis*, such a feature is not evident and hence it is proposed as a new genus.

Bacularetículosporis cutchensis gen. et sp. nov.

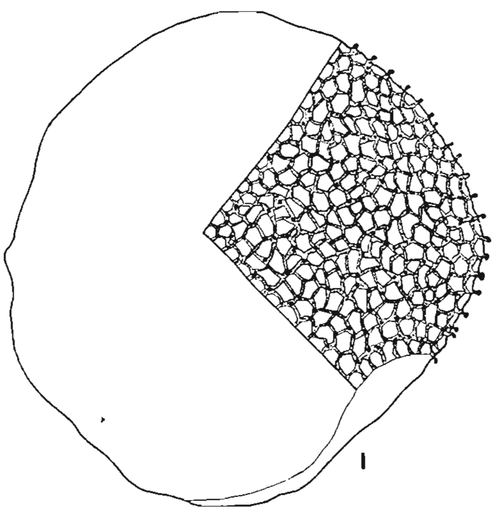
Pl. 3, Fig. 36; Pl. 10, Fig. 126; Text-fig. 1

Holotype — Pl. 3, Fig. 36; Sl. No. 1594.

Diagnosis — Miospores 110-115 μ in size, ± circular in equatorial outline; Y-mark not observed; exine reticulate; muri 1-2 μ broad, lumina 3-6 μ wide in diameter; bacula 1-2·5 μ long, 0·5-1 μ broad, present at the intersections of the muri, usually projecting beyond the *extrema lineamenta* which is rough.

Remarks — In *Baculatisporites sehorensis* Dev (1961, Pl. 2, Figs. 11, 12) the presence of bacula on the intersections of the muri is reported. In view of this, it can be transferred to the genus *Bacularetículosporis* under a new combination as *B. sehorensis* (Dev) comb. nov.

Occurrence — Trambau carbonaceous shale.



Text-fig 1 — Organization of *Bacularetículosporis cutchensis* gen. et sp. nov., in polar view; Text-fig 1, Sl. No. 1954.

Genus *Horstisporites* Pot. 1956

Horstisporites cf. *reticuliferus* (Dijk.) Pot. 1956

Pl. 3, Fig. 37

Description — Size range 560-940 μ, megaspores ± spherical in shape; spore wall 13-22 μ thick, ornamentation marked by irregularly thick anastomosing ridges, or raised ledges all over, 16-22 μ broad, lumina 30-42 μ in diameter, irregular or polygonal in shape; Y-mark ± 2/3 of the radius length, 20-35 μ broad, labra thick, thicker at the apex and narrower at the ends; contact facets and arcuate folds not seen.

Remarks — This species i.e. *H.* cf. *reticuliferus* is represented by many broken fragments and fewer intact specimens in the carbonaceous shale samples of Trambau. These megaspores probably appear to be very fragile and sensitive to the maceration techniques employed, thus crumbling into small fragments. The ornamentation in all these broken fragments and also in the complete specimens is almost similar to that of *H. reticuliferus*, a Wealden species of the Bore Coals of Netherland.

Occurrence — Trambau carbonaceous shale.

Horstisporites sp. A

Pl. 3, Fig. 38

Description — Size 564 μ, ± spherical megaspore; Y-mark faint and imperfectly discernible; arcuate ridges and contact facets not apparent; exine surface ornamented with rounded to irregularly polygonal cavities, separated by ± irregularly anastomosing muri or ridges (8-13 μ broad); spore wall single layered, 24-26 μ thick at the ridges and 13-16 μ thick at the cavities.

Remarks — The present megaspore specimen is the only one obtained. Its ornamentation is closely similar to *Triletes cyttaria* Kendall. In the opinion of one of us (Srivastava) the organization and the ornamentation of *T. cyttaria* type of megaspores is indistinguishable from that of *Horstisporites* Pot., and thus *T. cyttaria* type of megaspores can be included safely within the diagnosis of the genus *Horstisporites*.

Occurrence — Trambau carbonaceous shale.

Genus *Lycopodiumsporites* Thierg. 1938

Lycopodiumsporites trambauensis sp. nov.

Pl. 3, Figs. 39, 40

Holotype — Pl. 3, Fig. 40; Sl. No. 1645.

Diagnosis — Known size range 104-120 μ, roundly triangular miospores; Y-mark faintly discernible, Y-rays extending ± up to the equator; exine reticulate, meshes distally 12-20 μ broad, usually polygonal or irregular in shape, muri thick, raised, 2-4 μ high; projecting beyond the *extrema lineamenta*.

Comparison — Miospores of *L. trambauensis* differ from *L. austroclavatidites* Cooks. (1953, Pl. 2, Fig. 35) and *L. austroclavatidites tenuis* Balme (1957, Pl. 1, Figs. 9-11) in having faintly discernible Y-mark, bigger and broader meshes, and larger size. Rest of the species viz., *L. cerniidites* (Ross) Delc. & Sprum., *L. elongatus* Delc. & Sprum., *L. potoniei* (Thoms. & Pflug) Pot., and *L. triarcuatus* Delc. & Sprum., are known from the northern hemisphere, and besides that they also differ in having other morphographical characters as compared to the spores of *L. trambauensis*.

Occurrence — Trambau coal and carbonaceous shale.

Genus *Erlansonisporites* Pot. 1956

Erlansonisporites cf. *erlansonii* (Miner) Pot. 1956

Pl. 4, Fig. 41

Description — Size 448-608 μ, ± spherical megaspore in shape; spore wall 14-20 μ thick; Y-mark distinct, ± $\frac{3}{4}$ radius long, 16·5-24 μ broad; exine reticulate with irregular, diaphanous appendages on the muri, raised, 24-58 μ high; contact facets and arcuate ridges not found.

Occurrence — Trambau carbonaceous shale.

Genus *Ischyosporites* Balme 1957

Ischyosporites crateris Balme 1957

Pl. 4, Fig. 42

Description of our specimens — Size 50-76 μ, subtriangular miospore, sides ± convex with rounded angles; Y-rays clear, almost reaching the equator; exine ± 5 μ thick, proximally smooth, distally ornamented with thick ridges simulating negative reticulum; meshes 10-16 μ broad.

Occurrence — Trambau carbonaceous shale.

Genus *Contignisporites* Dettm. 1963

Contignisporites fornicatus Dettm. 1963

Pl. 4, Fig. 43

Description — See Dettmann 1963.

Occurrence — Trambau carbonaceous shale.

Contignisporites cooksonii (Balme) Dettm. 1963

Pl. 4, Figs. 44-45

Description — See Dettmann 1963

Remarks — In the Trambau shale samples, spore specimens of *C. cooksonii* occur quite abundantly. Balme (1957) opines that this species is very richly distributed in the Cretaceous deposits of eastern Australia. Dettmann (1963) has reported that the occurrence of *C. cooksonii* in the Mesozoic strata of Australia is also fairly good. Petrified spores, appearing similar to our specimens, are reported by Vishnu-Mittre (1954, Pl. 1, Figs. 10, 14-16) from the Nipania cherts in Rajmahal Series, Bihar, India.

Occurrence — Trambau carbonaceous shale.

Turma	***Zonales* (B. & K.) Pot. 1956**
Subturma	***Auritotriletes* Pot. & Kr. 1954**
Infraturma	***Auriculati* (Schopf) Pot. & Kr. 1954**

Genus *Trilobosporites* (Pant) Pot. 1956

Trilobosporites trioreticulosus Cooks. & Dettm. 1958

Pl. 4, Fig. 46

Description of our specimens — Size 88-90 μ, triangular miospore in equatorial contour, sides markedly concave with rounded angles; Y-mark distinct, Y-rays reaching $\frac{2}{3}$ of the radius; exine coarsely granulose, simulating strongly negative reticulate ornamentation at the angles.

Remarks — The specimens of *T. trioreticulosus* recovered by us are larger in size as compared to the size of the spores of the same species described by Cookson and Dettmann (*loc. cit.*).

Occurrence—Trambau carbonaceous shale.

Trilobosporites apiverrucatus Coup. 1958

Pl. 4, Figs. 47-48

Description of our specimens — Size 100-110 μ, triangular miospores in equatorial contour, sides slightly to deeply concave having rounded angles; Y-mark distinct, open, Y-rays thin, extending $\pm \frac{1}{2}$ or more of the radius; exine verrucose, verrucae big, projecting beyond the spore margin.

Occurrence — Trambau carbonaceous shale.

Genus *Valvisisporites* (Ibr.) Pot. & Kr. 1954

Valvisisporites minor sp. nov.

Pl. 4, Figs. 49-50

Holotype — Pl. 4, Fig. 49; Sl. No. 1692.

Diagnosis — Trilete megaspore, known size range 220-265 μ, (incl. cingulum) ± subtriangular in equatorial outline, spherical when laterally compressed. Cingulum weakly developed or very much reduced around the equator, usually distinct at the ray-ends as an auriculate expansion of the exine, auriculae 28-33 μ × 43-57 μ in size. Y-mark distinct, with thin lamellae, 19-28 μ high; ray-ends extending up to the margin of auriculae. Exine 5-8·5 μ thick; arcuate ridges inconspicuous. Inner body visible in one of the well preserved specimens.

Comparison — All the species, so far, described under the megaspore form-genus *Valvisisporites* belong to the Palaeozoic age. They are characterized by possessing an auriculate cingulum. Similar type of character is noticed in our specimens of *V. minor*. This new species as compared to the other species of the genus *Valvisisporites* is comparatively smaller in size and has smaller auriculae. Besides these morphographical differences, stratigraphical disparity in age is also great and for these reasons *V. minor* is separated from the other Palaeozoic forms.

Occurrence — Trambau carbonaceous shale.

Subturma *Zonotriletes* Waltz 1935
Infraturma *Cingulati* Pot. & Kl. 1954

Genus *Boseisporites* (Dev) emend.

Remarks — Dev (1959) has described *Boseisporites* from the Jabalpur Series of India. According to the generic diagnosis, as given by him, it is stated that the spore exine is sculptured but in the description of the geno-holotype i.e. *B. praeclarus* it is mentioned that the spore exine is laevigate, infragranulate. Evidently, this is a contradictory statement. The examination of a very closely resembling specimen and described under the same species from the present assemblage shows that the exine of the central body is thin and intrapunctate. Unfortunately, the type specimen of *B. praeclarus* was not traceable for examination, however, the fact remains that *Boseisporites* includes only those forms which are sculptureless but structured (intrapunctate). Accordingly, we have emended the diagnosis of *Boseisporites*.

Diagnosis (emend.) — Triangular miospores with straight to ± concave sides and rounded apices. Y-rays almost reaching the corners, faint to prominent. Equatorial cingulum smooth, broader at the angles than at the sides. Exine of the central body intrapunctate.

Boseisporites praeclarus (Dev) emend.

P. 4, Fig. 51

Diagnosis (emend.) — The same as generic diagnosis.

Description of our specimens — Triangular miospore in equatorial view, size 71-87 μ, sides straight or slightly concave with broadly rounded angles; Y-rays indistinct to fairly marked; cingulum unequal, broader at the angles (6-8 μ) and narrower at the sides; exine thin, intrapunctate.

Occurrence — Trambau carbonaceous shale.

Genus *Cyatheacidites* (Cooks.) Pot. 1956

? *Cyatheacidites verrucosus* sp. nov.

Pl. 4, Figs. 52-53

Holotype — Pl. 4, Fig. 53; Sl. No. 1621.

Diagnosis — Size ± 110 μ, triangular miospores in equatorial outline, sides ± straight, angles broadly rounded; Y-mark prominent, Y-rays long, just approaching the corners; cingulum thick, solid and smooth; proximal exine verrucose, verrucae closely spaced, measuring about 6-7 μ in size along the equator, simulating negatively reticulate ornamentation; distally intrapunctate.

Comparison — The spores of *C. verrucosus* differ from *C. annulata* (Cooks.) Pot. in having triangular shape, densely verrucose ornamentation of the exine on the whole of proximal face.

Occurrence—Trambau carbonaceous shale.

? *Cyatheacidites granulosus* sp. nov.

Pl. 4, Fig. 54

Holotype — Pl. 4, Fig. 54; Sl. No. 1621.

Diagnosis — Size ± 114 μ, roundly triangular miospores in equatorial outline, sides ± slightly convex, angles broadly rounded; Y-mark distinct, Y-rays extending almost up to the angles; cingulum ± smooth, usually broader near the angles than at the sides; proximal exine granulose, distally indeterminably structured.

Comparison — *C. granulosus* differs from *C. annulata* in having granulose ornamentation of the exine and bigger size. *C. verrucosus* has verrucose ornamentation of the exine and hence is not comparable.

Occurrence — Trambau carbonaceous shale.

Genus *Staplinisporites* Pocock 1962

Staplinisporites caminus (Balme) Pocock 1962

Pl. 4, Figs. 55-56

Description — See Pocock 1962.

Occurrence—Trambau carbonaceous shale.

Genus *Densoisporites* (Wey. & Krieg.) Dettm. 1963

Densoisporites mesozoicus sp. nov.

Pl. 4, Fig. 57

Holotype — Pl. 4, Fig. 57; Sl. No. 1618.

Diagnosis — Size 70-82 μ, miospore subtriangular in equatorial outline; Y-mark distinct, Y-rays nearly reaching the equator of the spore body; cingulum ± 10 μ wide; infragranulose, uniformly wide, exine infragranulose, two-layered.

Comparison — *D. velatus* Weyl. & Krieg., differs from *D. mesozoicus* by being smaller in size (25-35 μ) and in having granulose ornamentation of the exine.

Occurrence — Trambau carbonaceous shale.

Densoisporites sp.

Pl. 5, Fig. 58

Description — Size ± 116 μ, triangular miospore in equatorial outline; Y-mark distinct, Y-rays reaching the periphery of the cingulum, labra thick, wide and folded; central body ± circular, ± 64 in diameter, exine finely infragranulose. Cingulum 16-32 μ wide, wider at the angles.

Comparison — *D.* sp. resembles the spores of *D. triradiata* Delc. & Sprum. (1955, FIG. 11) superficially. Unlike *D. triradiata*, *D.* sp., has sharply triangular form with acutely pointed angles and a prominent trilete apparatus.

Occurrence — Trambau carbonaceous shale.

Megaspore sp. A

Pl. 5, Fig. 59a-b

Description — Trilete megaspore, size 322 μ in diameter, showing a ± roundly triangular equatorial outline of the spore body, dorsiventrally flattened. Cingulum (?) appears as an equatorial extension (outer layer) of the exine, uniformly wide (40-42 μ) and appearing like a saccus. Y-mark distinct, thin streaks straight, slightly elevated at the apex, and Y-rays reaching as far as the base of the cingulum. Exine of the spore body thick (10-16 μ), two layered, inner layer thick with granulose exine, having small grana; outer layer covering the inner layer of the spore body both proximally and distally, extending to form a cingulum-like extension at the equator of the spore body, the latter thus showing a marginally thickened rim. The outer layer is smooth and is proximally thinner than on the distal side but appears to be infragranulose.

Comparison and Remarks — Organizationally, the specimen figured here does not correspond with any of the megaspore genera so far known and, at present, its systematic status is not clear as this is the only specimen recovered from the Ghuneri carbonaceous shale. However, the presence of a cingulum-like feature, characteristic of this megaspore, suggests that it can safely be included under the infraturma *Cingulati* Pot. & Kl.

Sitholey (1943) has described some silicified casts of megaspore specimens from the Triassic of Salt Range in W. Punjab (Pakistan) as *Triletes sahnii* in which the spore body, in many cases, possesses a distally inverted conspicuous envelope, leaving a wide proximal opening through which the triradiate mark emerges. *Triletes annulus* Dijk. reported from the Lower Carboniferous of Moscow Basin, perhaps shows similar organization as it is found in our specimen.

Occurrence — Ghuneri carbonaceous shale.

Infraturma *Zonati* Pot. & Kr. 1954

Genus *Aequitriradites* (Delc. & Sprum.) Cooks. & Dettm. 1961

Remarks — *A. triangularis* sp. nov., *A. indicus* sp. nov., and *A. fusus* sp. nov., have been referred to the genus *Aequitriradites* from this assemblage. The exine on the central body of each of these species show considerable ornamentational variation, being granulose to foveolate and often appearing ruptured on one side of the central body (presumably proximal). Tetrad mark, in most of the specimens, has not been observed though faint Y-ray-like marks are noticed only on the poles of very few specimens. Organizationally *Aequitriradites verrucosus* (Cooks. & Dettm.) Coocks. & Dettm., and *A. tilchaensis* (Cooks. & Dettm.) Cooks. & Dettm., appear quite comparable to the spores of *A. triangularis* and *A. fusus* but both of them differ from the latter two species by having faint to prominent tetrad mark and coarser ornamentation. Strikingly enough, the tearing of the exine in *A. verrucosus* and *A. tilchaensis* is a feature very much comparable to the species described by us from the present assemblage.

Aequitriradites triangulatus sp. nov.

Pl. 7, Figs. 85, 86

Holotype — Pl. 7, Fig. 86; Sl. No. 1799.

Diagnosis — Miospores 96-130 μ, subtriangular. Y-mark not visible. Central body roundly triangular, 52-82 μ in diameter, about 4 μ thick, dark brown, dense, outline of the central body thick, delimiting the union of the flange. Exine 2·5-3·5 μ thick, coarsely granulose, simulating negative reticulum. One side of the exine thin (proximal ?), often ruptured and forming an irregular torn area ('fovea'). Flange thin, 8-15 μ wide, densely granulose, appearing matt. *Extrema lineamenta* appearing serrate, rough.

Comparison — *Zonalasporites ulughbeki* is different by being smaller in size. The body exine in *Z. acusus* Balme bears 2-3 μ long spines or bacula and hence is not comparable. *Aequitriradites verrucosus* is different by having verrucose ornamentation of the exine. Rest of the species do not compare.

Occurrence — Ghuneri coal.

Aequitriradites fusus sp. nov.

Pl. 7, Figs. 87, 88

Holotype — Pl. 7, Fig. 87; Sl. No. 1818.

Diagnosis — Miospores 100-120 μ, roundly triangular. Central body ± circular, ± 80 μ in diameter, concavo-convex, without a tetrad mark, flanked by a subequatorially attached 14 μ broad flange. Exine thin on one side (? proximal) often ruptured and forming an irregular area and usually thicker on the other side, coarsely granulo-foveolate, forming negative reticulum. Body outline diffused. Flange finely granulose; grana small, closely placed, appearing matt. *Extrema lineamenta* rough.

Comparison — *A. triangulatus* is different by having thinner body exine, thicker body outline of the central body and in having only granulose ornamentation of the body exine.

Occurrence — Ghuneri coal.

Aequitriradites indicus sp. nov.

Pl. 5, Fig. 60

Holotype — Pl. 5, Fig. 60; Sl. No. 1621.

Diagnosis — Size ± 148 μ, roundly triangular miospore in equatorial outline; zona leathery, ± 14 μ wide, finely granulose and translucent; Y-mark distinct, Y-rays slightly raised, reaching up to the margin of the zona. Central body roundly angular, ± 126 μ in diameter; exine minutely foveolate, forming low meshes.

Comparison — The specimens of *A. indicus* resemble the spores of *A. dubius* Delc. & Sprum., in having similar shape but differ in possessing a bigger size, more thickened and less wide zona, and foveolate exine.

Occurrence — Trambau carbonaceous shale.

Genus *Enzonalasporites* Lesch. 1955

Enzonalasporites sp.

Pl. 7, Fig. 89

Description — Size ± 62 μ, circular miospore, central body also roundish. Exine of the central body thin and irregularly rugulose or having irregularly scattered grana. Flange ± 8 μ broad, ornamentation radially disposed.

Remarks — The specimen described here is the only record from this assemblage. It resembles the figure of *E. vigens* Lesch., in general shape, but differs from it in having bigger size and coarser ornamentation of the exine.

Occurrence — Trambau carbonaceous shale.

Genus *Umiaspora* gen. nov.

Genotype — *Umiaspora bosei* gen. et sp. nov.

Generic Diagnosis — Trilete megaspore, spore body ± triangular in equatorial outline, ± dorsiventrally flattened, equatorial zona smooth, ± $\frac{1}{4}$ of the body size; Y-mark straight; ray-ends reaching up to the margin of the zona, tecta slightly elevated and mediumly thick; exine ± smooth.

Comparison — The closely comparable genera are viz., *Minerisporites* Pot., *Triangulatisporites* Pot. & Kr. and *Henrisporites* Pot., but they all differ from *Umiaspora* in having different type of ornamentation, Y-mark apparatus and the zona.

Umiaspora bosei sp. nov.

Pl. 5, Figs. 61-62

Holotype — Pl. 5, Fig. 61; Sl. No. 1750.

Diagnosis — Trilete megaspore, size range 215-255 μ, ± triangular in equatorial outline; spore body dorsiventrally pressed, polar breadth ± half of the equatorial breadth; zona membranous, thin, uniformly broad (28-30 μ) around the spore body, margin smooth; Y-mark distinct, Y-rays straight, extending up to the margin of the zona, tecta slightly elevated and 2-5 μ thick; exine of the spore body ± 2·5 μ thick and ± smooth.

Occurrence—Trambau carbonaceous shale.

Genus *Minerisporites* Pot. 1956

Minerisporites cutchensis sp. nov.

Pl. 5, Figs. 63-64

Holotype — Pl. 5, Fig. 63; Sl. No. 1744.

Diagnosis — Trilete megaspore, size 295-402 μ, ± roundly triangular in equatorial outline, laterally ± globose in shape. Equatorial zona or flange 25-44 μ broad, widest opposite the ray-ends, slightly triangular in shape, membranous; Y-mark (laminated) membranous, thin, often undulating, 22-36 μ in height; Y-rays extending up to the margin of the zona. Exine 4·5-7 μ thick, having a net-work of anastomosing ridges (muri 2-6 μ high) both on the proximal and distal faces, enclosing ± polygonal or isodiametric lumina, 8-15 μ in size. 'Innerbody' faintly visible in some of the specimens.

Comparison — These megaspores are quite abundant in the Trambau samples and appear to be quite characteristic of these shales. *M. cutchensis* differs from *M. mirabilis* (Miner) Pot., in having less high Y-mark wings, and smaller size. *M. borealis* (Miner) Pot., has a very broad and well-developed equatorial flange; while *M. marginatus* (Dijkstra) Pot., shows smaller reticulations and less broad equatorial zona at the ray-ends. *M. ales* (Harris) Pot. and *M. richardsoni* (Murray) Pot., do not compare.

Occurrence — Trambau carbonaceous shale.

Minerisporites auriculatus sp. nov.

Pl. 5, Fig. 65

Holotype — Pl. 5, Fig. 65; Sl. No. 1753.

Diagnosis — Trilete megaspore, size 248-316 μ, equatorial outline ± rounded, distal side hemispherical. Equatorial zona membranous, 44-53 μ broad at the ray-ends, 20-40 μ broad elsewhere, " auriculae " smooth and ± semicircular in outline. Y-mark winged; wings thin, membranous, often undulating, smooth and 20-43 μ high; ray-ends extending up to the margin of the auriculae. Exine surface ornamented with anastomosing ridges (simulating negatively reticulate pattern) 1-3 μ broad; lumina 4-7 μ in size, ± isodiametric; muri or ridges often continuing into the equatorial flange. Inner body inconspicuous.

Comparison — The present species clearly distinguishes itself from the rest of the species of *Minerisporites* as it possesses a conspicuously developed auriculate equatorial zona opposite the Y-ray ends and rounded shape of the spore body. *M. cuchensis* has got bigger reticulations and the equatorial zona opposite the Y-ray ends is not auriculate.

Occurrence—Trambau carbonaceous shale.

Minerisporites mesosporeoides sp. nov.

Pl. 5, Figs. 66-68

Holotype — Pl. 5, Fig. 66; Sl. No. 1668.

Diagnosis — Trilete megaspores, size 195-297 μ, equatorial outline subtriangular; ± globose in lateral view. Equatorial zona, thin, membranous, with often faint radial ridges, 7-30 μ wide (in a single spore ± uniformly broad). Y-mark winged; wings thin, membranous, smooth, often undulating, 15-38 μ high; Y-rays extending as far as the margin of the zona. Exine 2·5-3·5 μ thick, showing minute reticulations (lumina 4-7 μ in size) all over the distal and proximal side. A conspicuous inner body (= mesosporium, as in *Duosporites* Høeg, Bose & Manum 1955) present in most of the specimens.

Innerbody — (Fig. 67) ± subtriangular in shape, smooth and ± transparent, 176-250 μ in size. Triradiate, ray-lines thin extending up to the margin, conspicuous. Knobs or nipple-like protuberances 3-5 in number present on the "attachment area", each being 5-9 μ high.

Comparison — The presence of 'inner body' in this spore species differentiates it from the rest of the species of *Minerisporites*.

Remarks — Some specimens of the present species (Pl. 5, Fig. 68) are quite opaque in which the 'innerbody' is not visible. Such spores closely resemble *M. marginatus* (Dijk.) Pot., in ornamentation, though they are comparatively smaller in size and show a less broad equatorial zona.

'Innerbodies' of *M. mesosporoides* possess knob or nipple-like structures, which are comparable to those found in the specimens of *Duosporites congoensis* Høeg, Bose & Manum 1955. At present, it is difficult to comment on the probable relationship of these structures between *D. congoensis* and *M. mesosporoides*. If these megaspores are overmacerated, the 'innerbody' comes out of them, and can be picked out from the macerate.

Occurrence — Trambau carbonaceous shale.

Genus *Auriculozonospora* gen. nov.

Genotype — *A. reticulata* gen. et sp. nov.

Generic Diagnosis — Trilete megaspores, spore body ± rounded in equatorial outline, laterally globose. Equatorial zona narrow, membranous, radially thickened with thin ridges, broader at the ray-ends and auriculate in shape; Y-rays winged, wings membranous, smooth and showing ribs; ray-ends extending up to the margin of the zona. Exine ornamentation markedly reticulate, conspicuous near the vicinity of Y-mark area.

Comparison — Among the closely comparable megaspore genera, *Minerisporites* Pot., *Triangulatisporites* Pot. & Kr. and *Henrisporites* Pot., stand nearest to *Auriculozonospora*. However, the latter differs from *Minerisporites* by having conspicuous ribs in the Y-mark wing, a narrower zona and conspicuous row of meshes in the inter-ray area adjoining the Y-mark. In *Triangulatisporites* the tecta of Y-mark is raised vertically ± like a ridge. *Henrisporites* has got coni as well as spines on the spore surface instead of reticulations as is the case in *Auriculozonospora*.

Auriculozonospora reticulata sp. nov.

Pl. 5, Figs. 69-71

Holotype — Pl. 5, Fig. 70; Sl. No. 1705.

Diagnosis — Trilete megaspores, small, 176-225 μ in size, spore body ± circular in equatorial outline, appearing globose laterally. Equatorial zona membranous, narrow, finely granulose, 30-38 μ wide, broader at the ray-ends, (elsewhere 14-30 μ wide) auriculate and radially thickened with low ridges. Y-rays winged, wings thin and membranous, 28-38 μ high, each having 5-6 ribs; wings reaching as far as the margin of the auriculate zona. Exine reticulate, marked with low anastomosing ridges (1-1·5 μ high); lumina ± polygonal, varying 8-15 μ in size. Meshes in a single row 5-6 in number, ± rectangular in shape (17-20 μ × 30-39 μ) on each side of the Y-mark (= contact area).

Remarks — The megaspores are very small and seem to be representing a border case between miospore and megaspore, genera on the basis of size difference.

Occurrence — Trambau carbonaceous shale.

Turma *Barbates* Mädler 1954

Genus *Thomsonia* Mädler 1954

Thomsonia cf. *reticulata* Mädler 1954

Pl. 5, Fig. 72

Description of our specimens — Size 352-415 μ, trilete megaspores, roundly triangular in equatorial outline, spherical laterally. Equatorial zona ± uniformly broad (20-40 μ) excepting opposite the ray-ends in the form of a broader expansion looking like auriculae, (50-100 μ broad), membranous and finely granulose. Y-mark lamellate, frilled or fluted; lamellae 70-100 μ high, extending up to the margin of equatorial zona. Exine distally as well as proximally marked with reticulations formed by anastomosing ridges (4-7 μ high) enclosing ± polygonal lumina (size 8-15 μ). Spines unbranched, 50-85 μ long and 8-15 μ broad with tapering ends occurring on the area near the Y-mark. Spore wall 8-12 μ thick.

Remarks — These specimens found out of the Trambau shale samples compare more closely to those of *Thomsonia reticulata* in ornamentation and in general organization than any other species. *T. reticulata* is reported from the Wealden formations of Hannover, Germany (MÄDLER, 1954). Though our specimens closely compare with *T. reticulata* they are described here as *T.* cf. *reticulata* because of the geographical separation between the Umia-beds of Cutch and Wealden formations in Hannover.

Occurrence — Trambau carbonaceous shale.

Thomsonia cutchensis sp. nov.

Pl. 5, Figs. 73-74

Holotype — Pl. 5, Fig. 73; Sl. No. 1683.

Diagnosis — Trilete megaspores, known size 450-460 μ (incl. the zona) equatorial outline ± rounded and spherical in lateral view. Equatorial zona membranous, 70-110 μ broad, auriculate at the ray-ends and 30-60 μ in between, radially ridged, ridges low but well marked. Y-marks lamellate, very much frilled or fluted; lamellae 148-162 μ high, more prominent at the apex, extending up to the margin of auriculate zona. Spore exine reticulate proximally as well as distally, ridges anastomosing (8-15 μ high) enclosing ± irregularly polygonal lumina, 10-18 μ in size; the intersecting point of ridges show spine like processes or peaks (in most cases broken perhaps due to abrasion) 15-28 μ high. Capilli or spines more prominent in the apical region than near the Y-mark, 45-90 μ long and 8-10 μ broad. Spore wall 12-15 μ thick.

Comparison — The ornamentation and organization of *T. cutchensis* compare closely with the other species described under *Thomsonia*. *T. cutchensis* differs from *T. reticulata* in having higher, lamellate Y-mark and wart-like processes at the intersection of anastomosing ridges of the reticulum. *T. thorenensis* Mädler differs from *T. cutchensis* in having more irregular reticulations and ovule like warts or tubercles on the exine rather than spines or capilli. *T. phyllicus* (Murray) Pot., shows trilete lamellae as plates, one on each side of the Y-mark, and here the ridges or peaks are longer and higher. In comparison to this, *T. cutchensis* is bigger in size, possessing shorter spines and higher Y-mark, having lamellae especially at the apex. The remaining species of *Thomsonia* do not show any definite reticulation and hence are not comparable.

Occurrence — Trambau carbonaceous shale.

Genus *Dijkstraisporites* Pot. 1956

Dijkstraisporites filiformis sp. nov.

Pl. 6, Figs. 75, 76

Holotype — Pl. 6, Fig. 76; Sl. No. 17471.

Diagnosis — Known size range 1,086 to 1,344 μ, trilete megaspores, spore body ± roundly triangular in equatorial outline. Equatorial zona very broad, 288-384 μ, consisting of branched and ramifying radial rays (or ridges), and fusing into a single leathery, ± translucent, finely granulose zona. Triradiate mark having 10-25 μ broad and 8-12 μ high tecta, extending up to the margin of the zona. Spore wall 18-28 μ thick, exine of the spore body faintly reticulate, consisting of ± irregular polygonal shaped lumina (17-28 μ in size); muri faint and low. Hairs or capilli filiform unbranched forked with tapering ends and very rarely (175-240 μ long and 8-16 μ broad at the base) occurring on the intersection of muri, all over the surface of spore body, at the equator, and especially along the tecta of the Y-mark.

Comparison — The present species i.e. *D. filiformis* differs from the hitherto described species of *Dijkstraisporites*, viz., *D. helios* (Dijk.) Pot., and *D. decorus* (Dijk.) Pot., by the presence of a broader equatorial zona and longer filiform capilli on the spore body exine. In *D. helios* there are no tapering capilli, the exine is " ochre ", and the size of spores is smaller. *D. decorus* also lacks filiform appendages.

Occurrence —Trambau carbonaceous shale.

Turma ***Monoletes*** **Ibr. 1933**
Subturma ***Azonomonoletes*** **Luber 1935**
Infraturma ***Laevigatomonoleti*** **Dyb. & Jach. 1957**

Genus *Crassimonoletes* gen. nov.

Genotype — *C. surangei* gen. et sp. nov.

Generic Diagnosis — Miospores bilateral, oval. Monolete mark prominent, labra thick, raised, crumpled and undulating. Exine infragranulose. Distal surface deeply arched in lateral view, straight to slightly arched proximally.

Comparison — The miospore genera viz., *Laevigatosporites* Ibr., *Latosporites* Pot., & Kr. and *Monolites* (Erdtm.) Pot. differ from *Crassimonoletes* by having thinner exine and a simple monolete mark. *Leschikisporis* (Pot.) Bharad. and Singh is smaller in size and has got granulose exine. *Polypodiisporites* Pot., *Polypodiidites* Ross and *Verrucatosporites* (Pflug) Pot., do not agree in exine ornamentation and hence are not comparable. *Chasmatosporites* Nilsson is closely comparable with *Crassimonoletes* but differs from the latter by having a simple monolete mark and intrareticulate exine.

Crassimonoletes surangei sp. nov.
Pl. 6, Figs. 77-78

Holotype — Pl. 6, Fig. 78; Sl. No. 1795.

Diagnosis — Miospores 100-130 μ × 72-82 μ in size, bilateral, oval. Monolete slit ± 70 μ long; labra thick and crumpled, raised, open, suture straight. Exine on the proximal face thinner as compared to the distal face, densely intragranulose all over. Distal face of the spore deeply arched, proximally straight to slightly bulging. *Extrema lineamenta* thick.

Occurrence — Ghuneri coal.

Crassimonoletes minor sp. nov.
Pl. 6, Figs. 79, 80

Holotype — Pl. 6, Fig. 79; Sl. No. 1780.

Diagnosis — Miospore 80 × 70 μ, bilateral, oval. Monolete mark ± 48 μ long and ± 18 μ broad, biconvex when open; labra thick, raised, appearing denser. Exine thick on the proximal as well as on the distal face; densely intragranulose all over.

Comparison — The spores of *C. surangei* differ from *C. minor* by being bigger in size.

Occurrence — Ghuneri coal.

Genus *Monolites* (Erdtm.) Pot. 1956

Monolites intragranulosus sp. nov.
Pl. 6, Figs. 81, 82

Holotype — Pl. 6, Fig. 81; Sl. No. 1780.

Diagnosis — Miospores 90-120 μ, bilateral, concavo-convex in lateral view. Monolete slit straight, ± 60 μ long. Exine thin, laevigate, finely intragranulose on both the faces; perispore thin, transparent and often wrinkled in surface view.

Comparison — The specimens figured under *M. grandis* by Dev (1961, Pl. 3, Figs. 17, 18) differ by being bigger in size.

Occurrence — Ghuneri coal.

Infraturma *Sculptatomonoleti* Dyb. & Jach. 1957

Genus *Leschikisporis* (Pot.) Bharad. & Singh 1964

Leschikisporis indicus sp. nov.
Pl. 6, Fig. 83

Holotype — Pl. 6, Fig. 83; Sl. No. 1797.

Diagnosis — Miospores 20-25 μ, holotype 25 μ, bilateral, oval. Monolete mark straight. Exine finely granulose, grana closely spaced on both the faces. In lateral view, distal face appears to be more arched than the proximal face.

Comparison — Spores of *Leschikisporis, scabratus* (= *Marattisporites scabratus* Coup.) are closely comparable with the spores of *L. indicus* but they differ in having coarser grana and also are known from the northern hemisphere. *L. aduncus* (Lesch.) Bharad. & Singh differs by the presence of a monolete slit having a median bend in the middle.

Occurrence — Ghuneri coal.

Turma *Cystites* Pot. & Kr. 1954

Genus *Saccarisporites* Dev 1961

Saccarisporites lurzeri Dev 1961
Pl. 6, Fig. 84

Description of our specimens — Spore body ± 328-678 μ, circular in outline, the exine being copiously folded. Y-mark or arcuate ridges not distinguishable. Spore wall thin, ornamentation granulose to infragranulose.

Remarks — Some resemblance in the general shape and the texture of the spore wall of the specimens of *S. lurzeri* recorded here may be noted with *Sporites plicatus* (Schopf 1938, pp. 51-52).

Occurrence — Ghuneri underlying carbonaceous shale.

Anteturma ***Pollenites*** **R. Pot. 1931**
Turma ***Saccites*** **Erdtm. 1947**
Subturma ***Monosaccites*** **(Chitaley 1951) Pot. & Kr. 1954**

Genus *Callialasporites* Dev 1961

Syn. Pflugipollenites Pocock 1962
Callialasporites trilobatus (Balme) Dev 1961

Pl. 7, Figs. 90, 93

Diagnosis — See Balme 1957, p. 33; and Dev 1961, pp. 48, 49.

Description of our specimens — Miospores 80-105 μ, roundly triangular, central body ± subtriangular, possessing three equatorially attached bladders, joined narrowly at the angles giving a three lobed appearance. Y-mark usually absent, apparent in few specimens. Exine of the central body finely granulose to rugulose, rugulae dissolving into finer grana. Exine of the bladder infra-extragranulose, sometimes showing radial folds.

Occurrence — Ghuneri coal and Trambau shale.

Callialasporites dampieri (Balme) Dev 1961

Pl. 7, Fig. 91

Diagnosis — See Balme 1957, p. 32; and Dev 1961, p. 48.

Description of our specimens — Miospores 60-100 μ, ± circular, central body ± subcircular, 60-70 μ in diameter, surrounded by an equatorially attached bladder, 8-20 μ wide. Y-mark absent. Exine of the central body ± 1·5 μ thick, finely granulose on both the faces, sometimes appearing rugulose. Bladder finely infragranulose, radial folds often giving a frilled appearance to it.

Remarks — The pollen grains of *C. dampieri* are quite common in the Umia-bed samples. Sah (1953, Pl. 1, Fig. 14), has figured a spore under *Eurozonotriletes* from the Jurassic shales of Ceylon, which is comparable to the forms of *C. dampieri*. Lantz (1959) has recorded this species from the Upper Mesozoic of France. Hughes & Couper (1958) have also reported the presence of pollen grains comparable to *C. dampieri* from the Brora coals of Middle Jurassic in Scotland.

Occurrence — In all the samples.

Callialasporites segmentatus (Balme) Sriv. 1963

Pl. 7, Fig. 92

Diagnosis — See Balme 1957, p. 33.

Description of our specimens — Miospores 80-120 μ ± circular, central body ± circular; equatorial bladder very much dissected or segmented. Exine of the central body granulose, sometimes appearing warty or rugulose. Y-mark absent.

Callialasporites rimalis sp. nov.

Pl. 7, Fig. 94

Holotype — Pl. 7, Fig. 94; Sl. No. 1788.

Diagnosis — Circular to subcircular miospores, 80-90 μ, central body ± circular, demarcated by a thick, about 4 μ broad rim, peripheral folds many. Exine of the central body coarsely granulose, simulating a negative reticulum in deep focus. No Y-mark seen. Bladder equatorial, finely granulose, grana conspicuous. *Extrema lineamenta* indented.

Comparison — *C. dampieri*, *C. trilobatus* and *C. segmentatus* do not possess a thick rim and peripheral folds on the central body and hence are different. Hughes & Couper (1958) have figured *Zonalapollenites* sp. cf. *trilobatus* (*loc. cit.* Fig. 1) from the Mesozoic rocks of Britian, and these compare with the spores of *C. rimalis*.

Occurrence — Ghuneri coal.

Callialasporites triletus sp. nov.

Pl. 7, Figs. 95, 96

Holotype — Pl. 7, Fig. 96; Sl. No. 1803.

Diagnosis — Miospores 72-100 μ, ± circular; central body ± roundly triangular. Exine of the central body ± 2·5 μ thick, brownish in colour, granulose. Y-mark conspicuous; Y-rays extending up to the equator of the central body having a thick undulating labra, appearing crumpled. Equatorial bladder ± 12 μ wide, often dissected and with radial folds; exine finely granulose.

Comparison — *C. triletus* differs from the other known species of *Callialasporites* by the presence of a prominent and thick undulating Y-mark.

Remarks — Dev (1961, Pl. 4, Fig. 30) has described a single specimen of *Callialasporites* sp. from the Jabalpur Series of India, which closely resembles the specimens of *C. triletus* in possessing a distinct Y-mark.

Occurrence — Trambau coal and carbonaceous shale.

Subturma ***Disaccites*** **Cooks. 1947**
Infraturma ***Disacciatrileti*** **Lesch. 1955**

Genus ***Pityosporites*** **(Sew.) Manum 1960**

Pityosporites sp.

Pl. 8, Fig. 97

Description — Pollen grains bisaccate, bilateral. Bladders symmetrically disposed on either side of the central body, distally inclined, bladder length slightly lesser than the height of central body. Central body $\pm$ vertically-roundish to oval, exine $\pm$ 1·5 μ thick, finely granulose, no striations. Bladder exine finely intrareticulate.

Occurrence — Trambau carbonaceous shale.

Infraturma ***Podocarpoiditi*** **Pot., Thoms. & Thierg. 1950**

Genus ***Platysaccus*** **(Naum.) Pot. & Kl. 1954**

Platysaccus sp.

Pl. 8, Fig. 98

Description — Pollen grains bilateral, 146 $\times$ 100 μ, bisaccate. Central body $\pm$ elongated-oval, 36 $\times$ 42 μ in size, exine finely granulose. Bladders symmetrically disposed, very much bigger than the central body, more than hemispherical, distally inclined, laterally close, bladder meshes finely-coarsely intrareticulate. Distal sulcus long, narrow, nearly extending up to the whole length of the central body, sometimes faintly visible.

Remarks — The pollen grain described here is comparable to the specimen figured by Potonié (1958, Pl. 8, Fig. 84). The central body, however, in our specimen, is more oval and is comparatively smaller and the bladders possess slightly coarser meshes. *Platysaccus* sp., also shows some apparent resemblance to the forms of *Podocarpus horrida* described by Bolkhovitina (1958, Pl. 22, Fig. 226); and *Podocarpus tricocca* Bolkhovitina (1958, Pl. 23, Fig. 232).

Occurrence — Ghuneri shale overlying the coal seam.

Genus ***Podocarpidites*** **(Cooks.) Pot. 1958**

Podocarpidites ellipticus (Cooks.) Pot. 1958

Pl. 8, Figs. 100-101

Description — See Cookson 1947.

Occurrence — Ghuneri coal.

Podocarpidites rarus sp. nov.

Pl. 8, Figs. 102-104

Holotype — Pl. 8, Fig. 103; Sl. No. 1805.

Diagnosis — Pollen grains bilateral, 82-98 μ, bisaccate. Central body subcircular to broadly oval, $\pm$ 66 μ in diameter, exine finely granulose, proximally as well as distally, proximal cap slightly thicker, no striations. Bladders distally separated by $\pm$ 18 μ wide bladder-free channel, laterally approaching closely. Bladders large having small meshes.

Comparison — The central body in the pollen grains of *P. ellipticus* is smaller. *P. microreticuloidatus* Cooks., is different by having characteristic microreticulations in the bladders. Bladders in *P. morwickii* Coup. do not approach laterally. *P. major* Coup., is different by having microverrucose exine of the central body. *P. otagoensis* Coup., and *P. ohikaensis* Coup., do not compare.

Occurrence — Trambau carbonaceous shale and Ghuneri coal.

Podocarpidites major Couper 1953

Pl. 8, Figs. 105, 106

Lectogenotype — Couper 1953, Pl. 4, Fig. 10.

Description — See Couper 1953.

Occurrence — Trambau and Ghuneri coals.

Podocarpidites sp.

Pl. 8, Fig. 99

Description — Pollen grains bisaccate, 38-70 μ in size, bilateral. Bladders symmetrically disposed, $\pm$ as high as the height of central body. Central body $\pm$ roundish oval, mediumly dense, finely granulose. Bladder exine finely intrareticulate, laterally separated and distally inclined.

Remarks — The pollen grains of *P.* sp. are quite common in the shale samples. They are comparable with the pollen grains of *Disaccites* (= *Podocarpidites*) *elliptica* Cookson (1947, p. 131, Pl. 13, Figs. 5-7). The size range, granulose ornamentation of the proximal cap and the marginal crest of the central body in the specimens recovered from Cutch, is closely comparable with the above mentioned specimens figured by Cookson.

Occurrence — Trambau carbonaceous shale.

Subturma *Polysaccites* Cooks. 1947

Genus *Microcachrydites* (Cooks.) Coup. 1953

Microcachrydites antarcticus Cooks. 1947

Pl. 8, Fig. 107

Description — Pollen grains bisaccate to trisaccate, 58-60 μ. Central body ± circular, with proximal cap having finely granulose to infragranulose exine, distal exine ± smooth. Bladders more than hemispherical, very much smaller than the size of central body, attached clearly on the distal side below the equator; bladder exine finely intrareticulate.

Occurrence — Trambau carbonaceous shale.

Genus *Podosporites* Rao 1943

Podosporites micropteris (Cooks. & Pike) Balme 1957

Pl. 8, Fig. 108

Syn. — *Trisaccites micropteris* Cookson & Pike (1954, PL. 2, FIGS. 21-29).

Diagnosis & Description — See Cookson & Pike 1954, p. 64, and Balme 1957, p. 34.

Occurrence — Ghuneri coal.

Podosporites raoi sp. nov.

Pl. 8, Figs. 109, 110

Holotype — Pl. 8, Fig. 110; Sl. No. 1797.

Diagnosis — Pollen grains trisaccate, 30-35 μ, circular to subtriangular. Central body circular to subtriangular in equatorial view, ± 30 μ in diameter in holotype; proximal exine thick, thinner distally, intrareticulate, central body projecting out like a hemisphere. Bladders infolded distally, covering a wide area of the central body. Bladders finely intrareticulate; meshes small, sometimes partially confluent.

Comparison — Pollen grains of *P. micropteris* Cooks. & Pike, differ from *P. raoi* by being bigger in size. The central body in *P. tripakshi* Rao has granulose ornamentation as compared to the intrareticulate structure found in the case of *P. raoi*.

Occurrence — Ghuneri coal.

Turma *Aletes* Ibr. 1933

Subturma *Azonoaletes* (Luber) Pot. & Kr. 1954

Infraturma *Psilonapiti* Erdtm. 1947

Genus *Laricoidites* Pot., Thoms. & Thierg. 1950

Laricoidites indicus sp. nov.

Pl. 8, Figs. 111, 112

Holotype — Pl. 8, Fig. 112; Sl. No. 1808.

Diagnosis — Pollen grains circular in an equatorial view, 90-120 μ yellowish brown in colour. No germinal mark present. Exine mediumly thick, intrapunctate; puncta broad and closely spaced; secondary folds copious, more at the periphery than at the centre. *Extrema lineamenta* thick and smooth.

Comparison — *L. indicus* differs from the other known species of *Laricoidites* by having intrapunctate exine, exhibiting broader puncta which are very closely spaced.

Occurrence — Ghuneri coal.

Infraturma *Granulonapiti* Cooks. 1947

Genus *Araucariacites* Cooks. 1947

Araucariacites australis Cooks. 1947

Pl. 8, Fig. 113

Diagnosis — See Cookson 1947, p. 130.

Description of our specimens — Known size range 86-94 μ, pollen grains ± circular in outline, alete, generally having secondary folds. Exine less than 1 μ thick, subgranulose, grana closely placed.

Remarks — The pollen grains of *A. australis* are of frequent occurrence in both the shale and coal samples from Trambau and Ghuneri. These are slightly bigger in size than those described by Cookson (1947). They also agree and compare well with the specimens figured by Balme (1957, PL. 7, FIGS. 81-82), both in size and structure. Morphographically as well as organizationally pollen grains referable to *A. australis* are comparable with the pollen grains of some living species of Araucariaceae (COOKSON *loc. cit.*). *A. australis* also frequently occurrs in the Mesozoic and Tertiary rocks of Australia as reported by Cookson (*loc. cit.*) and Balme (1957). Recently Couper (1958) has also found similar type of pollen grains from the Mesozoic rocks of Great Britain.

Occurrence — Ghuneri coal, Trambau and Ghuneri carbonaceous shales.

Araucariacites ghuneriensis sp. nov.

Pl. 9, Figs. 114-116

Holotype — Pl. 9, Fig. 115; Sl. No. 1800.

Diagnosis — Known size 100-120 μ, pollen grains originally spherical, assuming various shapes due to folding of the exine. Alete. Exine ± 1·5 μ thick in optical section, densely and coarsely granulose, grana usually bigger at the periphery. *Extrema lineamenta* ± rough.

Comparison — *A. ghuneriensis* differs from *A. australis* in having a thicker exine, coarser grana and bigger size. *A. indicus* Dev (1961) has got very small grana on the exine and hence is not comparable.

Occurrence — Ghuneri coal.

Araucaricites cooksonii sp. nov.

Pl. 9, Figs. 117, 118

Holotype — Pl. 9, Fig. 117; Sl. No. 1812.

Diagnosis — Known size range 100-120 μ, pollen grains spherical, exine frequently folded. Alete. Exine 1-1·5 μ thick in optical section, finely granulose; peripheral grana gradually merging with the central ones, central exine prominently thinner and tending to shrivel. *Extrema lineamenta* dented.

Comparison — These pollen grains agree with the forms of *A. ghuneriensis* in the size range but differ from it in having differentially thickened exine, thinner at the central region and thicker at the periphery. In *A. australis* the exine is uniformly thin allover and the size of pollen grains is smaller. *A. cooksonii* slightly resembles *Inaperturopollenites turbatus* Balme, but the latter possesses thicker and darker exine in the central region than at the peripheral region.

Occurrence — Trambau coal.

Infraturma *Reticulonapiti* (Erdtm.) Vimal 1952

Genus *Schizosporis* Cooks. & Dettm. 1959

Remarks — Cookson & Dettmann (1959) have referred four species to *Schizosporis*, namely *S. reticulatus*, *S. rugulatus*, *S. spriggi* and *S. parvus* from the Cretaceous deposits of Australia. The latter two species, as compared to its genotype, are different by not having reticulate exine. The study of the photographs of these species show perfectly laevigate exine. Organizationally these two species approach nearness to the specimens of *Taxodiaceaepollenites* Kremp (1949). In our opinion, it is worthwhile to suggest that *S. spriggi* and *S. pravus* may preferably be referred either to *Taxodiaceaepollenites* or near it, and *Schizosporis* should be restricted to only those spores which truely conform to its genotype in ornamentation.

Schizosporis reticulatus Cooks. & Dettm. 1959

Pl. 9, Figs. 119-121; Pl. 10, Fig. 122

Diagnosis and Description — See Cookson & Dettmann 1959, p. 213.

Schizosporis rugulatus Cooks. & Dettm. 1959

Pl. 10, Figs. 123-126

Diagnosis and Description — See Cookson & Dettmann 1959, p. 216.

Remarks — Cookson & Dettmann (*loc. cit.*) have stated that the spores of *S. regulatus* are rarely represented in the Cretaceous deposits of Albian and ? Cenomanian age. But in the present assemblage the representation of *S. rugulatus* is quite frequent. Some specimens of *S. rugulatus*, from this assemblage are enveloped in a layer of perisporium, and this feature has not been reported in the specimens of the same species studied by Cookson & Dettmann (*loc. cit.*) from Australia.

Occurrence — Ghuneri coal.

Schizosporis vermiculatus sp. nov.

Pl. 10, Figs. 127-129

Holotype — Pl. 10, Fig. 128;

Diagnosis — Miospores laterally biconvex (flattened along the poles), 148-196 μ, ± circular in polar view (often assuming different shapes on flattening), usually dividing equatorially into two approximately equal, saucer-shaped sections. Exine 6-8 μ thick, two-layered, intectate; sexine ornamented with sinuous or ± irregular ridges (low muri) forming fine — irregularly vermiculate patterns (worm-like tracts), which may or may not unite to form a meshed and shallow reticulum; lumina broad in between the muri.

Comparison — *S. rugulatus* differs from *S. vermiculatus* by being smaller in size and also the latter possesses broader lumina or the meshes in between the muri, looking more like vermiculate-pattern than rugulate.

Occurrence — Trambau carbonaceous shale.

Turma ***Monocolpates*** **Iverson & Troels-Smith 1950**
Subturma **Intortes (Naum.) Pot. 1958**

Genus *Cycadopites* Wodehouse ex Wils. & Web. 1946

Cycadopites sp. A

Pl. 10, Figs. 130-131

Description — Pollen grains elongated-oval, 44 × 10 μ. Monosulcate, the furrow extending up to the full length of the distal surface and slightly rounded at the ends. Exine less than 1 μ thick, ± smooth.

Cycadopites sp. B

Pl. 10, Figs. 132-133

Description — Pollen grains 44 × 32 μ, ± oval or boat shaped, with a well defined sulcus, ± narrower in the centre and broader at the end, exine laevigate.

Occurrence — Trambau coal shale.

Incertae Sedis

Genus *Classopollis* (Pflug) Pocock & Jans.

Classopollis torosus (Reiss.) Couper 1958

Pl. 10, Figs. 134-135

Description of our specimens — Pollen grains ± 30 μ in diameter, circular to subcircular in equatorial contour, assuming various shapes due to folding of the exine. No germinal mark perceptible. Proximally (presumably) a weak circular to triangular, thin area of the exine noticeable. Exine about 2 μ thick, baculate, rod-like bacula inwardly directed appearing as radially disposed pits in polar view; polar exine thin, simulating negative reticulum; distally demarcated from the equator by a thick circular zone. *Extrema lineamenta* ± smooth.

Occurrence — Ghuneri coal and carbonaceous shale overlying the coal.

DISCUSSION AND CONCLUSION

The present analysis of the dispersed microfossil assemblage of the Umia-beds in Cutch shows that the spore ascemblage of Trambau carbonaceous shales mainly consists of pteridophytic miospores, megaspores, and coniferous pollen grains. The important pteridophytic trilete genera present in this assemblage are as follows: *Cyathidites*, *Gleicheniidites*, *Osmundacidites*, *Lycopodiumsporites*, *Baculatisporites*, *Contignisporites*, *Trilobosporites*, and *Concavisporites* etc. Monolete forms are very rarely represented. The pollen grains, which probably have coniferous affinity, are represented by the following genera: *Pityosporites*, *Podocarpidites*, *Microcachrydites*, *Araucariacites*, and *Laricoidites* etc. Spore genera like, *Schizosporis*, *Cycadopites*, *Classopollis*, *Callialasporites*, *Boseisporites* and *Ischyosporites* etc. also form an equally important component of the assemblage. Among all these, the pollen grains of *Callialasporites dampieri* and *C. trilobatus* are dominantly distributed whereas the forms referable to *Araucariacites australis* and *Pityosporites* spp., are subdominant. The megaspore types chiefly belonging to the following genera i.e., *Dijkstraisporites*, *Thomsonia Minerisporites*, *Erlansonisporites*, *Horstisporites*, *Verrutriletes and Trileites* have been richly found in the shale samples of Trambau but absent in the coals of the same locality.

The spore composition of Ghuneri coals, as represented by its spore genera, is much diversified in forms. The pteridophytic triletes spores as well as the monolete spores are referred to the following form genera viz., *Cyathidites*, *Alsophilidites*, *Osmundacidites*, *Lycopodiumsporites*, *Contignisporites*, *Crassimonoletes*, *Monoletes*, *Leschikisporis*, and *Aequitriradites*. The gymnospermic pollen grains represented by the genera like, *Callialasporites*, *Pityosporites*, *Podocarpidites*, *Podosporites*, *Laricoidites*, *Araucariacites* *Schizosporis* and *Classopollis* along with the pteridophytic spores are the main characteristic feature of the spore spectrum. Fossil megaspores were not found in the samples of Ghuneri coals, Trambau coals and also in the Ghuneri carbonaceous shales. The Ghuneri carbonaceous shale, underlying the coal seam, has forms belonging to the genus *Trileites* although they are rare. However, *Bacutriletes* and *Saccarisporites lurzeri* are exclusively confined to this layer and are well represented there. In the same layer, spores belonging to *Cyathidites minor* and *Callialasporites dampieri* are also abundantly found. *Classopollis* and *Platysaccus* have also been recovered from the overlying shales at Ghuneri. In Trambau coal samples the meagre spore content of *Cyathidites minor*, *Gleicheniidites*, *Concavisporites*, *Lycopodiumsporites*, *Callialasporites*, *Podocarpidites* and *Araucariacites* is apparently noticeable.

Keeping in view the above data, it is apparent that the spore floras of the carbonaceous shales of Trambau and Ghuneri coals resemble each other to a considerable degree by the presence of in common forms like, *Cyathidites minor*, *C. concavus*, *Callialasporites dampieri*, *C. trilobatus*, *C. triletus*, *Podocarpidites rarus*, *Araucariacites australis*, *Schizosporis reticulatus* and *Classopollis*. However, the Ghuneri coal spore assemblage differs from the Trambau carbonaceous shale assemblage mainly by having far less representation of pteridophytic spores as compared to the latter, while the coniferous pollen grains are equally distributed. The absence of megaspore types from the Ghuneri coal samples might also explain the rare occurrence of pteridophytic spores in it.

A comparison of the spore assemblage of Cutch with the other spore floras of Mesozoic formations such as, Rajmahal (India), Jabalpur (India), Salt Range (Pakistan), and the Mesozoic strata of western and eastern Australia shows certain interesting features. These assemblages, as represented by their spore genera, are different in character by the absence of some of the important genera found in the Umia-beds and having certain individualistic genera which are absent in the latter assemblage. Vishnu-Mittre (1954) has given an account of petrified spores and pollen grains from the Rajmahal hills, Bihar. He has recorded forms which are identifiable as *Osmundacidites* (= *loc. cit.*, PL. 1, FIG. 12), cf. *Contignisporites*, (= *loc. cit.*, PL. 1, FIGS. 10, 14-16), *Lycopodiumsporites* (= *loc. cit.*, PL. 1, 17-20), cf. *Callialasporites* (= *loc. cit.*, PL. 2 FIG. 36), *Pityosporites*, *Alisporites*, *Cycadopites* (= *loc. cit.*, *Entylissa*) and *Podosporites*. Except for the genus *Alisporites*, all the remaining forms are present in the Umia-beds also. The assemblage of Umia-beds is much richer in having many other additional genera which are not found in the Rajmahal spore flora.

The miospore assemblage of the Jurassic shales described by Sah (1955) from the salt range, as understandable to us, includes the following genera: *Matonisporites* (= *loc. cit.*, PL. 1, FIGS. 8, 8A), *Dictyophyllidites* (= *loc. cit.*, PL. 1, FIGS. 1-4, 12-13), cf. *Lygodioisporites* (= *loc. cit.*, PL. 1, FIG. 28), *Todisporites* (= *loc. cit.*, PL. 1, FIG. 10), *Callialasporites** (PL. 1, FIG. 17), *Pityosporites** (PL. 1, Fig. 21), *Podosporites** (PL. 1, FIG. 29), *Araucariacites** (PL. 1, FIG. 24), and *Classopollis** (PL. 1, FIGS. 6, 11, 11A, 18, 25, 27). Out of these the spores marked with an asterisk are present also in the Umia-beds; the latter, however, shows the presence of many additional genera which do not occur in the Salt Range spore flora.

A comparison of the Umia-beds spore flora with the Mesozoic assemblage of western Australian (BALME 1957) shows the presence of certain genera in common like, *Cyathidites*, *Gleicheniidites*, *Osmundacidites*, *Lycopodiumsporites* (= *Lycopodium* BALME 1957), *Cicatricosisporites*, *Zonalasporites*, *Callialasporites* (= *Zonalapollenites* in BALME 1957), *Baculatisporites*, *Concavisporites*, *Ischyosporites*, *Cingulatisporites*, *Cycadopites* (= *Entylissa* BALME 1957), *Araucariacites*, *Laricoidites*, *Microcachryidites*, *Podosporites*, *Pityosporites* and *Classopollis*.

From the IIb — spore flora of lower Cretaceous age, Australia, Balme (1957) has observed that the forms like *Microcachryidites antarcticus*, *Pityosporites ellepticus*, *Classopollis* and *Araucariacites australis* are quite characteristic and are richly distributed in it, a fact which is true for the Umia-beds also. The spore genera like *Exesipollenites*, *Pilasporites*, *Polypodiidites*, *Microreticulatisporites*, *Mohrioisporites*, *Foveosporites*, *and Sphagnites* which are found in the Australian assemblage (BALME, 1957) have not been encountered in the Umia-beds. On the other hand forms like *Schizosporis*, *Podocarpidites*, *Leschikisporis*, *Monolites*, *Crassimonoletes*, *Trilobosporites*, and *Baculareticulosporis* present in the assemblage of Umia-beds seem to be absent in the assemblage of western Australia.

The spore flora of Jabalpur Series (DEV 1961) is rich in having coniferous pollen grains but therein the pollen grains of Cycadophytes are poorly represented. Among the Pteridophytes, the spores of Lycopodiales, Cyatheaceae and Schizaeaceae are reported to be fairly common. Those spore forms which are common to the Umia-beds and the Jabalpur assemblages are — *Cyathidites*, *Lycopodiacidites*, *Baculatisporites*, *Lycopodiumsporites*, *Erlansonisporites*, *Boseisporites*, *Dijkstraisporites*, *Monolites*, *Saccarisporites*, *Zonalasporites*, *Callialasporites*, *Pityosporites*, *Platysaccus*, *Podocarpidites*, *Araucariacites*, and *Cycadopites* (= *Ginkgocycadophytus*). All these forms are considered to be characteristic of the Jurassic age. Their presence in the Umia-beds samples along with many other genera which are not present in the Jabalpur Series, probably reflects an extension of this flora in Cutch although the latter becomes richer by the incoming forms like *Schizosporis*, *Leschikisporis*, *Crassimonoletes*, *Baculareticulosporis* and many other megaspore types. The bisaccate striate pollen grains reported from the Jabalpur Series (DEV, 1961) have not been met with in the Umia-beds.

The trilete spore genera in the assemblage from the eastern Australia (COOKSON & DETTMANN, 1957), are quite different as compared to those of the Umia-beds, excepting very few genera common to the two assemblages, viz. *Osmundacidites*, *Ischyosporites*, *Lycopodiumsporites*, *Trilobosporites*, *Staplinisporites* and *Minerisporites* (megaspore). From this evidence, Cookson & Dettmann (*loc. cit.*) have shown that several of the Victorian deposits in Australia referred to lower Jurassic strata really belong to the lower Cretaceous age. The presence of the above mentioned genera common to the Umia-beds samples also indicates the possibility of these beds being of Lower Cretaceous age. Later Cookson & Dettmann (1959) described 4 species of the genus *Schizosporis* from the Lower-Middle Cretaceous deposits of S. Australia, out of which *S. reticulatus* along with one more new species of the same genus have been found both from the Trambau carbonaceous shale as well as from the Ghuneri coal in the Umia-beds. According to Cookson & Dettmann (*loc. cit.*) all the species of *Schizosporis*, are of infrequent occurrence and, so far known, at present they are restricted to the Cretaceous deposits only. Their occurrence in the Umia-beds lends further support to the estimated Wealden age of these beds.

The study of the megaspores in this assemblage of Umia-beds also helps to conclude Wealden as the probable age. As the forms similar to *Horstisporites reticuliferus* from the Wealden of Netherlands, *Thomsonia reticulata* from the Wealden of W. Germany, and *Erlansonisporites erlansonii* from the Createaceous of Greenland occur also in the Trambau shale samples so the possibility of the Umia-beds being of Lower Cretaceous age is possible though the geographic separation among the strata compared is quite wide. Hughes (1958) has distinguished three characteristic megaspore-composition-floras from the English Wealden. They are *Verrutriletes* flora (Berriasian), *Thomsonia*-flora (Valanginian) and *Pyrobolospora*-flora-*Arcellites* (Barremian-Aptian). *Thomsonia*, which according to Hughes (1958), is the chief constituent of *Thomsonia*-flora in the Wealden, is also present in the Trambau shale of Umia-beds. At the same time, in addition to this, the presence of *Verrutriletes*, *Minerisporites*, *Horstisporites*, *Dijkstraisporites* in the Trambau shale samples, also indicates its possible relationship with the *Verrutriletes* and *Thomsonia*-horizons of the English Wealden (HUGHES, 1958). In fact, most of the megaspores described in this paper have been reported in some or the other Lower Cretaceous spore floras of European deposits.

Thus, from the above evidence of microfossil analysis, it is concluded that the Umia-beds, (the so-called Uppermost limits of the Gondwana formations of Cutch = Bhuj Series), correspond more to the Lower Cretaceous (= Wealden) age than any of the younger and older formations.

ACKNOWLEDGEMENTS

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EXPLANATION OF PLATES

(All photomicrographs magnified × 500, unless otherwise stated)

PLATE 1

1. *Deltoidospora pseudoreticulata* sp. nov.; Fig. 1, Sl. No. 1626.

2, 3. *Cyathidites australis* Coup.; Fig. 2, Sl. No. 1607; Fig. 3, Sl. No. 1607.

4, 5. *C. minor* Coup.; Fig. 4, Sl. No. 1782; Fig. 5, Sl. No. 1783.

6, 7. *C. pseudopunctatus* sp. nov.; Fig. 6, Sl. No. 1780; Fig. 7, Sl. No. 1781.

8, 9. *C. cutchensis* sp. nov.; Fig. 8, Sl. No. 1784; Fig. 9, Sl. No. 1783.

10, 11. *C. grandis* sp. nov.; Fig. 10, Sl. No. 1785; Fig. 11, Sl. No. 1786.

12, 13. *C. ghuneriensis* sp. nov.; Fig. 12, Sl. No. 1787; Fig. 13, Sl. No. 1787.

PLATE 2

14, 15. *Alsophilidites densus* sp. nov.; Fig. 14, Sl. No. 1789; Fig. 15, Sl. No. 1790.

16-18. *Gleicheniidites indicus* sp. nov.; Figs. 16-18, Sl. No. 1792.

19. *Concavisporites cutchensis* sp. nov.; Fig. 19, Sl. No. 1791.

20a. *C.* cf. *punctatus* Delc. & Sprum.; Fig. 20a, Sl. No. 1595.

20b. *Matonisporites* sp.; Fig. 20, Sl. No. 1604.

21. *Trileites* sp. A. × 50; Fig. 21, Sl. No. 1710.

22. *T.* sp. B. × 100; Fig. 22, Sl. No. 1682.

23, 24. *Lycopodiacidites minor* sp. nov.; Figs. 23-24, Sl. No. 1613.

25. *Verrutriletes* sp. A. × 50; Fig. 25, Sl. No. 1729.

26. *Lophotriletes* sp.; Fig. 26, Sl. No. 1600.

27. *Osmundacidites* cf. *wellmanii* Coup.; Fig. 27, Sl. No. 1656.

28, 29. *O. indicus* sp. nov.; Fig. 28, Sl. No. 1793; Fig. 29, Sl. No. 1610.

30. *Baculatisporites comaumensis* (Cooks.) Pot.; Fig. 30, Sl. No. 1610.

31-33. *Bacutriletes cutchensis* sp. nov., Fig. 31 × 100, Fig. 32 × 150, Fig. 33 × 50. Figs. 31-32, Sl. No. 1717; Fig. 33, Sl. No. 1726.

PLATE 3

34, 35. *Bacutriletes dijkstrae* sp. nov. × 50; Fig. 34, Sl. No. 1722.

36. *Baculareticulosporis cutchensis* gen. et sp. nov.; Fig. 36, Sl. No. 1594.

37. *Horstisporites* cf. *reticuliferus* (Dijk.) Pot. × 100; Fig. 37, Sl. No. 1682.

38. *H.* sp. A. × 50; Fig. 38, Sl. No. 1734.

39, 40. *Lycopodiumsporites traumbauensis* sp. nov.; Fig. 39, Sl. No. 1794; Fig. 40, Sl. No. 1645.

PLATE 4

41. *Erlansonisporites* cf. *erlansonii* (Miner) Pot. × 50; Fig. 41, Sl. No. 1681.

42. *Ischyosporites crateris* Balme; Fig. 42, Sl. No. 1655.

43. *Contignisporites fornicatus* Dettm.; Fig. 43, Sl. No. 1608.

44, 45. *C. cooksonii* (Balme) Dettm.; Fig. 44, Sl. No. 1613; Fig. 45, Sl. No. 1610.

46. *Trilobosporites trioreticulosus* Cooks. & Dettm.; Fig. 46, Sl. No. 1592.

47, 48. *T. apiverrucatus* Coup.; Fig. 47, Sl. No. 1620; Fig. 48, Sl. No. 1623.
49, 50. *Valvisisporites minor* sp. nov. × 50; Fig. 49, Sl. No. 1692; Fig. 50, Sl. No. 1703.
51. *Boseisporites praeclarus* (Dev) emend.; Fig. 51, Sl. No. 1592.
52, 53. ? *Cyatheacidites verrucosus* sp. nov.; Fig. 52, Sl. No. 1621.
54. ? *C. granulosus* sp. nov.; Fig. 54, Sl. No. 1621.
55, 56. *Staplinisporites caminus* (Pocock) Balme; Fig. 55, Sl. No. 1606; Fig. 56, Sl. No. 1607.
57. *Densoisporites mesozoicus* sp. nov., Fig. 57, Sl. No. 1618.

PLATE 5

58. *Densoisporites* sp.; Fig. 58, Sl. No. 1598.
59a-b. *Megaspore* sp. A. × 50; Fig. 59, Sl. No. 1723.
60. *Aequitriradites indicus* sp. nov.; Fig. 63, Sl. No. 1621.
61, 62. *Umiaspora bosei* gen. et sp. nov. × 50; Fig. 61, Sl. No. 1750; Fig. 62, Sl. No. 1750.
63, 64. *Minerisporites cutchensis* sp. nov. × 50; Figs. 63-64, Sl. No. 1744.
65. *M. auriculatus* sp. nov. × 50; Fig. 65, Sl. No. 1753.
66-68. *M. mesosporeoides* sp. nov. × 50; Figs. 66-68, Sl. No. 1668.
69-71. *Auriculozonospora reticulata* gen. et sp. nov. × 50; Fig. 69, Sl. No. 1705; Fig. 70, Sl. No. 1707; Fig. 71, Sl. No. 1727.
72. *Thomsonia* cf. *reticulata* Mādler × 50; Fig. 72, Sl. No. 1707.
73, 74. *T. cutchensis* sp. nov. × 50; Fig. 73, Sl. No. 1683; Fig. 74, Sl. No.

PLATE 6

75, 76. *Dijkstraisporites filiformis* sp. nov. × 50; Fig. 75, Sl. No. 1700; Fig. 76, Sl. No. 1747.
77, 78. *Crassimonoletes surangei* gen. et sp. nov.; Fig. 77, Sl. No. 1789; Fig. 78, Sl. No. 1795.
79, 80. *C. minor* sp. nov.; Fig. 79, Sl. No. 1780; Fig. 80, Sl. No. 1808.
81, 82. *Monolites intragranulosus* sp. nov.; Fig. 81, Sl. No. 1780; Fig. 82, Sl. No. 1796.
83. *Leschikisporis indicus* sp. nov.; Fig. 83, Sl. No. 1797.
84. *Saccarisporites lurzeri* Dev × 100; Fig. 84, Sl. No. 1715.

PLATE 7

85, 86. *Aequitriradites triangulatus* sp. nov.; Fig. 85, Sl. No. 1795; Fig. 86, Sl. No. 1799.
87, 88. *A. fusus* sp. nov.; Fig. 87, Sl. No. 1818; Fig. 88, Sl. No. 1819.
89. *Enzonalsporites* sp.; Fig. 89, Sl. No. 1602.
90, 93. *Callialasporites trilobatus* (Balme) Dev; Fig. 90. Sl. No. 1618; Fig. 93, Sl. No. 1801.
91. *C. dampieri* (Balme) Dev; Fig. 91, Sl. No. 1800.
92. *C. segmentatus* (Balme) Sriv. Fig. 92, Sl. No. 1801.
94. *C. rimalis* sp. nov.; Fig. 94, Sl. No. 1788.
95, 96. *C. triletus* sp. nov.; Fig. 95, Sl. No. 1802; Fig. 96, Sl. No. 1803.

PLATE 8

97. *Pityosporites* sp.; Fig. 97, Sl. No. 1609.
98. *Platysaccus* sp.; Fig. 98, Sl. No. 1775.
99. *Podocarpidites* sp.; Fig. 99, Sl. No. 1629.
100, 101. *P. ellipticus* (Cooks.) Pot.; Fig. 100, Sl. No. 1804; Fig. 101, Sl. No. 1788.
102-104. *P. rarus* sp. nov.; Fig. 102, Sl. No. 1629; Fig. 103, Sl. No. 1805; Fig. 104, Sl. No. 1806.
105, 106. *P. major* Coup.; Fig. 105, Sl. No. 1791; Fig. 106, Sl. No. 1788.
107. *Microcachrydites antarcticus* Cooks.; Fig. 107, Sl. No. 1593.
108. *Podosporites micropteris* (Cooks. & Pike) Balme; Fig. 108, Sl. No. 1789.
109, 110. *P. raoi* sp. nov.; Fig. 109, Sl. No. 1807; Fig. 110, Sl. No. 1797.
111, 112. *Laricoidites indicus* sp. nov.; Fig. 111, Sl. No. 1809; Fig. 112, Sl. No. 1808.
113. *Araucariacites australis* Cooks.; Fig. 113, Sl. No. 1810.

PLATE 9

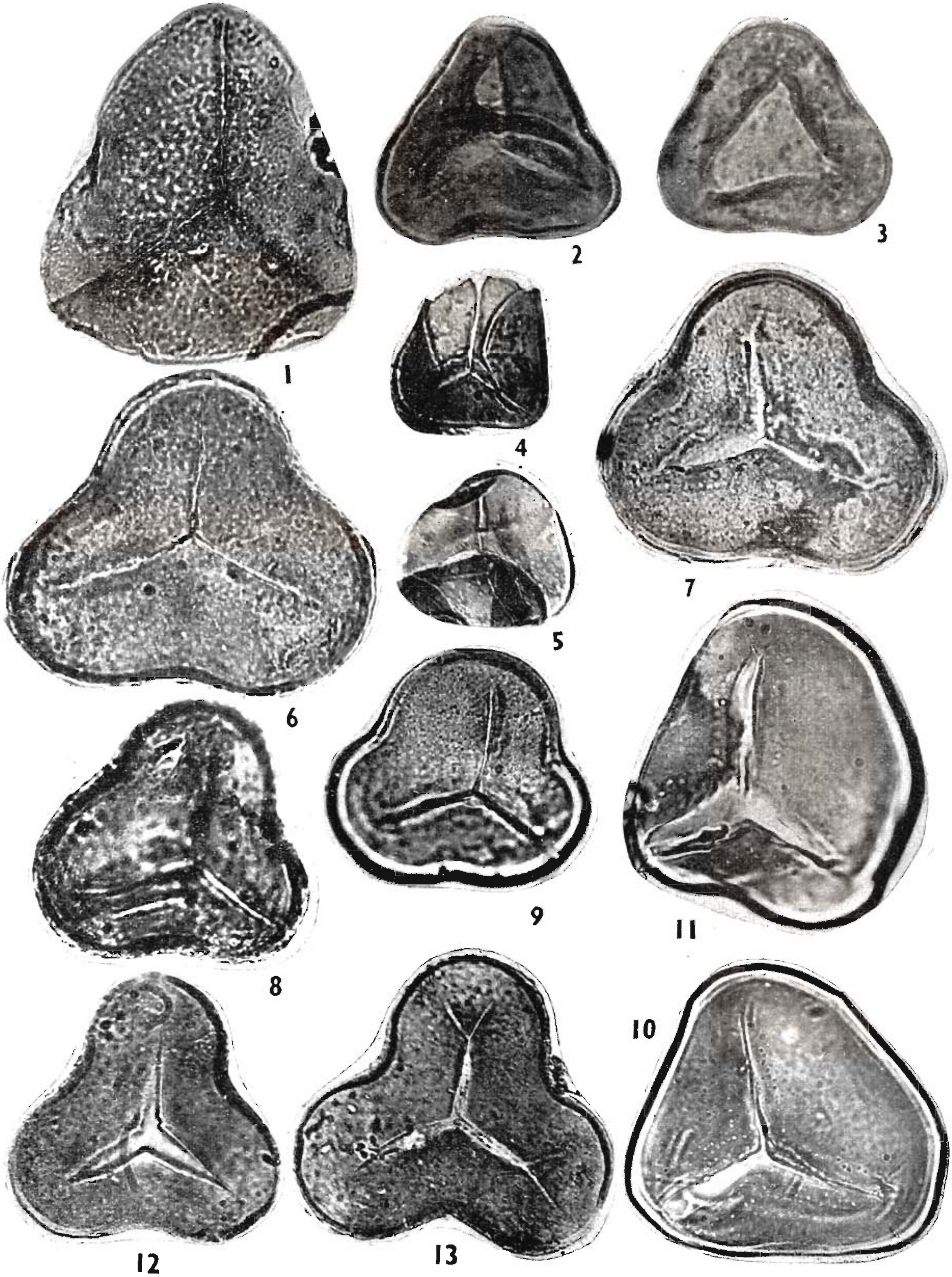
114-116. *Araucariacites ghuneriensis* sp. nov.; Fig. 114, Sl. No. 1811; Fig. 115, Sl. No. 1800; Fig. 116, Sl. No. 1785.
117, 118. *A. cooksonii* sp. nov.; Figs. 117-118, Sl. No. 1812.
119-121. *Schizosporis reticulatus* Cooks. & Dettm.; Fig. 119, Sl. No. 1798; Figs. 120-121, Sl. No. 1649.

PLATE 10

122. *Schizosporis reticulatus* Cooks. & Dettm.; Fig. 122, Sl. No. 1813.
123-125. *S. rugulatus* Cooks. & Dettm.; Fig. 123, Sl. No. 1814; Fig. 124, Sl. No. 1815; Fig. 125, Sl. No. 1655.
126. *Baculareticulosporis cutchensis* gen. et sp. nov.; Fig. 126, Sl. No. 1591.
127-129. *Schizosporis vermiculatus* sp. nov.; Figs. 127-129, Sl. No. 1685.
130, 131. *Cycadopites* sp. A.; Fig. 130, Sl. No. 1608; Fig. 131, Sl. No. 1610.
132, 133. *C.* sp. B.; Fig. 132, Sl. No. 1610; Fig. 133, Sl. No. 1607.
134-135. *Classopollis torosus* (Reiss.) Coup.; Fig. 134, Sl. No. 1817; Fig. 135, Sl. No. 1802.

ADDENDUM

The monograph entitled "Upper Mesozoic microfloras from south-eastern Australia" by M. E. Dettmann (1963, *Proc. roy. Soc. Vict.* **77** pt. 1) was published after this paper had been completed. However, an attempt has been made to refer to the above work in the text. At the moment, the present authors opine to retain *Boseisporites* and *Callialasporites* as distinct genera from *Matonisporites* and *Tsugaepollenites* respectively as they require discussion.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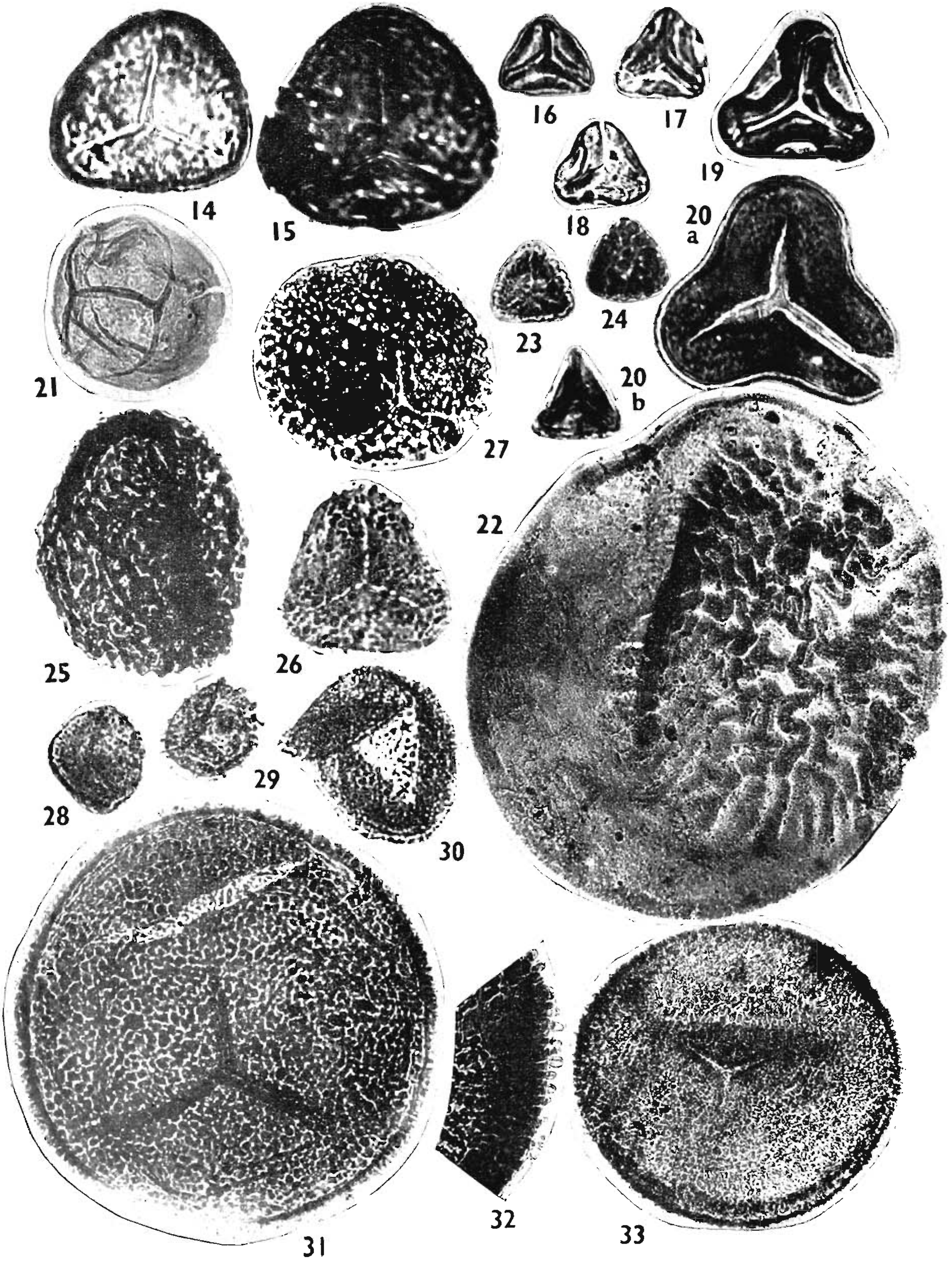

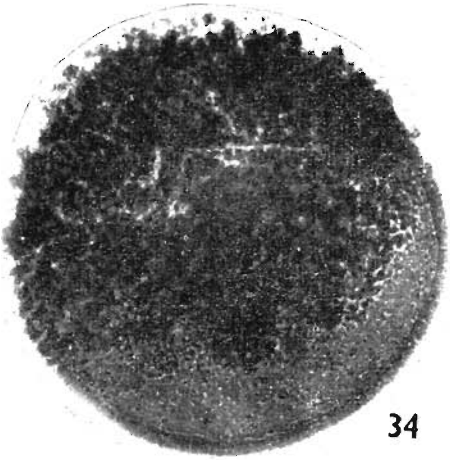
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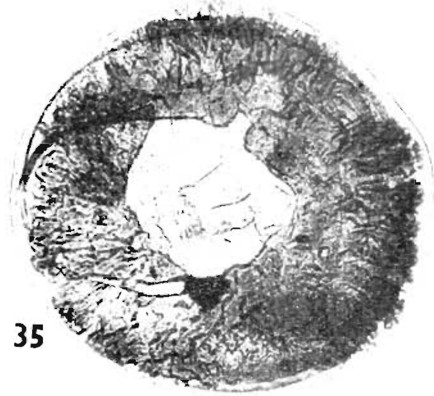
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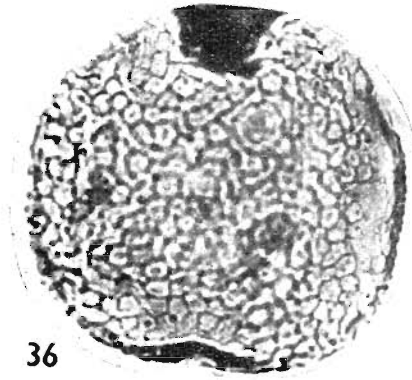
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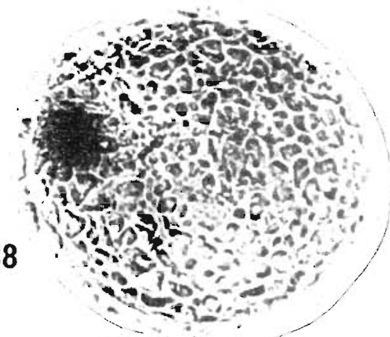
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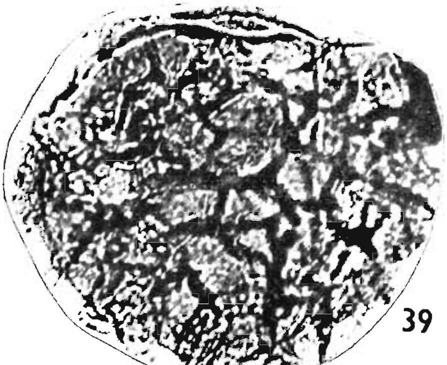
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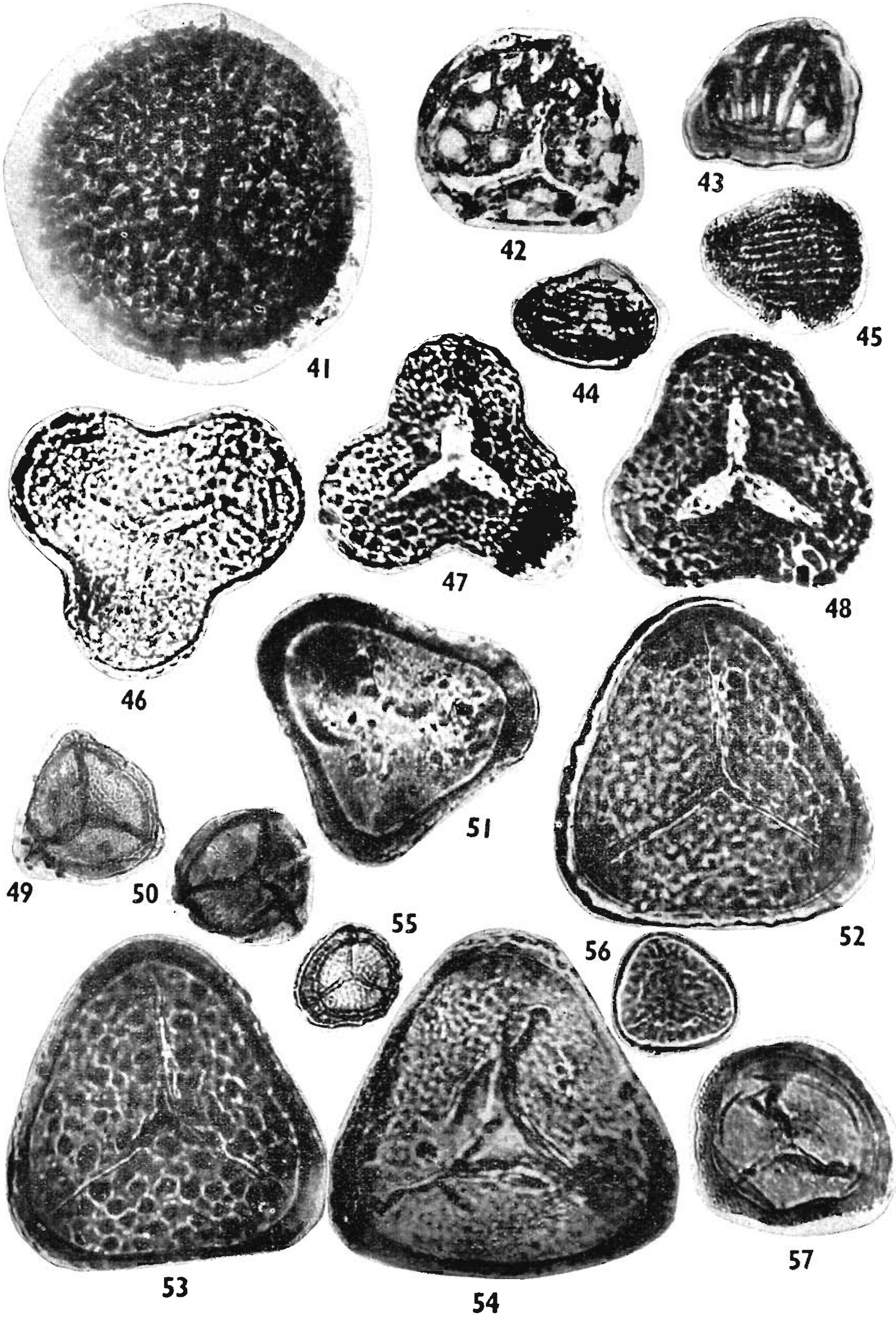
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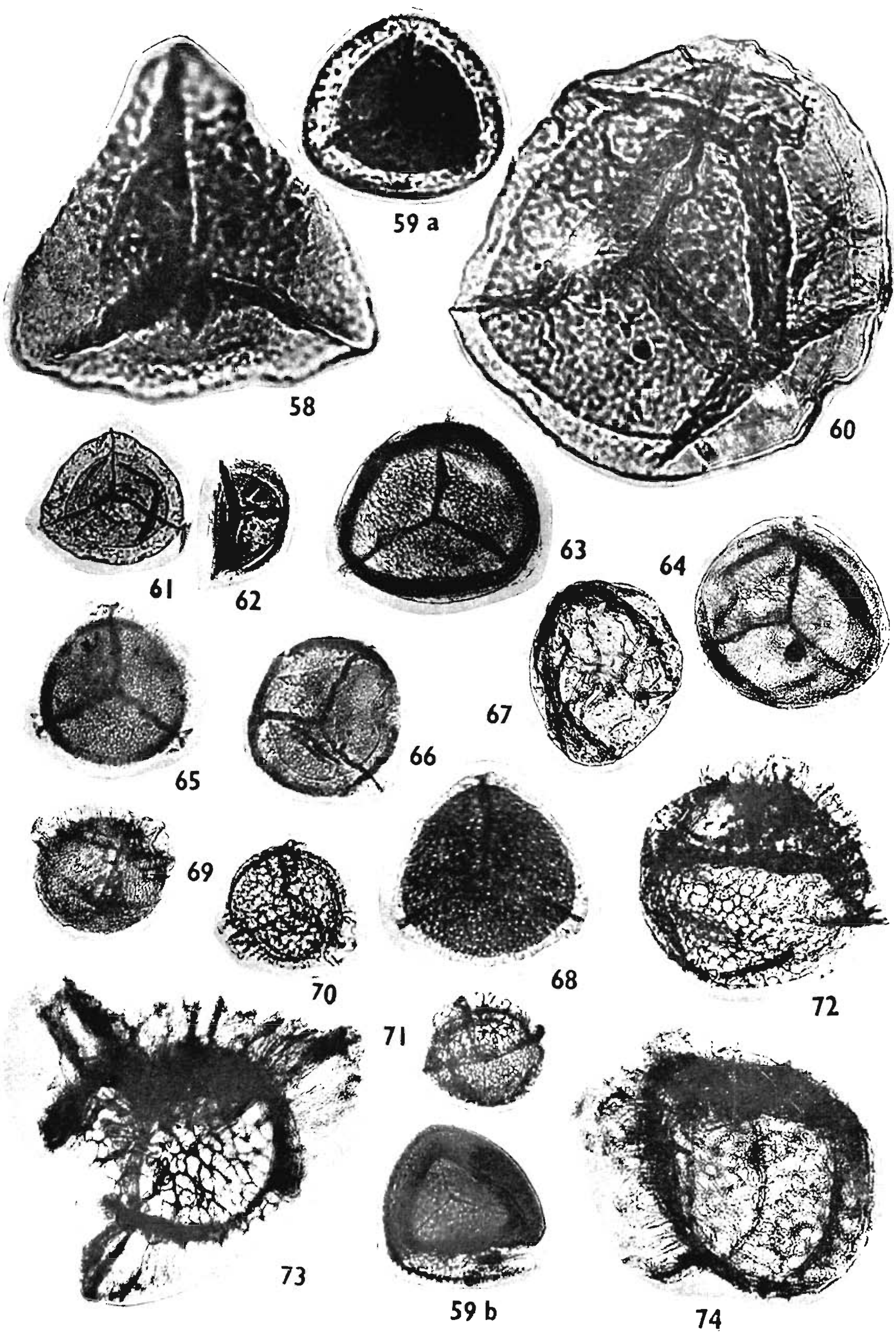
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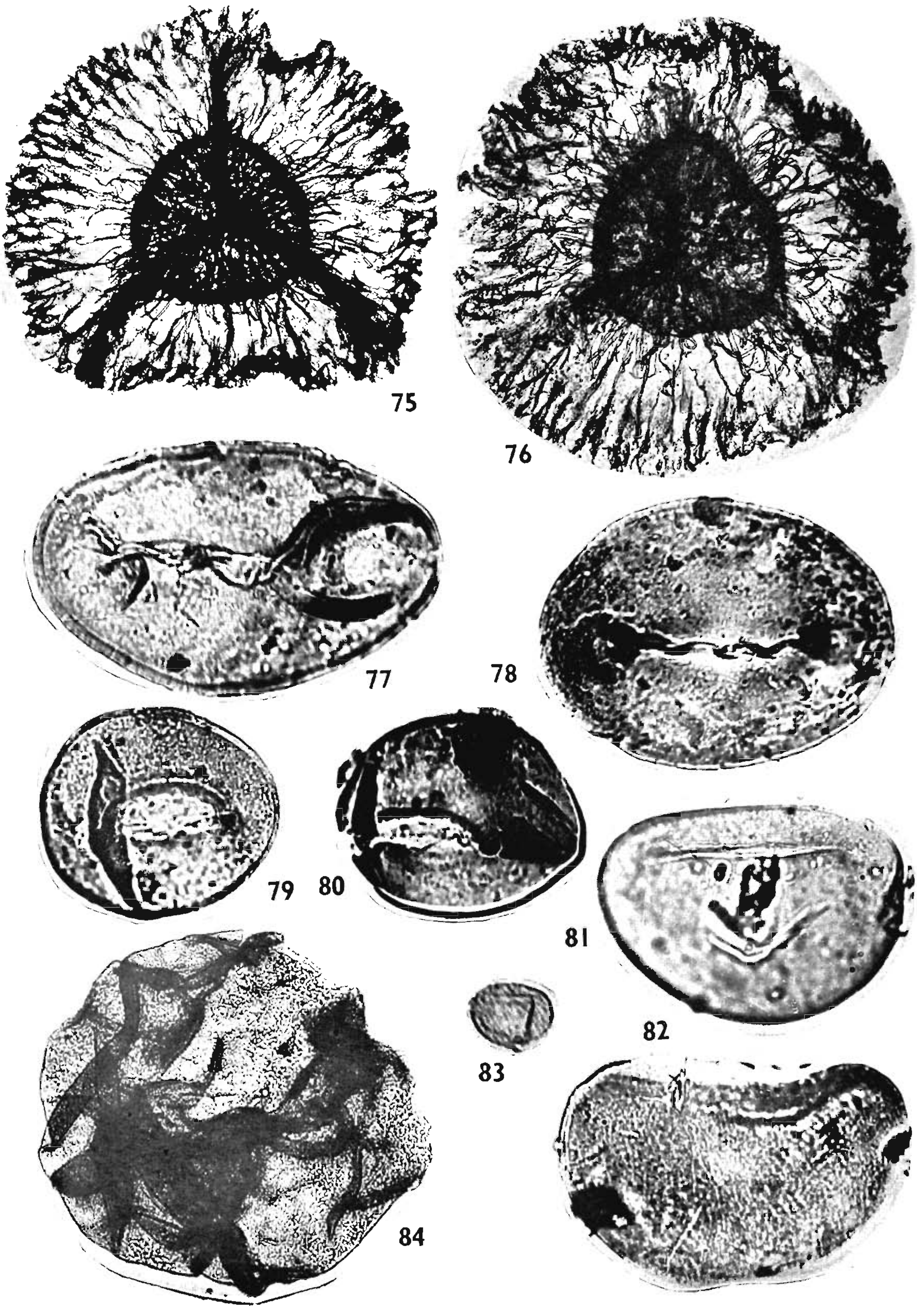
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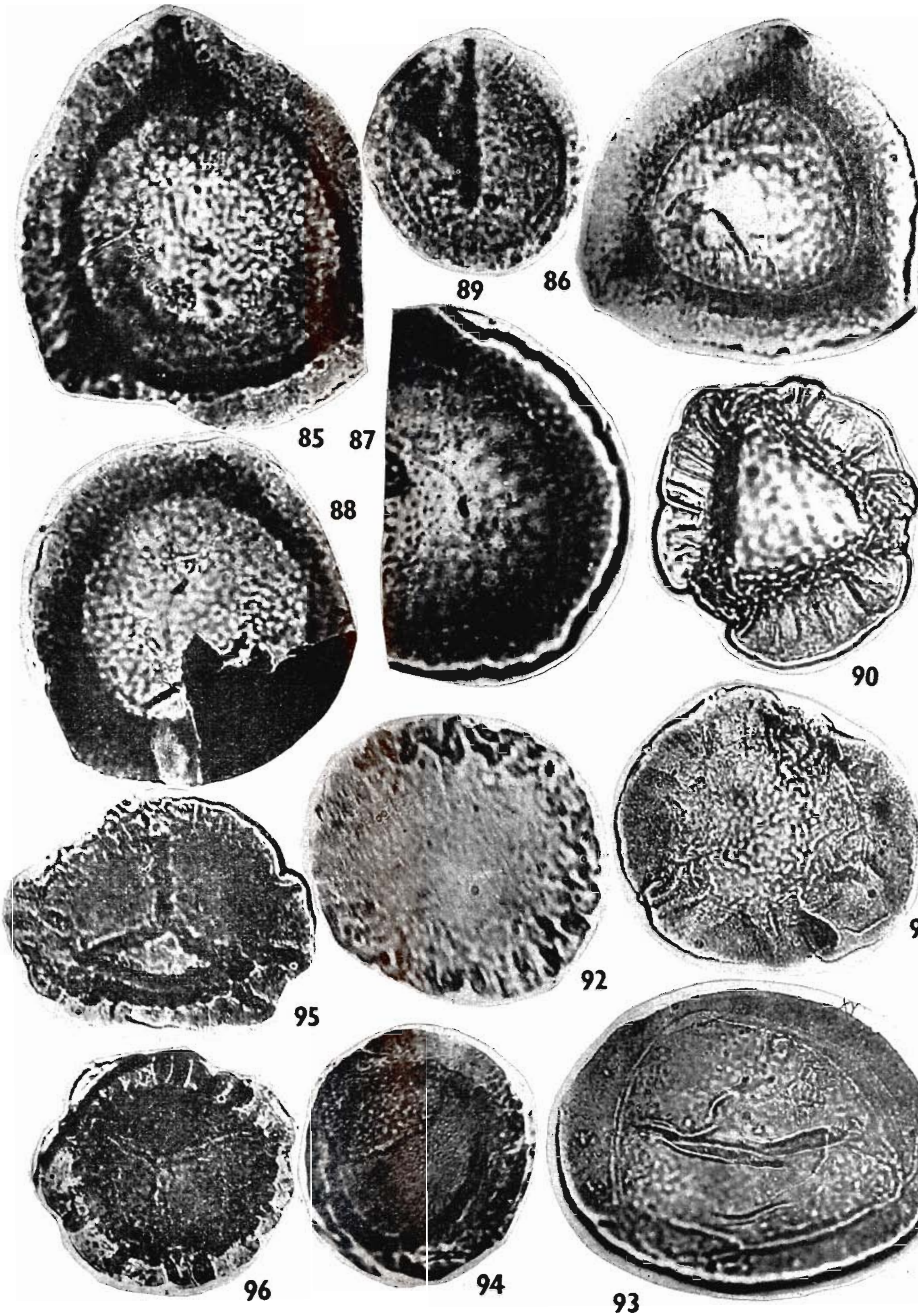

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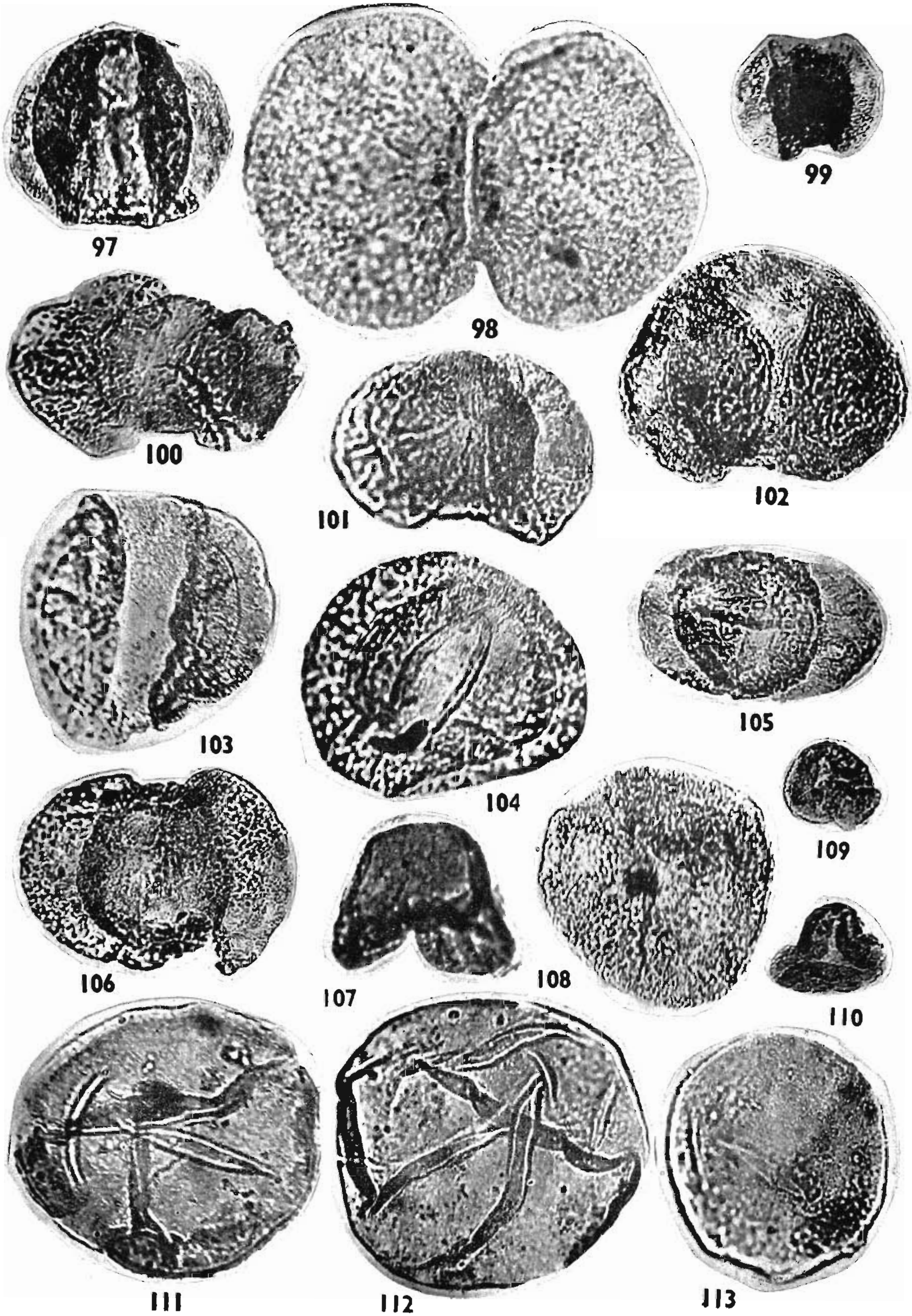
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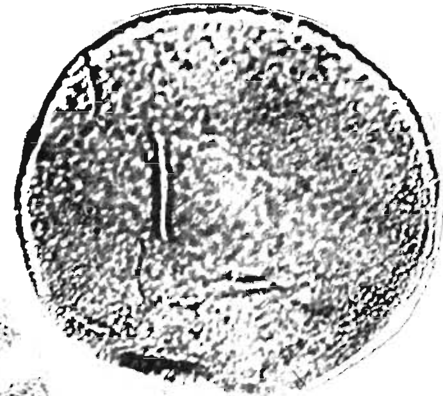

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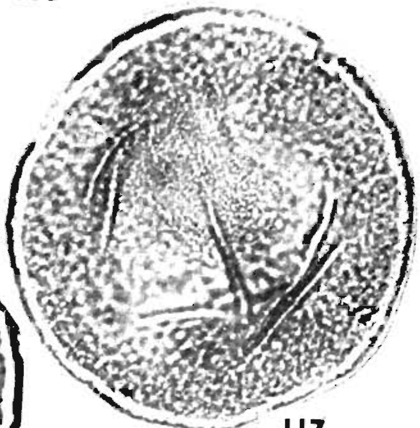

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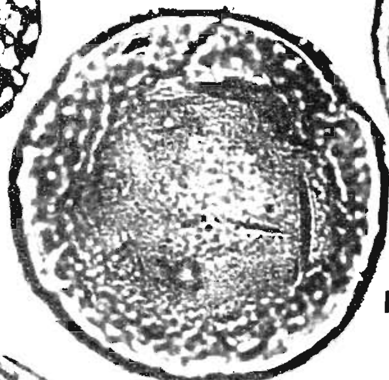

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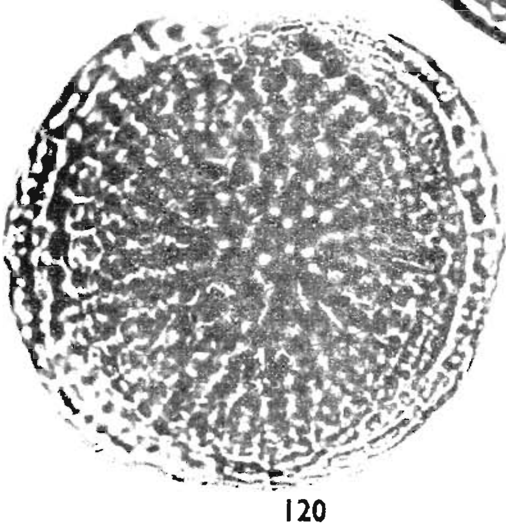

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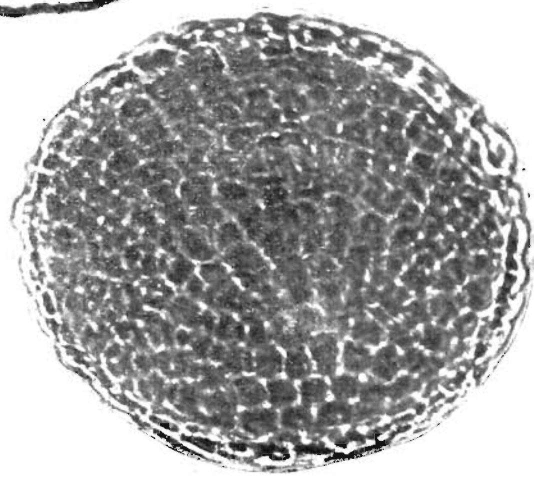

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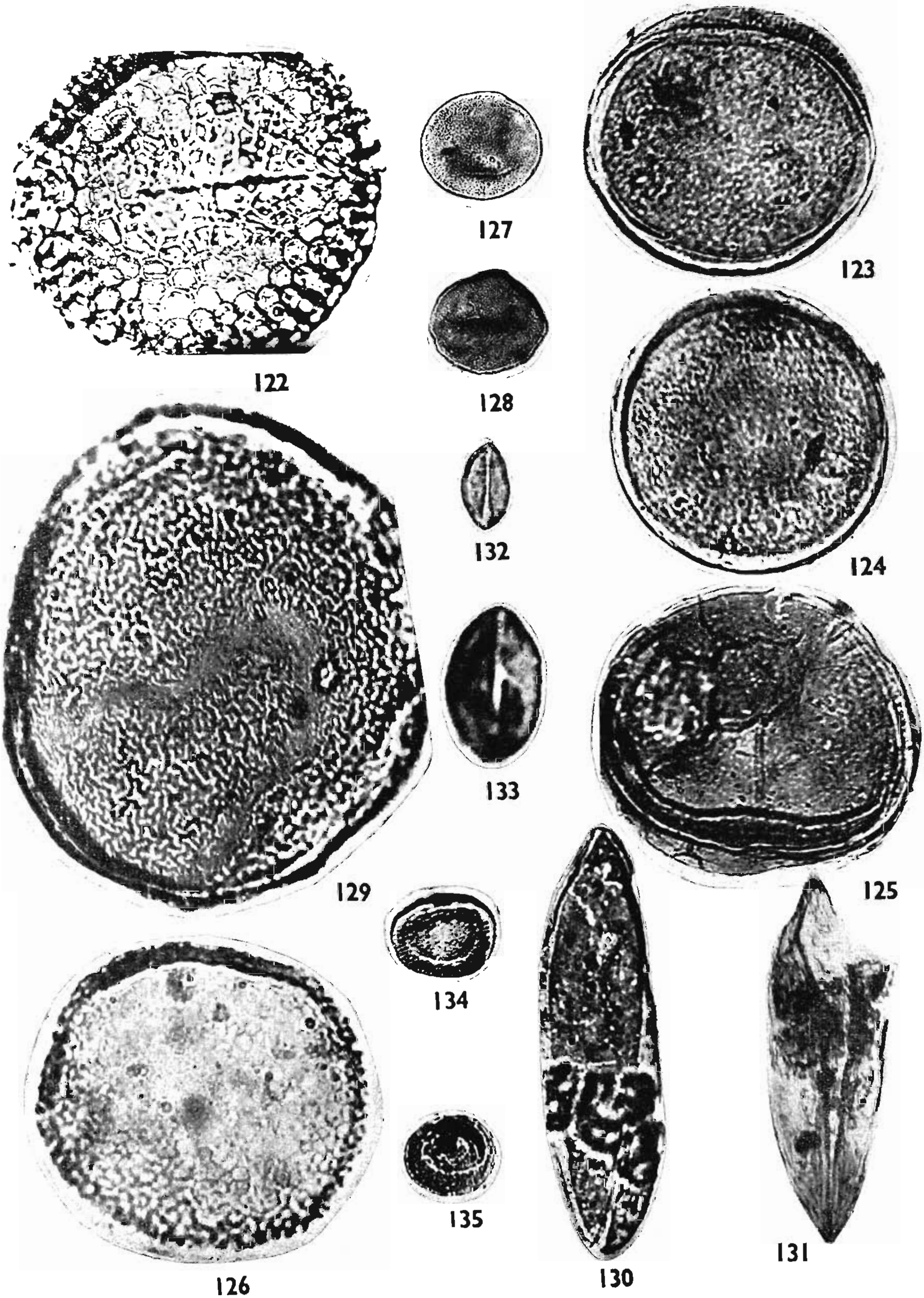
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