JURASSIC SPORES AND POLLEN GRAINS FROM THE RAJMAHAL HILLS, BIHAR, INDIA : WITH A DISCUSSION ON THE AGE OF THE RAJMAHAL INTERTRAPPEAN BEDS

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ABSTRACT

The present paper describes a rich mioflora obtained by maceration from carbonaceous shales collected from Sakrigalighat and Basko in the Rajmahal Hills, Bihar. The mioflora comprises 51 species belonging to 35 genera. The spores and pollen grains have been described here according to the system of classification proposed by Potonié and Kremp (1954, 1955 & 1956) and Potonié (1956, 1958 & 1960). The Sakrigalighat and Basko mioflora referred to the Rajmahal miofloral assemblage has been compared with the Mesozoic miofloras of India [including Nipania (Rajmahal Hills), Vemavaram (East Coast), Dhrangadhra (Saurashtra), Jabalpur and Cutch]; Pakistan (Salt Range); Ceylon (Andigama); Australia; Britain and Canada. The age of the Rajmahal Series is concluded to range between Middle and Upper Jurassic (Bajocian to Oxfordian).

INTRODUCTION

OUR knowledge of fossil spores and pollen grains from the richly fossiliferous rocks of the Rajmahal Hills is very little. So far, no record of spores and pollen grains obtained by maceration is available. Up till now the spores and pollen grains have been described only from thin sections of Nipania chert by Rao (1943) and Vishnu-Mittre (1954). Rao (*l.c.*, p.132) tried the maceration technique to obtain spores and pollen grains in their entirety from the cherts but did not recover any.

The shale samples from Basko and Sakrigalighat were collected in 1957 by one of us (SAH) in collaboration with Prof. O.A. Høëg and Dr M.N. Bose. The Basko shale is carbonized, fragile and brownish in colour with a fairly high percentage of silica. Whereas the Sakrigalighat sample is a highly carbonized, compact shale, black in colour and more or less coaly in appearance with fairly good amount of silica.

The nomenclature adopted for the Rajmahal *Sporae dispersae* is according to the International Code of Botanical Nomenclature as used by Potonié and Kremp (1954, 1955 & 1956) and subsequently reorganized by Potonié (1956, 1958 & 1960). It is essentially a conventional classification with morphologically circumscribed species and genera, grouped under suprageneric taxa, equivalent to families and orders based on comparative morphology.

SYSTEMATIC DESCRIPTION

Anteturma – *Sporites* H. Pot. 1893
Turma – *Triletes* (Reinsch 1881) Pot. & Kr. 1954
Subturma – *Azonotriletes* Luber 1935
Infraturma – *Laevigati* (Benn. & Kidst. 1886) Pot. 1956

Genus *Deltoidospora* (Miner 1935) Pot. 1956

Deltoidospora triangularis n. sp.

Pl. 1, Fig. 1

Holotype — Pl. 1, Fig. 1, Reg. No. 3110, Sl. No. 16/7.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 26-30 μ, holotype 27 μ, amb triangular with ± straight margins and somewhat pointed ends; trilete prominent, rays reaching periphery; exine proximally infrapunctate.

Description — Miospores tending to remain more triangular than deltoid or sub-deltoid in form, trilete functional, rays distinct and low with slight thickenings along the pyramic area. Labra thin, ± straight. Exine appearing smooth in surface view but in deep focus, a ± bright reticulum formed of very small rather pinpoint puncta fairly well discernible.

Comparison — *D. triangularis* differs from *D. hallii* Miner (1935) in having a triangular form with comparatively pointed apices and infrapunctate exine. *D. rhytisma* Rouse (1957) compares well but differs mainly in its larger size and comparatively larger puncta on the body exine.

Genus *Cyathidites* Couper 1953

Cyathidites rajmahalensis n.sp.

Pl. 1, Figs. 2-3

Syn. — *Laevigatisporites* Type 1, in Ramanujam, 1957, p.351; Pl. 10, Fig. 1; Text-fig. 1.

Holotype — Pl. 1, Fig. 2, Reg. No. 3110, Sl. No. 4/1.

Paratype — Pl. 1, Fig. 3, Sl. No. 9/14.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 27-38 μ, holotype 36 μ; amb triangular. Y-mark distinct, rays extending up to periphery. Exine infragranulate.

Description — Miospores triangular in polar view with ± markedly rounded ends, sides straight or slightly retracted (perhaps due to shrinkage); Y-mark with rather thin labra and usually opened sutures. Exine comparatively thinner at the polar ends than at the interapical edges, usually folds appearing at the polar ends.

Comparison — *C. rajmahalensis* differs from *C. australis* Couper (1953) and *C. minor* Couper (*l.c.*) in its ornamented exine. *C. australis* (in DEV 1961; p.43; PL.1, FIG.1) resembles our specimen in its infragranular exine but differs mainly in its much larger size.

Cyathidites medicus n. sp.

Pl. 1, Fig. 4

Syn. — *Leiotriletes*, in Sah, 1953, p. 3; Pl. 1, Photo 6.

Leiotriletes Type 8, in Sah, 1955, p. 63; Pl. 1, Fig. 14.

Holotype — Pl. 1, Fig. 4; Reg. No. 3110, Sl. No. 18/7.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 40-50 μ, holotype 45 μ; amb triangular; trilete distinct, Y-mark extending to three fourth or more of the radial distance, labra low. Exine thick, ± infrapunctate.

Description — Miospores triangular with ± sharply rounded apices and slightly concave sides. Y-mark open, labra as thick as the exine. Exine about 2 μ thick, appears to be minutely and evenly infrapunctate.

Comparison — *C. medicus* differs from *C. rajmahalensis* in its size, shape and exine ornamentation. *C. australis* Couper (*l.c.*) differs in having smooth exine. *C. medicus* agrees with *C. minor* Couper (1953) in size but differs in possessing slightly shorter rays and having less broadly rounded apices. A few species belonging to this genus have been described by Singh *et al.* (1964) from the Cretaceous coals of Cutch. But these grains differ from the present species in being much larger in size.

Cyathidites trilobatus n. sp.

Pl. 1, Figs. 5-7

Syn. — *Brachytrilistrium* Type 1, in Sah, 1955, p. 66 ; Pl. 1, Fig. 19 ; Text-figs. 2-3.

Barachytrilistrium, in Naumova, 1937; Pl. 1, Fig. 5, No. 7.

Holotype — Pl. 1, Fig. 5; Reg. No. 3110, Sl. No. 33/3.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 30-42 μ, holotype 32 μ; amb triangular to sub-triangular, apices broadly rounded, sides concavo-convex ; trilete distinct, rays long, ± reaching periphery, labra thin and low; exine thin, almost translucent and sculptureless.

Description — Miospores with broadly rounded ends and usually with convex sides tending to appear oval. Exine very thin with a marked tendency of folding during compression. When pressed along the meridional plane the sides remain rounded or straight and a fold ± triangular in shape appears over the Y-mark, completely enveloping it. The folds seem to be characteristically attached as a vertical flap to the longitudinal axis giving the spore a triplaned appearance (PL. 1, FIGS. 5 & 7). When obliquely pressed the sides become concave and a ± V-shaped fold appears along the laesurae covering only one of the proximal sides.

Comparison — *C. trilobatus* agrees in shape and size to *C. minor* Couper (1953) but differs in showing peculiar folding of exine. *C. minor* may also be showing this characteristic folding but in the absence of confirmation either from Couper's figured specimen or from his description, the Sakrigalighat specimens are assigned to a new species. From the other known species of *Cyathidites* our specimens differ in their smaller size and in having very thin and translucent exine.

Remarks — Fossil spores similar in form have been recorded from the Bacchus

Marsh Tillites of Victoria (PANT, 1943, p. 73; PL. 6, FIG. 6; TEXT-FIG. 2), the Lower Gondwana rock of India (MEHTA, 1944, p. 70; PL. 1, FIG. 7), and from the Lower Cretaceous and Jurassic of Caucasia (NAUMOVA, 1937; PL. 1, FIG. 5; No. 7). Spores showing somewhat similar tendency of the exine to fold in this characteristic manner giving a trilobed flap-like appearance, have been described under a new genus *Triplanosporites* by Pflug (in THOMSON & PFLUG, 1953, p. 28; PL. 3, FIGS. 58-59) from the Tertiary formation of Europe.

A large number of these grains, (many single mounts) from the Sakrigalighat shale were examined. All of them, when compressed from the polar surface, appeared triangular, comparing closely in their shape and size to those described under the form genus *Cyathidites* Couper; *Coniopteris hymenophylloides* Brong. (THOMAS, 1911; PL. 3, FIG. 5); *Thyrsopteris elegans* Kze. (THOMAS, *l.c.*, FIG. 7); *Eboracia lobifolia* (THOMAS, *l.c.*, p. 387; WILSON & YATES, 1953, p. 935; FIGS. 3 E & F); *Cladophlebis* (*Eboracia*) *lobifolia* (SZE, 1933; PL. 11; FIGS. 20-22); *Poroplanites* (PFLUG, 1953, p. 68; PL. 15, FIGS. 37-38; TEXT-FIG. 2, in COUPER, 1955, p. 471). Couper (*l.c.*) has compared them with the grains of *Cyathea pubescens*, a living tree fern, with their photographs and transferred (at least until further evidence of their affinity is forthcoming) to the form genus *Triletes* Cookson ex Couper. The present spores also resemble with *Cyathidites australis rimalis* Balme (1957, pp. 21-22; PL. 3, FIG. 36); *Todisporites major* Couper, (1958; PL. 16, FIG. 7); *Coniopteris hymenophylloides* (COUPER, *l.c.*, PL. 20, FIG. 6); *Dictyophyllidites harrisii* (COUPER, *l.c.*, PL. 21, FIG. 5) and also to those of the spores described under *Dictyophyllum rugosum* L. & H. (in HARRIS, 1944).

Couper (1953, p. 27) while discussing the affinities of the genus *Cyathidites* concluded that they may be the spores of an ancestral tree fern, thereby implying cyatheaceous relationship to the genus. Balme (1957, p. 21) on the other hand is of the opinion that there is little justification for regarding *Cyathidites* as more than a purely morphographic form genus, for although spores of this type occur among the Cyatheaceae, similar types are also found in Dicksoniaceae and Polypodiaceae. Thomson and Pflug (1953, p. 28) in their morphological explanations to some of the systematic groups have pointed out that although it is not certain regarding the affinity of the spores assigned to *Triplanosporites* Pflug, they may belong between the *Cicatricosisporites* group and the *Triplanosporites* group.

From the above perusal it is fairly clear that spores folded in this characteristic manner may belong to a divergent group of plants and hence creating a new taxon simply on the basis of this tendency does not seem to be justified. The Sakrigalighat spores show a close similarity with *Cyathidites* Couper and therefore, referred to this genus. They differ from those of *Dictyophyllidites* Couper in the absence of a distinct margo bordering the laesurae of the Y-mark.

Genus *Alsophilidites* (Cookson 1947) Pot. 1956

Alsophilidites grandis n. sp.

Pl. 1, Fig. 8

Syn. — *Leiotriletes*, in Sah, 1953, p. 3; Pl. 1, Photo 1 & 3; Pl. 2; Text-fig. 33.

Holotype — Pl. 1, Fig. 8; Reg. No. 3110; Sl. No. 26/14.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 78-88 μ; holotype 86 μ; amb triangular in polar view, apices broadly rounded, sides ± straight or slightly concave; trilete distinct, rays extending up to the periphery, laesurae thin and low; exine 4-6 μ thick, uniformly infragranulate along the Y-mark and scabrate in the contact area.

Description — Miospores fairly large in size with a distinct Y-mark; commissures low, not bordered by a margo. Exine uniformly thick and smooth along the *extrema lineamenta*; along the Y-mark it appears to be thin and mildly infragranulate; contact area uniformly scabrate.

Comparison — *Alsophilidites grandis* differs from *A. kerguelensis* Cookson (1947) in its larger size, comparatively thicker exine and infragranulate area along the Y-mark.

Alsophilidites exilis n. sp.

Pl. 1, Figs. 9-10

Holotype — Pl. 1, Fig. 9; Reg. No. 3110; Sl. No. 3/2.

Paratype — Pl. 1, Fig. 10; Sl. No. 31/1.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 48-56 μ, holotype 50 μ; amb triangular; apices broadly rounded; sides ± straight or sometimes slightly concave; Y-mark distinct, rays extending up to the periphery. Laesura ± thin flanked by a distinctly raised margo; exine thin and sculptureless; margo along the pyramic area finely punctate.

Description — Miospores triangular with a distinct trilete; rays long, commissures flanked by a distinctly raised margo, leaving a small depression along the inter-ray angles. Exine uniformly thick (1-2 μ), usually smooth along the *extrema lineamenta*, minutely punctate along the Y-mark, puncta small, closely arranged in tiers along the inter-ray areas between the margo and the commissures.

Comparison — *Alsophilidites exilis* differs from *A. grandis* in being smaller in size and having a thinner exine. *A. kerguelensis* Cookson (*l.c.*) compares in its shape, size and exine but differs in the absence of tiers of puncta along the commissures of the Y-mark.

Genus *Gleicheniidites* (Ross 1949) Delc. & Sprum. 1955

Remarks — The genus *Gleicheniidites* was instituted by Ross (1949, pp. 31-32; PL. 1 FIGS. 3-4) without a generic diagnosis. He regarded these spores as belonging to the family Gleicheniaceae. Later, Delcourt and Sprumont (1955, pp. 26-27; PL. 1, FIG. 5) validated this genus by giving a generic diagnosis and designating a genotype. Discussing the affinities of the genus, they pointed out that apart from the Gleicheniaceae, these spores also showed considerable similarity to those of *Matonidium*, as similar spores have been found on a pinnule of a Middle Jurassic *Matonidium* (SEWARD, as cited in DELC. & SPRUM., *l.c.*). This implies that the genus *Gleicheniidites* is a purely morphographic form-genus and that it should not be regarded as anything more than that.

Remarkably similar grains referred to *Gleichenia* Smith, have also been recorded by Cookson (1953, pp. 464-65; PL. 1, FIGS. 5-6) and Balme (1957, p. 23; PL. 3, FIGS. 42-44) from the Upper Mesozoic and Tertiary sediments of Australia; by Couper (1953, p. 20) from the Cretaceous and Tertiary deposits of New Zealand; and by Rouse (1957, p. 363; PL. 2, FIGS. 36-48; PL. 3, FIG. 49) from the Cretaceous of Western Canada. Cookson (*l.c.*) referred her spores to a new sporomorph *Gleichenia circinidites* because she finds a very close similarity between her spores and those of *Gleichenia circinata* (Swartz) Christen and further tries to substantiate it by pointing out that the pinnules of *Gleichenia circinata* type occur at certain levels in the Yallourn deposits of Southern Australia.

The spores recovered from Sakrigalighat and Basko shales (PL. 1, FIGS. 11-18), no doubt, compare closely to those of the present day *Gleichenia*, except in being slightly smaller in size (*G. circinata*, 43-56 μ and *G. microphylla*, 50-60 μ). The Rajmahal fossil flora is fairly rich in fronds referred to the form genus *Gleichenites* Goepp. This form genus was created, even though the fossil fronds showed considerable similarity with the living *Gleichenia*, because their relationship was not definitely established. Similarly, appears to be the case with these fossil spores and so referring them to a living taxon does not seem advisable. The Sakrigalighat spores are, therefore, referred to the form genus *Gleicheniidites* (Ross) Delc. and Sprum. There is a great possibility that these spores may belong to some of the species of *Gleichenites* recorded from the Rajmahal Hills but in the absence of any direct relationship, it still remains an open question.

Gleicheniidites mundus n. sp.

Pl. 1, Figs. 11-14

Holotype — Pl. 1, Fig. 11; Reg. No. 3110; Sl. No. 30/5.

Paratype — Pl. 1, Fig. 14; Sl. No. 27/3

Type Locality—Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 28-32 μ, holotype 30 μ; spores tetrahedral; amb triangular, apices ± rounded, sides usually concave; Y-mark distinct, rays extending up to the apical angle, laesurae thin, ± raised, commissures flanked by a distinct margo. Exine laevigate, very thin at the angles but broader between the interapical edges.

Description — Miospores small, triangular in equatorial contour, sides usually concave sometimes straight. Exine laevigate, very thin at the apices (less than 1 μ) but prominently thickened (3·5-4·5 μ) at the concavities.

Comparison — Organizationally *G. mundus* agrees closely with *Gleichenia circinidites* Cookson (1953, pp. 464-465; PL. 1, FIGS. 5-6) but the latter differs in having comparatively sharper apices and delicate sculpture. *Gleicheniidites senonicus* (Ross) Delc. and Sprum. (1955) and *Gleichenia concavisporites* Rouse (1957) are also somewhat comparable but as both are northern hemisphere species, detailed comparison has not been attempted.

Gleicheniidites microgranulosus n. sp.

Pl. 1, Figs. 15-17

Holotype — Pl. 1, Fig. 16 ; Reg. No. 3110; Sl. No. 40/1.

Paratype — Pl. 1, Fig. 17 ; Sl. No. 48/4

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 28-36 μ, holotype 32 μ; spore tetrahedral, amb triangular, apices rounded; Y-mark fairly distinct, laesurae rather thin and low, rays extending up to the apices, commissures flanked by a thin margo, pyramic area around the trilete distinctly raised; exine ornamented with minute grana, thin at the apices with rather prominent thickenings between the interapical edges.

Description — Miospores small, triangular in polar view. Sides ± straight or slightly concave; apical ends acutely rounded. Y-mark long, extending to the radius. Exine appears to be minutely granular in both the distal and proximal surfaces, about 1 μ thick at the apices and 3-4 μ between the apices. A thin area between the contact and interapical thickening is closely formed owing to the depression.

Comparison — *Gleicheniidites microgranulosus* differs from *G. mundus* mainly in the ornamentation of the exine while *G. senonicus* (Ross) Delc. and Sprum. (*l.c.*) differs in possessing smooth exine.

Gleicheniidites sp.

Pl. 1, Fig. 18

Description — Size 45 μ; spore tetrahedral; amb triangular, sides ± straight, apices ± rounded ; Y-mark distinct, laesurae raised, rays extending up to the apices, commissures flanked by distinct margo, a small krytome (tori) clearly discernible; proximal surface smooth, distal face around the pyramic area ornamented by very small, irregular but closely packed pilate appendages; exine fairly thick at the apices but 4-8 μ between the apices.

Comparison — This species is distinct from the other known species of *Gleicheniidites* in having the distal face of the exine ornamented with peculiar pilate appendages and also in the absence of a distinct thickening along the interapical margins. It is also not certain whether these spores should be correctly assigned to the genus *Gleicheniidites*. But as it shows considerable resemblance in appearance to *G. senonicus* Ross, described by Couper (1958, p. 138; PL. 20, FIGS. 14-15) from the British Mesozoic rocks, it is for the present described under this genus.

Genus *Divisisporites* (Thomson in Thoms. & Pfl. 1953) Pot. 1956

Divisisporites ovalis n. sp.

Pl. 1, Fig. 19

Holotype — Pl. 1, Fig. 19; Reg. No. 3110; Sl. No. 15/10.

Type Locality — Sakrigalighat, Rajmahal, Hills, Bihar, India. Jurassic.

Diagnosis — Size range 29-32 μ, holotype 29 μ; spore tetrahedral, amb oval to subtriangular, apices broadely rounded, sides convex; Y-mark distinct, rays extending up to more than half the radial distance, laesura thin, low and distinctly forked at the ends. Exine thin and infrapunctate.

Description — Miospores small, oval to nearly subtriangular in polar view due to broadly rounded apices and convex sides. Y-mark fairly long, rays almost reaching up to the equator, thin and not flanked by a margo. Exine about 1 μ thick and regular throughout the equatorial contour, sculptureless to faintly infrapunctate.

Comparison — The genotype is a Tertiary species from the northern hemisphere. However, the same species has been described by Cookson and Dettmann (1958, p. 98, PL. 14, FIG. 1) from the lower Cretaceous of Southern Australia. The Sakrigalighat species however differs in its comparatively smaller size, longer and slender arms of the Y-mark.

Genus *Callispora* Dev. 1961

Callispora baculoexinus n. sp.

Pl. 1, Fig. 20

Holotype — Pl. 1, Fig. 20; Reg. No. 3110; Sl. No. 1/2.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 66-72 μ, holotype 68 μ; amb triangular, trilete, sides ± straight or planoconvex, apices broadly rounded; Y-mark indistinct, rays extending to more than 3/4 of the radial distance, laesurae thin and low; *extrema lineamenta* smooth, exine thick, regular throughout the equatorial contour, occasionally folded along the apices, infrabaculate.

Description — Miospores large, appearing ± oval in polar view due to much rounded apices and frequently planoconvex sides; sides sometimes slightly concave. Y-mark usually faint but clearly discernible in some, laesurae always thin and low. Exine at the equatorial contour smooth, regular, measuring 2·5-4 μ in thickness; sculpture infrabaculate, forming a fine negative reticulum in deep focus.

Comparison — *Callispora baculoexinus* differs from *C. potoniei* Dev (1961) and *C.* sp. (Dev, *l.c.*) in having a more or less oval form, faint Y-mark and infrabaculate exine.

Infraturma — *Apiculati* (Benn. & Kidst. 1886) Pot. 1956

Subinfraturma — *Verrucati* Dybova & Jachowicz 1957

Genus *Converrucosisporites* Pot. & Kr. 1954

Remarks — The genus *Converrucosisporites* was instituted by Potonié and Kremp (1954, p. 37; Pl. 6, Fig. 18) for certain Palaeozoic iso- or micro-spores having a triangular form and similar exine ornamentation as in the genus *Verrucosisporites* (Ibrahim) Potonié and Kremp (1954). Somewhat similar spores were recovered from the Sakrigalighat shale and these have been described under the genus *Converrucosisporites* as they approach nearest to it in form, size and ornamentation. The exine of the Sakrigalighat spores, however, exhibit a mixed sculpturing of low verrucae or coni-like verrucae to baculae or even pilae like verrucae. These Mesozoic spores, therefore, in the sculptural elements show certain morphological features quite distinct from the Palaeozoic forms, which may later prove to be of stratigraphical interest.

Converrucosisporites santalensis n. sp.

Pl. 1, Figs. 21-22

Holotype — Pl. 1, Fig. 22; Reg. No. 3110; Sl. No. 15/1.

Paratype — Pl. 1, Fig. 21 ; Sl. No. 27/11.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 36-48 μ, holotype 41 μ; spore tetrahedral, trilete, amb triangular to subtriangular, sides ± straight or plano-convex, apices broadly rounded; Y-mark distinct, rays ± extending up to the equator; exine thin, verrucose, verrucae with rounded to blunt tops.

Description — Miospores small, equatorial contour triangular, sides ± convex; Y-mark sometimes prominent or faint, laesurae usually elevated, sometimes thin. Exine mediumly thick on proximal face and covered little more densely by rounded verrucae as compared to the distal, equatorial contour showing about 50 verrucae.

Comparison — *C. santalensis* differs from other species of the genus in having slightly larger verrucae with rounded top.

Converrucosisporites sinuotectus n. sp.

Pl. 1, Figs. 23-24

Holotype — Pl. 1, Fig. 24; Reg. No. 3110; Sl. No. 4/6.

Paratype — Pl. 1, Fig. 23 ; Sl. No. 21/8.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 33-42 μ, holotype 38 μ; spore tetrahedral; amb triangular to sub-triangular, sides usually convex or sometimes ± straight, apices rounded; Y-mark functional, rays extending almost up to the equator, laesurae thin, low and markedly wavy; exine mediumly thick, verrucose, verrucae rather low, with ± rounded or sometimes flat with truncated tops.

Description — Trilete miospores distinctly triangular in form. Y-mark not very distinct in low focus due to the verrucose ornamentation, but fairly distinct in high focus; equatorial outline notched, composed of short and low outgrowing verrucae, giving it a ± bastionic appearance.

Comparison — *C. sinuotectus* clearly identifies itself in possessing distinctly wavy arms of the Y-mark.

Genus *Concavissimisporites* (Delc. & Sprum. 1955) Delc. *et al.* 1963

Concavissimisporites minor n. sp.
Pl. 1, Fig. 25

Holotype — Pl. 1, Fig. 25; Reg. No. 3110 ; Sl. No. 45/9.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 37-46 μ; Spore tetrahedral, amb concavely triangular, apices ± rounded; Y-mark present, rays extending to more than three-fourths the radial distance, laesurae thin and low ; exine mediumly thick, ornamented with rounded verrucae.

Description — Small miospores, triangular in polar view with markedly concave sides. Y-mark fairly long, usually not very distinct owing to verrucose ornamentation of the exine. Exine about 1-2 μ thick, verrucae with rounded tops, fairly large, about 2 μ high, closely packed, ± 24 verrucae along the equatorial contour.

Comparison — *C. minor* differs from the Wealden species *C. verrucosus* (Delc. & Sprum.) Delc. *et al.* (1963) in being comparatively much smaller in size. Moreover, the latter species is recorded from the Northern hemisphere.

Genus *Verrucosisporites* (Ibrahim) Smith et Coll. 1964

Verrucosisporites dubius n. sp.
Pl. 1, Figs. 26-27

Holotype — Pl. 1, Fig. 26, Reg. No. 3110; Sl. No. 47/1.

Paratype — Pl. 1, Fig. 27 ; Sl. No. 28/1.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 40-48 μ; holotype 43 μ; amb circular to oval to sub-triangular ; Y-mark distinct, rays extending up to more than three-fourths the radial distance, laesurae thin and low, not flanked by a margo ; exine mediumly thick, covered by rather low verrucae, broad at the base, or rounded at the apex.

Description — Small miospores, light yellowish in colour, circular in polar view, tending to appear subcircular to oval in irregularly flattened condition. Trilete very distinct, rays functional, moderately long, almost reaching the equator, in most cases sutures opened. Exine 1·5-2·5 μ thick, equatorial contour appearing slightly notched due to the outgrowing verrucae ; verrucae almost always very low, with widely ranging width, apex usually rounded.

Comparison — *V. dubius* differs from both the Palaeozoic species *V. grandiverrucosus* (Kos.) Smith et Coll. (*l.c.*) and *V. ovimammus* Imgr. in its comparatively smaller size and also in possessing smaller verrucae.

Genus *Baculatisporites* Thoms. & Pfl. 1953

Baculatisporites clavaeoides n. sp.
Pl. 1, Fig. 28

Holotype — Pl. 1, Fig. 28; Reg. No. 3110 ; Sl. No. 3/4.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 50-68 μ; holotype 68 μ; trilete; amb ± circular to oval; Y-mark fairly distinct in surface view, rays extending to more than three-fourths the radial distance, laesurae thin and low; exine mediumly thick, densely covered with short finger-like baculae, usually having rounded tops.

Description — Rare, medium-size miospores, yellowish-brown in colour. Trilete sometimes faint due to dense baculae, rays appearing to extend almost up to the equator. Y-mark usually with open sutures. Equatorial outline unevenly rough owing to the outprojecting baculae. Exine about 1·5-2 μ, thickly set with fairly high baculae; each bacula 2-3 μ in length, broad at the base, usually having broadly rounded but sometimes with acutely rounded or even truncated apex.

Comparison — *B. clavaeoides* can easily be identified from the other species of *Baculatisporites* by its comparatively larger finger-like baculae or clavae.

Baculatisporites emarginatus n. sp.
Pl. 1, Figs. 29-31

Holotype — Pl. 1, Fig. 30; Reg. No. 3110; Sl. No. 18/8.

Paratype — Pl. 1, Fig. 29, Sl. No. 37/3.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 40-60 μ, holotype 54 μ; amb circular; Y-mark not very distinct, obscured by baculae, rays extending to more than 3/4 the radial distance, laesurae thin and low ; *extrema lineamenta* markedly notched, composed of small outprojecting baculae, 0·5-2 μ in length with ± rounded tops, interbacular space 1-3 μ wide; 70-80 baculae along the equatorial margin.

Description — Medium-sized trilete miospore. Trilete functional, usually faint but in some specimen clearly seen, rays moderately long, labra low and somewhat wavy probably due to the baculae. Exine mediumly thick, densely set with baculae of almost unifrom height, baculae comparatively low but with widely ranging width, giving the exine sculpturing a vermiculate appearance in low focus. *Extrema lineamenta* bastionic in form due to the regularly outgrowing baculae.

Comparison — *B. emarginatus* is quite distinct from *B. clavaeoides* in having low baculae of uniform height. It differs from the other known species of the genus in having a vermiculate exine sculpture formed due to the closely compact short baculae.

Subinfraturma – *Nodati* Dybova & Jachowicz 1957

Genus *Osmundacidites* Couper 1953

Remarks — The genus *Osmundacidites* was instituted by Couper (1953, p. 20, PL. 1, FIG. 5) for the reception of fossil spores of Osmundaceous affinities which cannot be more accurately placed. Cookson (1953, pp. 470-471) discussed the possible affinities of this genus, comparing it with the southern osmundaceous genera *Todea* and *Leptopteris*.

A number of spores from the present assemblage come within the morphographical circumscription of the genus *Osmundacidites* and at the same time it is also fairly apparent that all the species of this assemblage might not have osmundaceous affinity. These are, therefore, referred to the genus *Osmundacidites* Couper (*l.c.*), without regarding it as any thing more than purely a form (morphographic) genus.

Osmundacidites microgranifer n. sp.

Pl. 2, Fig. 41

Syn. — *Trachytriletes* Type 2, in Sah 1955, p. 63, Pl. 1, Fig. 24.

Holotype — Pl. 2, Fig. 41; Reg. No. 3110; Sl. No. 16/4.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 72-86 μ, holotype 86μ; equatorial contour usually ± spherical rays slightly wavy, extending up to one half or one third of the radial distance, laesurae raised; exine mediumly thin, minutely granulate.

Description — Miospores large, circular to spherical in outline but in some specimens a broadly sub-triangular form is also approached. *Extrema lineamenta* partly irregular or ± undulated. Trilete fairly well discernible in some, laesurae short, differing in breadth from specimen to specimen. Exine about 1 μ thick, ornamented with very small, evenly placed grana or sometimes coni; grana numerous, distinctly visible over the equatorial contour.

Comparison — *Osmundacidites microgranifer* differs from the other Mesozoic species in its comparatively larger size. The Australian and New Zealand species have also comparatively larger and fewer grana.

Osmundacidites formosus n. sp.

Pl. 1, Fig. 32; Pl. 2, Figs. 37-40

Holotype — Pl. 2, Fig. 37; Reg. No. 3110; Sl. No. 29/11.

Paratype — Pl. 1, Fig. 32; Sl. No. 37/1.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 41-48 μ, holotype 45 μ; amb circular to oval ; Y-mark distinct, rays extending to more than three-fourths of the radial distance, laesurae thin and low; exine thin, covered with very minute, evenly placed grana.

Description — Miospores spherical in outline, sometimes oval or broadly ellipsoid. Y-mark distinct, rays moderately long, almost always extending to more than three-fourths the radial distance, sometimes reaching the equator, laesurae thin, low and not flanked by a margo. Exine about 1 μ thick, usually showing arcuate secondary folds on the inner side of the equatorial contour. Both proximal and distal surfaces sculptured with small, dense grana, showing a fine negative reticulum under deep focus. The granules appear to be rounded at the *extrema lineamenta*, nearly equal in size and tightly arranged; about 90 grana along the equatorial contour.

Comparison — *Osmundacidites formosus* differs from *O. microgranifer* in being comparatively smaller in size, while *O. wellmanii* Couper (1953) differs from the former in the form and size of the sculptural elements. *O. comaumensis* (COOKSON) Balme (1957) differs from the present species in possessing blunt rod-like processes.

Osmundacidites minutus n. sp.

Pl. 1, Figs. 33-36

Holotype — Pl. 1, Fig. 36; Reg. No. 3110; Sl. No. 33/8.

Paratype — Pl. 1, Fig. 33 ; Sl. No. 15/9.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 19-27 μ, holotype 19 μ; amb circular to oval; Y-mark distinct, rays extending almost up to the equator, laesurae thin and low; exine very thin, covered with minute and regularly spaced grana.

Description — Circular miospores, sometimes flattened along the equatorial plane giving a sub-circular to oval appearance. Y-mark almost always fairly distinct, rays long, apex and vertex low. Exine less than 1 μ, both proximal and distal surfaces ornamented with uniformly distributed, very small grana of equal size. Equatorial margin appearing rough due to the presence of these minute grana, ± 80 grana along the equatorial contour.

Comparison — This species differs from the other species of *Osmundacidites* in its comparatively much smaller size.

Remarks — Organizationally and in size this species cannot be identified from those of the genus *Cyclogranisporites* Pot. & Kr. They also come within the circumscription of the genus *Osmundacidites* Couper, except for their comparatively smaller size. *Cyclogranisporites* is a Palaeozoic genus and the variations seen in the sculptural elements of the exine is very much suggestive of the composite nature of this genus. On the other hand *Osmundacidites* is also a fairly well circumscribed Mesozoic genus and as has been suggested in remarks on the genus *Osmundacidites* it should be treated as a purely form genus. Hence these small spores have been assigned to this genus, rather than to *Cyclogranisporites*.

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

Acanthotriletes baskoensis n. sp.

Pl. 2, Figs. 51-52

Holotype — Pl. 2, Fig. 52 ; Reg. No. 28038; Sl. No. 104/1.

Paratype — Pl. 2, Fig. 51; Sl. No. 84/6.

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 32-44 μ, holotype 44 μ; amb rounded triangular, Y-mark faint, laesurae long, extending up to the periphery, lips thin; exine 1-1·5 μ thick, proximal surface smooth, distally ornamented with numerous regularly placed spines.

Description — Miospores small, tetrahedral, triangular in polar view, angles broadly rounded, sides almost straight to sometimes convex, spines of the exine large, 4·5-5 μ in size, broad at the base (1 μ) and pointed or slightly truncate at the apex.

Comparison — *Acanthotriletes baskoensis* shows considerable similarity to *A. levidensis* Balme (1957) in form and somewhat in exine ornamentation. The former however differs in being slightly larger in size and in having larger spines as compared to its body size.

Affinities — Spores having thin exine ornamented with long spines occur amongst the present day Selaginellaceae. The present spores show some comparison in shape, size and ornamentation to *Selaginella selaginoides* (Erdtman, 1947, p. 150; Pl. 28, Figs. 487-488).

Subinfraturma — *Baculati* Dybova & Jachowicz 1957

Genus *Neoraistrickia* Pot. 1956

Neoraistrickia truncatus (Cookson) Pot. 1956

Pl. 2, Figs. 44-48

Syn. — *Piliferosporites* Type 1, in Ramanujam 1957, p. 356, Pl. 10, Figs. 22 & 23; Text-fig. 15.

Holotype — Cookson, 1953 : 471; Pl. 2, Fig. 36.

Diagnosis — (*See* POTONIÉ 1956, p. 34) size range 31-36 μ.

Description — See Cookson, 1953: 471.

Remarks — Balme (1957, p. 18) transferred *Triletes truncatus* Cookson (*l.c.*) to *Baculatisporites* Thoms. & Pfl. However, Cookson's description and illustrations clearly indicate that they should be placed under *Neoraistrickia* Potonié. Cookson and Dettmann (1958, p. 101) correctly assigned *Triletes truncatus* to the genus *Neoraistrickia* Pot., and therefore, the same generic name should be retained.

The present spores from Sakrigalighat cannot be identified from *Neoraistrickia truncatus*. *Piliferosporites* Type 1 of Ramanujam, also seems to belong to the same species.

Genus *Ceratosporites* Cooks. & Dettm. 1958

Ceratosporites sp.
Pl. 2, Fig. 53

Description — Miospore circular to oblong in shape; size 69 μ; Y-mark faint; exine thin, proximally smooth, distally sculptured with 7-10 μ long processes, base swollen, 2-3 μ in size, apex pointed to slightly dentate.

Comparison — *Ceratosporites* sp. differs from the only known species *C. equalis* Cookson and Dettmann (1958) in being comparatively bigger in size, in having faint Y-mark and in possessing much longer and pointed processes which in the latter are blunt to furcate.

Only a single specimen was recovered and hence no new specific name is proposed.

Genus *Paucibaculisporites* n. gen.

Genotype — *Paucibaculisporites increbescens* n. sp.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Generic Diagnosis — Trilete miospores, amb triangular to rounded triangular. Exine ornamented on both proximal and distal surfaces with dense baculae, ± uniform in height, *extrema lineamenta* uneven, prominent at the angles.

Generic Comparison — The genus *Paucibaculisporites* may be compared with a number of genera, i.e. *Callispora* Dev, *Alsophilidites* (Cooks.) Pot., and *Concavisporites* (Pfl.) Delc. and Sprum. *Callispora* resembles in having a triangular shape but differs mainly in having granulate to pilate exine. *Alsophilidites* is characterized by smooth and unsculptured exine. *Concavisporites* is distinguished by possessing krytome (torus) which is absent in the present genus.

Paucibaculisporites increbescense n. sp.
Pl. 2, Figs. 54-56

Holotype — Pl. 2, Fig. 54; Reg. No. 3110; Sl. No. 22/6.

Paratype — Pl. 2, Fig. 55 ; Sl. No. 16/1.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 55-60 μ, holotype 60 μ; amb triangular, angles broadly rounded, sides straight to concave, Y-mark distinct. Exine ornamentation on both proximal and distal surface baculate. *Extrema-lineamenta* uneven.

Description — Miospores medium-sized, tetrahedral, triangular in polar view. Y-mark distinct, rays extending up to 3/4 the radial distance, lips raised, sutures usually open; baculae on the exine surfaces uniform in height; each bacula narrow at the base than at the apex; interbacular space narrow and uniform.

Infraturma — *Murornati* Pot. & Kr. 1954
Genus *Foveosporites* Balme 1957

Foveosporites sp.
Pl. 2, Figs. 49-50

Description — Size 36 μ, amb rounded triangular, apices broadly rounded, sides convex ; Y-mark faint, laesurae reaching up to periphery. Exine 2-3 μ thick, ornamented with numerous small foveolae, foveola 2-4 μ in diameter, simple and never coalescing to form short channels.

Comparison — So far only a single species *Foveosporites canalis* Balme (1957) is known from the Mesozoic of Western Australia. The present specimens differ from *F. canalis* in having a faint Y-mark and simple pits which do not coalesce to form short channels.

This clearly shows that the Sakrigalighat spores distinctly form a new species. However, no new specific name is proposed for these spores as only two incomplete specimens were recovered.

Genus *Lycopodiumsporites* Thiergart 1938 ex Delc. & Sprum. 1955

Lycopodiumsporites austroclavatidites (Cookson) Pot. 1956
Pl. 2, Figs. 61-63

Syn.— *Dictyotriletes*, in Sah, 1953, p. 5; Pl. 1, Photo 17; Pl. 2, Fig. 39.

Reticulatisporites Type 1 and 5, in Ramanujam 1957, p. 355-356; Pl. 10, Figs. 16 & 21.

Holotype — Cookson 1953: 469 ; Pl. 2, Fig. 35.

Type Locality — Bore at Comaum, South Australia.

Diagnosis — (*See* COOKSON, 1953, p. 469).

Description — Spores spherical to broadly subtriangular, size range 40-48 μ; Y-mark extending up to the equator; exine ornamentation reticulate on the distal side. Meshes 4-6 μ wide. Muri on the margin projecting beyond the equator.

Genus *Cicatricosisporites* Pot. & Gell. 1933

Cicatricosisporites australiensis (Cooks.) Pot. 1956

Pl. 2, Figs. 57-60

Syn.— *Liratosporites* Type 1, in Vishnu-Mittre 1954, p. 119 ; Pl. 1, Figs. 10, 14-16.

Liratosporites Type 1, in Ramanujam 1957, p. 356 ; Pl. 10, Fig. 26.

Holotype — Cookson 1953, p. 58; Pl. 2, Fig. 32.

Type Locality — Comaum, South Australia. Jurassic.

Diagnosis — (*See* COOKSON 1953, p. 470).

Description — Size range 35-48 μ, amb triangular, angles ± rounded; Y-mark dissinct, laesurae reaching up to the equator, commissures slightly raised. Exine proximally smooth, distally sculptured with ridges flat, 7-12 in number, 1-2 μ apart, running parallel to the sides of the grain. Contact area smooth.

Genus *Ischyosporites* Balme 1957

Ischyosporites irregularis n. sp.

Pl. 2, Figs. 64-66

Syn.—*Dictyotriletes*, in Sah, 1953, p. 5; Pl. 1, Photo 16 and 20; Pl. 2, Figs. 41-42.

Striatotuberculatisporites Type 1, in Ramanujam 1957, p. 356; Pl. 10, Figs. 24 & 25.

Holotype — Pl. 2, Fig. 66; Reg. No. 3110 ; Sl. No. 44/1.

Paratype — Sah, 1953; Pl. 1, Photo 16; Pl. 2, Fig. 42.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 30-40 μ, holotype 40 μ; amb triangular to broadly subtriangular; Y-mark faint, laesurae long, reaching ± up to the periphery ; exine raised into prominent thick ridges on the distal surface, ridges running obliquely and anastomosing to form an irregular reticulum. Ridges extending beyond the body margin. Proximal surface infragranulate.

Description — Miospores subtriangular to subcircular in polar view. Exine 2-3 μ thick, distal surface covered with thick, 3-4 μ wide ridges, longer than broad, placed very near to each other, generally anastomosing, giving an appearance of imperfect reticulum with wide irregular lacunae. Sometimes the ridges appear to project beyond the margin.

Comparison — *Ischyosporites irregularis* differs from *I. crateris* Balme (1957) and *I. punctatus* Cookson & Dettmann (1958) in having infragranulate proximal exine, the latter two species possess smooth and punctate proximal exine respectively.

Turma – *Zonales* (Benn. & Kidst.1886) Pot. 1954
Subturma – *Auritotriletes* Pot. & Kr. 1954
Infraturma – *Auriculati* (Schopf) Pot. & Kr. 1954

Genus *Trilobosporites* (Pant 1954) ex Pot.

Trilobosporites purverulentus (Verbitskaya) Dettm. 1963

Pl. 3, Figs. 71-74

Holotype— Vervitskaya, 1962, p. 101; Pl. 9, Fig. 48a-c.

Diagnosis — (*See* Verbitskaya, 1962, p. 101).

Description — Size range 50-55 μ, amb triangular, trilete distinct, laesurae reaching ± up to the periphery, strongly rimmed, exine uniformly thickened, 1·5-2μ thick, densely covered with coarse grana on both proximal and distal surfaces ; distal surface characterized with shallow cushion-like thickenings localized at the polar angles, the thickening being formed of irregular ridges with small, 1-3 μ in diameter lacunae in between.

Subturma – *Zonotriletes* Waltz 1955
Infraturma – *Cingulati* Pot. & Kl. 1954

Genus *Cingulatisporites* Thoms. (In Thoms. & Pfl. 1935) Pot. 1956

Cingulatisporites notaclarus n. sp.

Pl. 2, Figs. 67-68

Holotype — Pl. 2, Fig. 68; Reg. No. 3110; Sl. No. 80/2.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 39-76 μ, holotype 76 μ; amb triangular, apices knobed, sides convex; Y-mark prominent, raised. Equator surrounded by a narrow cingulum, ornamented with coarse grana. Exine on proximal and distal surfaces coarsely granulate.

Description — Miospores medium sized, equatorial margin fairly thick, dark in colour, cingulum 3-4·5 μ broad; rays of the Y-mark ending in a knob-like structure at the angles.

Comparison — *Cingulatisporites notaclarus* differs from all the known species of the genus *Cingulatisporites* in its ornamented cingulum and distinct Y-mark forming a knob-like structure at the angles.

Genus *Foraminisporis* Krutsch 1959

Foraminisporis sp. cf. *asymmetricus* (Cookson & Dettm.) Dettm. 1963

Pl. 2, Fig. 42

Diagnosis — See Dettmann (1.c., p. 72).

Description — Miospore trilete, 45 μ broad at the widest region; amb ± subtriangular, sides ± straight; Y-mark indistinct, rays appear to extend up to the equatorial margin, laesurae thin and low; exine verrucate, cingulum 8-12 μ at the equatorial contour ornamented with verrucae.

Comparison — Both organizationally and in size, the Sakrigalighat spore compares closely to *F. asymmetricus* described by Dettm. (*l.c.*) from the Upper Mesozoic of S. Australia. The Indian species, however, shows a comparatively much thicker exine. This feature in itself appears to be just a minor variation and is of no specific importance.

Foraminisporis sp.

Pl. 2, Fig. 43

Description — Small miospores measureing 36-48 μ in diameter, trilete; equatorial contour ± oval in lateral view and subtriangular in polar, sides concave, apex ± rounded; Y-mark ± indistinct; exine mediumly thick, about 1·5-2 μ, usually folded, surface ornamented with sparse coni, about 1-2 μ long.

Remarks — Only two spores of this type were recovered. No comparison has been attempted because both the grains are not suitably preserved to show clearly all the details.

Anteturma – ***Pollenites* R. Pot. 1931**
Turma – ***Saccites* Erdtm. 1947**
Subturma – ***Monosaccites* (Chitaley 1951) Pot. & Kr. 1954**
Infraturma – ***Aletesacciti* Leschik 1955**

Genus *Callialasporites* Dev

1962 — *Pflugipollenites* Pocock

Remarks — Recently Dettmann (1963) has made *Callialasporites* Dev as a synonym of *Tsugaepollenites* Pot. & Venitz. She has based her observations only on the illustrations and descriptions of the type species of *Tsugaepollenites* but not on the type specimen itself. In view of this objection the generic name *Callialasporites* has been maintained here.

Callialasporites (al. *Zonalapollenites*) *trilobatus* (Balme) Dev 1961

Pl. 3, Figs. 81-84; Pl. 4, Figs. 87-89 & 91-92; Pl. 7, Fig. 153

Syn.— 1953 — *Euryzonotriletes*, Sah, Pl. 1, Photo 14.

1954 — Monolete spore, Vishnu-Mittre, Pl. 2, Fig. 36.

1957 — *Zonalapollenites trilobatus* Balme, Pl. 8, Figs. 91-92.

1958 — *Sporopollenites zonalis* var. *triangulus* Pautsch, Pl. 1, Fig. 13.

1958 — *Zonalapollenites trilobatus* Balme, in Lantz, Pl. 4, Figs. 37-40.

1961 — *Callialasporites* (al. *Zonalapollenites*) *trilobatus* (Balme) Dev, Pl. 4, Figs. 28-29.

1962 — *Pflugipollenites trilobatus* (Balme) Pocock, Pl. 12, Figs. 286-87.

1964 — *Callialasporites triletus* Singh *et al.* Pl. 7, Figs. 95-96.

Description — Miospores circular to subcircular, 50-68 μ in size, body triangular distalo-convex, apices broadly rounded, bladder equatorially attached, three lobed, 20 μ deep, crassitudo prominent. Body exine finely granulose, 1·5-2 μ thick, bladder surface coarsely granulate. Proximal radial folds seen.

Callialasporites grandis n. sp.

Pl. 3, Figs. 85; Pl. 4, Fig. 86

Holotype — Pl. 4, Fig. 86; Reg. No. 28038; Sl. No. 95/4.

Paratype — Pl. 3, Fig. 85; Sl. No. 61/2.

Type Locality — Basko, Rajmahal Hills Bihar, India. Jurassic.

Diagnosis — Size range 80-152 μ; subcircular in outline; body triangular, fairly large, apices broadly round; bladder attached equatorially, ornamented with dense baculae. Body exine infragranulate.

Description — Miospores large in size, measuring 60-130 μ, body broadly triangular: Bladder lobed, 10-20 μ deep free margins with crassitudo, 2-3 μ thick, uniform, no radial folds.

Comparison — *Callialasporites grandis* differs from *C. trilobatus* (Balme) Dev in its much larger size and in having baculate bladder surface.

Callialasporites (al. *Zonalapollenites*) *segmentatus* (Balme) Srivastava 1963

Pl. 3, Figs. 77-78; Pl. 4, Figs. 90, 93 & 94

Syn.— 1957 — *Zonalapollenites segmentatus* Balme, Pl. 9, Figs. 93-94.

1955 — *Lophotriletes* type 2, in Sah, Pl. 1, Fig. 31.

1958 — *Zonalapollenites segmentatus* Balme, in Lantz, Pl. 4, Figs. 41-42.

1963 — *Callialasporites segmentatus* (Balme) Sukh Dev, in de Jersey, Pl. 3, Fig. 6.

Description — Miospores circular, 50-100 μ in size, body broadly triangular to subcircular; bladder attached equatorially giving a frilled appearance to the bladder along the periphery of the body, 8-12 μ deep, bladder faintly granulate, radial folds present, body exine infragranulate.

Callialasporites (al. *Zonalapollenites*) *dampieri* (Balme) Dev 1961

Pl. 3, Figs. 75-76 & 79-80

Syn.— 1957 — *Zonalapollenites dampieri* Balme, Pl. 8, Figs. 88-90.

1958 — *Zonalapollenites dampieri* Balme, in Lantz, Pl. 3, Figs. 34-35; Pl. 4, Fig. 36.

1963 — *Callialasporites* (al. *Zonalapollenites*) *dampieri* (Balme) Sukh Dev, in de Jersey, Pl. 3, Fig. 5.

Description — Miospores circular, 60-90 μ in diameter, central body rounded triangular, 50-60 μ in size, bladder equatorial. Radial folds present but not much segmented. Bladder surface granulate, grana closely pact. Body exine infragranulate.

Callialasporites monoalasporus Dev 1961

Pl. 4, Figs. 95-96

Syn.— 1961 — *Callialasporites monoalasporus* Dev, Pl. 4, Fig. 25.

1962 — *Pflugipollenites lucidus* Pocock, Pl. 12, Fig. 185.

Description — Miospores similar in general organization to *C. dampieri* except in having unfrilled bladder outside the body and slightly subcircular body outline. Size of the grain 85 μ, central body 52 μ in size with 12-16 μ deep bladder.

Subturma — *Disaccites* Cookson 1947
Infraturma — *Pinosacciti* (Erdtm. 1945) Pot. 1958

Genus *Alisporites* (Daugh., 1941) Nilsson 1958

Remarks — The genus *Alisporites* was originally instituted by Daugherty (1941, p. 98) from the Triassic of Arizona. Later Nilsson (1958, p. 81) emended the description of Daugherty giving it in the form of generic diagnosis and also included the genus *Pteruchipollenites* Couper (1958) as its synonym. Rouse (1959, P. 314) probably unaware of Nilsson's paper also emended the diagnosis of the genus *Alisporites* emphasizing the same characters, except for elaborating its size range. Hence, Nilsson's emended diagnosis of the genus *Alisporites* Daugh., has nomenclatural priority over that of Rouse.

Alisporites rajmahalensis n. sp.

Pl. 5, Fig. 97

Holotype — Pl. 5, Fig. 97; Reg. No. 28038; Sl. No. 102/5.

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, holotype 76 μ long and 100 μ broad. Body longer than broad, margins prominent; bladders diametrically opposed, furrow narrow, surface ornamented with distinct reticulations. Body exine thick, granulate.

Description — Pollen grains large, body measuring 72×40 μ in size; bladders placed close to each other at the point of attachment, not fusing or overlapping, but leaving a fusiform furrow, about 4 μ in width. Ornamentation of the bladder composed of coarse reticulum on the outer side but finer towards the inner.

Comparison — *Alisporites rajmahalensis* compares very closely with the genotype *A. opii* Daugh. (1941) in all its important features. It, however, differs in having a comparatively faint margin of the body which in *A. opii* is very distinct and fairly thick. *A. jurassicus* Rao (1943) differs in having a distinct and subspherical body. *Alisporites* sp. (DEV. 1961, p. 51; Pl. 6, FIG. 49) compares very closely with the present species but differs mainly in its much bigger size.

Alisporites hemiglobosaccatus n. sp.

Pl. 5, Figs. 98-100

Holotype — Pl. 5, Fig. 98; Reg. No. 28038 ; Sl. No. 99/3.

Paratype — Pl. 5, Fig. 99 ; Sl. No. 104/4.

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, 56-80 μ long and 68-96 μ broad, body much longer than broad, oval, margins distinct ; bladder diametrically opposed, semiglobose in shape, surface moderately reticulate. Body exine thick, cristate on the proximal side.

Description — Pollen grains bilaterally symmetrical. Bladders closely attached throughout the furrow length, furrow 6 μ wide. Body exine cristate, cristae curved, forming a ± incomplete negative reticulum, distal surface smooth.

Comparison — *Alisporites hemiglobosaccatus* differs from *A. rajmahalensis* in its cristate proximal exine. Other species of the genus also differ in their body exine ornamentation.

Alisporites baskoensis n. sp.

Pl. 5, Figs. 101-102

Holotype — Pl. 5, Fig. 101; Reg. No. 28038; Sl. No. 85/3.

Paratype — Pl. 5, Fig. 102; Sl. No. 94/1.

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, 80×44 μ in size; body elliptical, acutely rounded at the ends, margin fairly thick; bladders well developed, longer than broad, surface finely reticulate; body exine microreticulate.

Description — Pollen grains haploxylonoid, bladder length and breadth ratio over 2·5, measuring 68×28 μ in size. Furrow almost indistinct, a poorly developed sulcus is seen. Body rim 2-3μ thick.

Comparison — *Alisporites baskoensis* compares well with *Pteruchipollenites microsaccus* Couper (1958; PL. 26, FIGS. 13-14) in its longer than broad body and poorly developed sulcus but differs mainly in having well developed bladders, bigger size and microreticulate proximal cap. *A. rajmahalensis* and *A. hemiglobosaccatus* differ in having different type of body exine ornamentation.

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

Genus *Platysaccus* (Naum. 1937) ex Pot. & Kl. 1954

Platysaccus indicus n. sp.

Pl. 5, Figs. 103-106

Holotype — Pl. 5, Fig. 103; Reg. No. 3110; Sl. No. 1/24.

Paratype — Pl. 5, Fig. 105; Sl. No. 86/7.

Type Locality — Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, over all size 40-45 μ × 50-60 μ, diploxylonoid; body circular to oval; bladders diameterically opposed, surface finely reticulate, furrow slit-like. Body exine on the proximal side granulate, distal surface smooth.

Description — Disaccate grains with a circular to oval central body and a distinct marginal rim; bladders attached distally, leaving a 3-4 μ wide furrow, exine ornamented with a distinct reticulum formed of fine meshes. Body exine 2-7 μ thick, granulate to smooth.

Comparison — *Platysaccus indicus* differs from *Platysaccus* sp. (in DEV 1961) from the Jabalpur Series in its smaller size while *P. papilionis* Pot. & Kl. (1954) differs in having bigger size and comparatively thicker exine.

Platysaccus sp. A

Pl. 5, Fig. 107

Description — Pollen grain disaccate, 82 × 96 μ in size. Body ± oval, 64 × 52 μ in size, marginal rim present; bladders large, 80 × 52 μ in size, semispherical, attachment diametrically opposed, furrow 2-3 μ wide, surface reticulate, meshes dense, radially elongated at the roots; body exine distally smooth and proximally ornamented with fine rugae.

Comparison — *Platysaccus* sp. A differs from all the known species of the genus in its rugulate proximal body exine. It is not assigned to a new species of *Platysaccus*, as only a single specimen of this type was recovered.

Platysaccus sp. B

Pl. 5, Fig. 108

Description — Pollen grain disaccate, bilateral, 64×44 μ in size; body ± circular, 36 μ in diameter, dark in colour, marginal rim prominent; bladders semi-spherical, 48×28 μ in size, attached distally throughout the length of the body, line of attachment curved, surface reticulate, furrow 8-10 μ wide. Body exine rugulate.

Remarks — This particular grain exhibits certain mixed characters which are found partly in *Platysaccus* and partly in *Cuneatisporites* Leschik. The curved line of attachment is a characteristic feature of *Cuneatisporites* otherwise in other feature it shows greater affinities to *Platysaccus* and hence referred to it.

Genus *Podocarpidites* (Cooks. 1947) Pot. 1958

Podocarpidites cristiexinus n. sp.

Pl. 5, Figs. 109-111; Pl. 6, Fig. 112

Holotype — Pl. 5, Fig. 109; Reg. No. 28038; Sl. No. 96/1.

Paratype — Pl. 6, Fig. 112; Sl. No. 89/1.

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, 44-64 μ × 68-100 μ in size, holotype 64×100 μ; body oval; bladders subequatorially attached, surface finely reticulate. Body exine distally smooth but proximally ornamented with cristae.

Description — Pollen grains variable in size, body broadly oval, measuring from 42×32 μ to 56×48 μ in size, ± flattened at the poles. Body margin appears to be thick probably due to the cristate exine. Bladder inflated, 44×28 μ to 64×40 μ in size, furrow 10-16 μ wide, surface finely to coarsely reticulate. Cristae on the body exine in certain specimens appearing to anastomose, forming a sort of negative reticulum.

Comparison — *Podocarpidites cristiexinus* differs from all other species of the genus in its cristate exine ornamentation.

Podocarpidites novus n. sp.

Pl. 6, Figs. 113-114

Holotype — Pl. 6, Fig. 113; Reg. No. 3110; Sl. No. 29/12.

Paratype — Pl. 6, Fig. 114; Sl. No. 42/2.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, holotype 44×60 μ in size; body circular to ± oval, marginal rim prominent; bladder surface coarsely reticulate, furrow wide. Body exine very finely sculptured.

Description — Body usually circular, occasionally compressed in a ± oblong-oval manner, measuring 32-42 μ in diameter. Bladders 44×24 μ, slightly projecting surface the body margin at the ends, bladder reticulate, muri broadly diverging towards the root forming regular reticulation on the free side.

Comparison — *Podocarpidites novus* differs from *P. cristiexinus* in the body exine ornamentation. It also compares well with *P. microreticuloidatus* Cookson (in Couper 1953, p. 36) in size and in having ± similar exine cap, but differs mainly in having marginal rim and coarsely reticulate bladder. *P. ellipticus* Cookson (1947) resembles with the present grains in having ± the same size, finely ornamented exine cap, well developed marginal rim and wide furrow, but is distinguished mainly in having delicate and fused bladders with small and obscure meshes of the mesoexinous reticulum. *Podocarpus multisima* Bolkhov. (1958) shows some resemblance in shape.

Podocarpidites grandis n. sp.

Pl. 6, Figs. 115-117

Holotype — Pl. 6, Fig. 115; Reg. No. 3110 ; Sl. No. 62/7.

Paratype — Pl. 6, Fig. 116; Sl. No. 61/3.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, holotype 68×120 μ; body ± rounded, marginal rim prominent; bladders inflated, covering 2/3 area of median longitudinal furrow, not extending beyond the body margin, surface reticulate, furrow much wider with distinct margins. Body exine finely microreticulate.

Description — Pollen grains fairly large in size, bilateral. Body ± circular to oval, 60-68 μ in diameter, surrounded by a distinct rim. Bladders large, almost spherical in shape, 68×52 μ to 72×48 μ in size, line of attachment distinct, surface reticulate with broad lumina at the free ends, distinct towards the root.

Comparison — *Podocarpidites grandis* shows considerable resemblance with *P. major* Couper (1953) in its large size and circular to subcircular shape of the body but mainly differs in having a microreticulate body exine which in the latter is granulate to verrucose. Both *P. cristiexinus* and *P. novus* differ in being comparatively smaller in size. *P.* sp. (Dev, 1961, p. 51) compares well with the present species in its size, shape and a distinct body rim but distinguishes itself chiefly in having a granulate proximal coat and the projecting bladder beyond the body.

Podocarpidites alareticulosus n. sp.

Pl. 6, Figs. 118-119

Syn.—*Pityosporites* Type 2, in Ramanujam 1957, p. 363; Pl. 11, Fig. 40; Text-figs. 37-38.

Holotype — Pl. 6, Fig. 118; Reg. No. 28038; Sl. No. 97/1.

Paratype — Pl. 6, Fig. 119; Sl. No. 82/7

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grain disaccate, holotype 72×60 μ in size; body oblong, marginal rim present; bladders much smaller than the body, distally inclined, coarsely reticulate with dense muri; furrow wide. Body exine infra-microreticulate.

Description — Grains fairly big, body size 60-75 μ in length and 40-60 μ in breadth. Bladders 52-60 μ×30-40 μ in size, sometimes unequal, occupy more than 2/3 part of the body length.

Comparison — *P. alareticulosus* is comparable to *P. microreticuloidatus* Cookson (1947) and *P. otagoensis* Couper (1953) in having smaller wings than the body (haploxylonoid type), but differs mainly in having finely reticulate body exine and coarsely reticulate bladder surfaces. Other known species and the new species described here also differ in not having haploxylonoid condition apart from other details.

Podocarpidites typicus n. sp.

Pl. 6, Figs. 120-122

Holotype — Pl. 6, Fig. 121; Reg. No. 28038; Sl. No. 86/9.

Paratype — Pl. 6, Fig. 122; Sl. No. 99/5.

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, subspherical, holotype 80 μ in diameter. Body ± rounded or oblong, marginal rim distinct; bladders smaller than body, flattened, surface finely reticulate. Body exine microreticulate.

Description — Pollen grains 60-80 μ in diameter; body 60-76 μ long and 60-68 μ broad; texture of the bladders at the proximal root merging with the cap at the margin, ornamented with a fine meshed reticulum; bladders measuring 44-60×20-28 μ in size.

Comparison — *Podocarpidites typicus* differs from *P. alareticulosus* in having finely meshed bladder reticulum and well defined marginal rim.

Genus *Phyllocladidites* (Cookson 1947) Couper 1953

Phyllocladidites florinii (Cooks. & Pike, 1953) n. comb.

Pl. 6, Fig. 123

Holotype — *Dacrydiumites florinii* Cooks. and Pike, 1953, p. 479; Pl. 3, Fig. 20.

Type Locality — New Guinea, Australia and Tasmania. Tertiary.

Description — Pollen grain disaccate, 96×64 μ in size; body spherical, 64 μ in diameter; bladders united in a frill around the region of furrow, 44×24 μ in size; surface covered with prominent radial loops or a coarse reticulum. Body exine 2 μ thick, coarsely granulate to finely rugulate.

Remarks — *Dacrydiumites balmei* Cookson and Pike (*l.c.*) shows a close resemblance with the present pollen grain but differs mainly in their larger size.

Genus *Vitreisporites* (Leschik) Jansonius 1962

Vitreisporites rajmahalensis n. sp.

Pl. 6, Figs. 124-126

Holotype — Pl. 6, Fig. 125; Reg. No. 28038; Sl. No. 93/1.

Paratype — Pl. 6, Fig. 124; Sl. No. 20/5.

Type Locality — Basko, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains disaccate, holotype $44 \times 36\ \mu$ in size; body oval in polar view, marginal rim unevenly thickened; bladder attached along the median longitudinal plane; furrow narrow, ornamentation fairly distinct composed of a rather fine reticulum. Body exine granulate.

Description — Grains relatively small, body $32 \times 24\ \mu$ in size, marginal rim thicker on the lateral sides forming curved darker bands on both the sides of the wing. Bladders usually not extending beyond the body margin, slightly bigger, measuring $36 \times 16\ \mu$ in size, attachment slightly concave or straight, reticulum on the bladder surface fairly regular, lacunae small, mostly roundish, muri thin and slightly raised. Bladders sometimes appear to join at the polar ends. Body exine granulate, grana small, fairly crowded with some of them fusing.

Comparison — *Vitreisporites rajmahalensis* compares with *V. pallidus* (COUPER) Jansonius (*l.c.*) in general shape and size but differs mainly in having distinct reticulations on the bladder surface.

Subturma — *Polysaccites* Cookson 1947
Genus *Trisaccites* Cookson and Pike 1954

Trisaccites microsaccatus (Couper) Couper 1960

Pl. 7, Figs. 130-136

Syn.— *Trichotomonosulcites subgranulatus* Couper 1953, p. 64; Pl. 8, Figs. 127-128.

Trisaccites micropterus Cookson and Pike 1954, p. 64; Pl. 2, Figs. 21-29.

Podosporites micropterus (COOKSON & PIKE) Balme 1957, p. 34; Pl. 9, Figs. 101-103.

Podosporites micropterus (Cooks. & Pike) Balme 1957, in Singh *et al.* 1964, p. 299; Pl. 8, Fig. 108.

Holotype — Couper 1960; Pl. 4, Figs. 12-13.

Type Locality — (*See* COUPER 1960, p. 46).

Diagnosis and Description — (*See* COOKSON & PIKE, 1954).

Remarks — The genus *Trisaccites* was proposed by Cookson and Pike (1954, p. 64) for grains having a triangular outline, 3-rudimentary (frill like when unexpanded), narrow and broadly attached bladders with inconspicuous reticulum on their surfaces. Leschik (1956, p. 129) used the name *Trisaccites* at the level of Infraturma under the Subturma *Polysaccites* without substituing another name for the grains described by Cookson and Pike as *Trisaccites*. Thus in the present position the same name *Trisaccites* is for both as a genus and as a higher group which is invalid according to the International rules of nomenclature. Also according to the rules the name *Trisaccites* has nomenclatural priority because it is a validly published genus. Now, therefore, a new name should be suggested for the group if it is necessary to do so. We feel that it is not necessary because the name *Polysaccites* as a subgroup is itself sufficient to embrace winged grains having more than two wings. If not then for every addition of a wing a new group will have to be created which seems unjustifiable. Balme (1957, p. 34) made *Trisaccites* a synonym of *Podosporites* Rao (1943). But the study of type slides of *Podosporites* and many other grains from this assemblage, has revealed that these grains are always spherical with three inflated wings having distinctly reticulate ornamentation. In view of the above facts the well established genus *Trisaccites* is retained here.

Genus *Dacrycarpites* Cookson and Pike 1953

Dacrycarpites australiensis Cookson & Pike (1953)

Pl. 7, Figs. 137-138

Syn.— *Podosporites* Type 1, in Ramanujam 1957, p. 363; Pl. 11, Fig. 41; Text-fig.39.

Diagnosis — (*see* COOKSON & PIKE, *l.c.*, p. 78).

Description — Pollen grains trisaccate. Body circular to triangular; 52 μ in diameter, marginal rim well defined, 2-4 μ thick, outer edge finely to coarsely crenate. Bladders 40-44 $\mu \times$ 24-32 μ in size, subequatorially attached forming a broad triangular furrow, surface sculpturing composed of a distinct reticulum. Body exine granulate to finely rugulate.

Comparison — These Rajmahal grains do not possess any distinguishing character which can separate them from *D. australiensis* Cookson and Pike. These grains also show considerable resemblance with some of the pollen grains described from New Zealand by Couper (1960, p. 45) as *Podocarpus* aff. *dacrioides* Pich.

Genus *Podosporites* Rao 1943

Podosporites sp. cf. *tripakshii* Rao

Pl. 6, Figs. 127-129

Description — Pollen grains ± spherical, 40-64 μ in diameter, trisaccate, bladders inflated, oblong, 24·0×30·4 μ to 18×24 μ in size, surface ornamentation reticulate. Body exine infragranulate.

Remarks — The present grains differ from *P. tripakshii* Rao in their bigger size, but this seems to be a variable character and, therefore, no attempt has been made to describe them under a new species.

Turma — *Aletes* Ibr. 1933
Subturma — *Azonaletes* (Luber, 1935) Pot. & Kr. 1954
Infraturma — *Psilonapiti* Erdtm. 1947

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

Laricoidites communis n. sp.

Pl. 7, Figs. 139-140

Holotype — Pl. 7, Fig. 140; Reg. No. 3110; Sl. No. 61/1.

Paratype — Pl. 7, Fig. 139; Sl. No. 29/5.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Pollen grains circular, size range 80-120 μ, no germinal mark seen. Exine mediumly thick, microgranulate, secondary folds conspicuous, irregular.

Description — Grains equatorially rounded, yellowish brown in colour, secondary folds mostly found in the centre than the periphery. *Extrema lineamenta* smooth.

Comparison — *Laricoidites communis* differs from *L. indicus* Singh *et al.* (1964) in having granulate exine and more secondary folds in the centre while the other species also differ in their over all characteristics.

Infraturma — *Granulonapiti* Cookson 1947

Genus *Araucariacites* Cookson 1947

Araucariacites australis Cookson 1947

Pl. 7, Fig. 141

Diagnosis — See Cookson 1947, p. 130.

Description — Pollen grains large, 80-100 μ in diameter, spherical to ovoid in shape, inaperturate, outline 3 μ thick, smooth, exine infragranulate, grana closely placed.

Remarks — The Rajmahal pollen grains resemble very closely with the grains described by Balme (1957, PL. 7, FIGS. 81-82) as *A. australis*.

Turma — *Monocolpates* Iversen & Troels-Smith 1950
Subturma — *Intortes* (Naum. 1937) Pot. 1958

Genus *Cycadopites* (Wodehouse, 1933) ex Wils. & Webs. 1946

Remarks — The genus *Cycadopites* has been used here in a broad sense as suggested by Jansonius (1962, p. 80) to include genera like *Ginkgocycadophytus* Samoilowitz and *Cycadaceaelagenella* Malawkina, etc.

Cycadopites crassisulcatus n. sp.

Pl. 7, Figs. 142-143

Holotype — Pl. 7, Fig. 143; Reg. No. 3110; Sl. No. 11/6.

Paratype — Pl. 7, Fig. 142; Sl. No. 29/25.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 20×40 μ to 16×44 μ; holotype 20×40 μ; equatorial outline ± oval elongate; monosulcate, furrow extending full length of the body from pole to pole. Lips distinctly thickened, characteristically rolled inwards, slightly opened at the extremities. Exine 1·5-2 μ thick, scabrate to finely granulate.

Description — Monosulcate grains, usually twice as long as broad, sometimes slightly longer probably due to lateral compression. Grains characteristically elongate-oval in shape with rounded ends and convex sides. Sulcus usually slightly curved, lips guarded by strong thickenings, near ends showing small, distinct key hole like openings. Exine uniform throughout.

Comparison — *C. crassisulcatus* differs from all the other known species of the genus in having a strongly thickened sulcus and also in the ornamentation of the exine which in other species is smooth or infrapunctate.

Cycadopites sakrigaliensis n. sp.

Pl. 7, Figs. 144-145

Syn.— Unclassified spore, in Sah, 1953, p. 7; Pl. 1, Fig. 28.

Holotype — Pl. 7, Fig. 144; Reg. No. 3110; Sl. No. 28/8.

Paratype — Pl. 7, Fig. 145; Sl. No. 5/2.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Size range 64 × 32μ to 68 × 36μ, elongate-oblong in shape; monosulcate, sulcus long, running from pole to pole. Exine 1·5 μ thick, ornamented with coarse grana.

Description — Monosulcate grains twice as long as broad, with roundish to pointed ends; furrow broader at the poles; exine ornamented with rather coarse and densely packed grana.

Comparison — *C. sakrigaliensis* differs from the genotype *C. follicularis* Wils. and Webs. ( ) in having a coarsely granulate exine which in the latter is smooth. The same character (exine ornamentation) also distinguishes it from other known species of the genus.

Cycadopites gracilis n. sp.

Pl. 7, Figs. 146-149

Holotype — Pl. 7, Fig. 147; Reg. No. 3110; Sl. No. 29/13.

Paratype — Pl. 7, Fig. 148; Sl. No. 15/11.

Type Locality — Sakrigalighat, Rajmahal Hills, Bihar, India. Jurassic.

Diagnosis — Grains monosulcate, elliptical in shape, size range 32-44 μ in length and 16-20 μ in breadth, holotype 44 × 20 μ in size, ends pointed, sulcus lips overlap each other, straight. Exine scabrate.

Description — Monosulcate grains, twice as long as broad, sulcus uniform, running throughout the median length; exine thin, finely structured.

Comparison — *C. gracilis* resembles *C. crassisulcatus* in exine ornamentation but differs in having elliptical body pointed ends and no key hole-like openings at the ends. The gross features of the present species distinguishes it from the other known species of the genus.

Cycadopites sp.

Pl. 7, Fig. 150

Description — Monosulcate grain, oval-elongate in shape, twice as long as broad, measuring 28 × 14 μ. Median longitudinal furrow traversing the entire body from pole to pole, lips widely open, not rimmed. Exine thin, uniformly ornamented with minute grana.

Remarks — In shape and size the grain is indistinguishable from *Cycadaceaelagenella capertiformis* Malw. (1953, p. 135; Pl. 4, Fig. 16) described from the Mesozoic of Ural. As only a single specimen was recovered, further specific comparison has not been attempted.

Pollen Grains — INCERTAE SEDIS

Genus *Classopollis* (Pflug) Pocock & Jansonius 1961

Classopollis sp. cf. *torosus* (Reiss.) Couper

Pl. 7, Figs. 151-152

Description — Miospores 24-28 μ in diameter, circular to oval in shape, exine scabrate, consisting of small inwardly projecting granules forming a sort of negative reticulum in polar view. No band structure seen. Poorly developed vestigial Y-mark present on the proximal surface. An almost completely encircling line of parting between the thickened equatorial zone and the thinner exine of the distal polar area is developed on the distal side, immediately below the thickened equatorial zone.

Remarks — These Rajmahal specimens show a close similarity in form with *Classopollis torosus* (Reiss.) Couper (1958, p. 156; Pl. 28, Figs. 2-5). As there are only three grains available in polar view, a complete comparison is not possible.

INCERTAE SEDIS

Specimens — A & B (Pl. 3, Figs. 69-70)

Description — Trilete spores, measuring 75-85 μ in diameter. Proximal side convex, triangle ends broadly obtuse. Y-mark prominent, thick, raised, arms reaching almost up to the margin. Distal surface ornamented, exine moderately thick, scabrate, not well preserved.

DISCUSSION

Elements of the Flora — The present assemblage of the dispersed spores and pollen grains from Sakrigalighat and Basko shows an association of pteridophytic, cycadophytic, coniferous and some other miospores of uncertain affinities.

The pteridophytic and other trilete spores are represented by 22 genera viz., *Deltoidospora, Cyathidites, Alsophilidites, Gleicheniidites, Divisisporites, Callispora, Converrucosisporites**, *Osmundacidites, Concavissimisporites**, *Foraminisporis, Baculatisporites**

*Verrucosisporites**, *Ceratosporites*, *Acanthotriletes**, *Neoraistrickia*, *Paucibaculisporites*, *Lycopodiumsporites*, *Cicatricosisporites*, *Foveosporites*, *Ischyosporites*, *Trilobosporites* and *Cingulatisporites*. The genera marked with an asterisk are the Late Palaeozoic genera found in the Rajmahal assemblage. The monolete types and the megaspores are entirely absent in both the localities.

The cycadophytic pollens are fairly common in both Sakrigalighat and Basko shales. All of them have been described under a single genus *Cycadopites*, using the generic name in a very broad sense as suggested by Jansonius (1962, p. 80).

The conifer pollen grains are comparatively more predominant quantitatively than the pteridophytic or the cycadophytic grains. They are represented by mono-, di- and tri-saccate grains. The wingless pollen grains are represented by three genera, *Araucariacites*, *Classopollis*, and *Laricoidites* which are equally common to both as compared to the winged grains. Winged conifer types are represented by 8 genera viz. *Callialasporites*, *Alisporites*, *Platysaccus*, *Podocarpidites*, *Phyllocladidites*, *Podosporites*, *Dacrycarpites* and *Trisaccites*.

The genus *Vitreisporites* and a few pollen grains of *Alisporites* show a close resemblance with the pollen grains of pteridosperms like *Caytonanthus* and *Pteruchus* respectively.

Comparison between Sakrigalighat and Basko Miofloral Assemblage — Comparing the Sakrigalighat assemblage with the Basko assemblage it becomes apparent that although the two in certain cases show strikingly close similarity with one another, their overall picture shows a clear distinction between the two. The pteridophytic spores dominate the Sakrigalighat assemblage while they are comparatively much less represented both generically and numerically in the Basko assemblage. The Sakrigalighat shale yielded 20 genera while only eight genera are represented in the Basko material. This might have been the result of localization of the vegetation. The coniferous grains are almost equally represented in both the assemblages but in Basko the occurrence of trilete spores is almost negligible as compared to the coniferous grains. The cycadophytic grains are not so abundant and are equally represented in the two assemblages.

Of the total 22 pteridophytic genera, the following seven are common to both viz., *Cyathidites*, *Gleicheniidites*, *Osmundacidites*, *Acanthotriletes*, *Lycopodiumsporites*, *Ischyosporites* and *Cingulatisporites*. The common coniferous genera are *Callialasporites*, *Alisporites*, *Platysaccus*, *Podocarpidites*, *Vitreisporites*, *Podosporites*, *Trisaccites*, *Araucariacites*, *Laricoidites* and *Cycadopites*.

Comparison with Indian Mesozoic Miospore Assemblages — The Indian Mesozoic spores and pollen grains have been described by Rao (1943) and Vishnu-Mttire (1954) from the Nipania chert in the Rajmahal Hills, Bihar; Ramanujam (1957) from Vemavaram of the East Coast Gondwanas; Dev (1961) from Sehora of the Jabalpur Series and Srivastava (1963) from the Jurassic of Rajasthan. Recently Singh *et al.* (1964) and Verma and Rawat (1964) have given an account of the miospore assemblages from Cutch (Umia Series) and Dhrangadhra (Saurastra).

The petrified miospores from Nipania show a fairly good representation of the spores and pollen grains. From the illustrations and descriptions given by Vishnu-Mittre (*l.c.*) the following constituent genera seem to be represented viz., *Gleicheniidites*, (= PL. 1, FIG. 1), cf. *Acanthotriletes* (= PL. 1, FIG. 13), *Cicatricosisporites* (= PL. 1, FIGS. 14-16), *Lycopodiumsporites* (= PL. 1, FIGS. 17-20), *Cycadopites* (= PL. 1, FIGS. 25, 28, 31 & 32; TEXT-FIGS. 10-20), *Podocarpidites* (= PL. 2, FIGS. 43-47), *Callialasporites* (= Pl. 2, FIG. 36) and *Podosporites* (= TEXT-FIGS. 32-36). From the above recognition of the Nipania assemblage it appears that the Rajmahal and Nipania miofloral assemblages have a similar composition and therefore, they belong to more or less the same age group.

The Vemavaram miospores also show a very close relationship with the present Rajmahal assemblage. The spores and pollen grains described by Ramanujam (*l.c.*) can be included under the following genera viz., *Cyathidites* (= PL. 10, FIGS. 1-2; TEXT-FIGS. 1-2), *Gleicheniidites* (= PL. 10, FIG. 3; TEXT-FIG. 3), cf. *Osumundacidites* (= PL. 10, FIGS. 6-7; TEXT-FIG. 6), *Neoraistrickia* (= Pl. 10, Figs. 22-23; Text-figs. 14-15), *Lycopodiumsporites* (= PL. 10, FIGS. 16-21; TEXT-FIG. 16), *Acanthotriletes* (= PL. 10, FIGS. 11-12; TEXT-FIG. 9), *Ischyosporites* (= PL. 10, FIGS. 24-25), cf. *Cicatricosisporites* (= PL. 10, FIG. 26), *Cycadopites* (= PL. 10, FIGS. 27-28; TEXT-FIG. 40), *Callialasporites*

(= PL. 10, FIGS. 29-30), cf. *Vitreisporites* (= PL. 10, FIGS. 42-43), *Podocarpidites* (= PL. 11, FIGS. 31-38; TEXT-FIGS. 31-35) and *Dacrycarpites* (= PL. 11, FIG. 41; TEXT-FIG. 39). Ramanujam (*l.c.*, pp. 368-369) while comparing the miospores with that of Nipania, pointed out that the general nature and composition of the miospore flora are easily distinguishable from the Rajmahal Hills, chiefly because the coniferous pollen grains are relatively more abundant. But in the light of the present analysis it seems rather difficult to distinguish between the two.

The Jaisalmer (Rajasthan) miospore assemblage described by Srivastava (*l.c.*) resembles with the Rajmahal assemblage in having the following common genera viz., *Cyathidites, Osmundacidites, Ischyosporites, Classopollis, Cycadopites, Callialasporites, Laricoidites* and *Araucariacites*. The age of these beds is supposed to be Lower-Middle Jurassic.

The Jabalpur assemblage (DEV, *l.c.*) is represented by a number of trilete spores but only four genera viz., *Cyathidites, Callispora, Concavissimisporites* and *Lycopodiumsporites* are common to both. The other genera *Matonisporites* (syn. *Boseisporites* DEV), *Iniquiornatisporis, Erlansonisporites, Dijkstraisporites, Monolites, Saccarisporites, Sehorisporites* and *Circella* characterize the Jabalpur Series. These genera, except for the last two, are also represented in the Umia beds. The Rajmahal, Vemavaram and the Andigama (Ceylon) assemblages differ from the Jabalpur assemblage in the entire absence of these genera. The miofloral contents of the Jabalpur Series suggest a slightly younger age for them than the Rajmahal Series. Stratigraphically also the Jabalpur Series are regarded as younger than the Rajmahal Series (KRISHNAN, 1960, p. 276; WADIA, 1957, p. 181).

A comparison with the fairly well known mioflora from the Lower Cretaceous of Cutch (SINGH *et al.*, *l.c.*) reveals that of the several genera recorded from this area, the following are common to both viz., *Deltoidospora, Cyathidites, Alsophilidites, Gleicheniidites, Osmundacidites, Acanthotriletes, Lycopodiumsporites, Cicatricosisporites, Trilobosporites, Ischyosporites, Cingulatisporites, Callialasporites, Platysaccus, Podocarpidites, Podosporites, Araucariacites, Cycadopites, Laricoidites* and *Classopollis*. However, the Cutch assemblage can easily be distinguished by the presence of the following characteristic Lower Cretaceous genera like, *Iniquiornatisporis, Erlansonisporites, Dijkstraisporites, Saccarisporites, Schizosporis, Leschikisporites, Crassimonoletes* and *Baculareticulosporis*. The entire absence of these genera makes it quite evident that the Rajmahal beds are comparatively older than those of the Cutch.

Recently Verma and Rawat (1964) published a short note on the age of the Dhrangadhra formation (Saurashtra) in the light of spores and pollen grains. The composition of the assemblage suggests an Upper Jurassic age rather than Lower Cretaceous as assigned by the authors. Jain and Sah (in press) have dealt in detail this question of the age of the Dhrangadhra formation while comparing it with the Andigama mioflor. The Rajmahal assemblage seems to be older in age than the Dhrangadhra formation, as indicated by the absence of *Contignisporites cooksonii* type of spores from the Rajmahal assemblage.

Comparison with other Mesozoic Miospore Assemblages — Comparing the Rajmahal spores with the spore assemblage from Andigama, Ceylon (SAH, 1953; JAIN & SAH-revision, in press) a close similarity in general aspect is apparent. The important common constituents among the two are *Cyathidites, Osmundacidites, Ceratosporites Baculatisporites, Acanthotriletes, Gleicheniidites, Foveosporites* and *Lycopodiumsporites*. A detailed specific comparison, however, reveals that the Andigama mioflora contains certain elements which suggest that the Andigama beds are slightly younger than the Rajmahal Series. *Contignisporites cooksonii* (BLAME) Dettm., a Upper Jurassic and Lower Cretaceous species is richly represented in the Andigama shales while it is completely absent in both Sakrigalighat and Basko.

Apart from this characteristic form, the other supporting evidence is afforded by the presence of the following species in Andigama shale and their absence in Rajmahal assemblage: *Cyathidites concavus*; *Osmundacidites wellmanii*; *Ceratosporites equalis*; *Baculatisporites comaumensis*; *Acanthotriletes levidensis, Gleicheniidites indicus*; *Foveosporites canalis* and *Lycopodiumsporites eminulus*. These species are mostly recorded from the upper Jurassic or Lowe Cretaceous sediments.

The Salt Range mioflora also described by Sah (1955) shows some similarity with the Rajmahal assemblage. Most of the miospore genera are common to both, except for two genera, which may probably be referred to *Matonisporites* (syn, *Boseisporites* DEV) (= PL. 1, FIG. 2), *Sehorisporites* (= PL. 2, FIG. 17). The varigated shales from the Salt range are regarded by the geologists as Middle Jurassic in age and Sah (*l.c.*, p. 70) supported the view on the basis of fossil spores and pollen grains.

So far, the best known Upper Gondwana miofloral assemblages, have been described from Australia by Cookson (1953), Balme (1957), Cookson and Dettmann (1958), De Jersey (1962, 1963) and Dettmann (1963).

The miospore genera described by Cookson (*l.c.*) from a bore at Comaum, South Australia (below 651') can be referred to the following common genera viz., *Cyathidites*, *Lycopodiumsporites*, *Cicatricosisporites*, *Osmundacidites*, *Neoraistrickia*, *Cycadopites*, *Podocarpidites* and *Podosporites*. The Comaum assemblage is regarded to be Jurassic in age (COOKSON, *l.c.*, p. 463).

A comparison with the Triassic and Jurassic records of Australian miospore genera described by De Jersey (*l.c.*) also throws some light on the question of dating the Rajmahal assemblage.

The Triassic spore and pollen spectrum from the Ipswich coalfield shows that out of the 20 genera the following are represented in the Rajamahal assemblage, they are — *Osmundacidites*, *Verrucosisporites*, *Cingulatisporites*, *Alisporites*, *Platysaccus*, *Vitreisporites*, *Cycadopites*, *Araucariacites*, *Laricoidites* and *Callialasporites*. But the other constituent genera viz., *Calamospora*, *Annulispora**, *Granulatisporites**, *Punctatisporites*, *Verrucososporites*, *Chordasporites*, *Pilasporites*, *Tenuisaccites* and *Circulisporites**, are not found in the present assemblage. The genera marked by an astrisk are more characteristic of the Late Palaeozoic and Triassic formations but have also been recorded to extend up to Liassic (Marburg sandstone) but not beyond. Their total absence in the Rajmahal assemblage tends to restrict the lower limits of the Rajmahal beds up to the end of the Liassic period.

The miofloral assemblages (I, IIa & IIb) described by Balme (*l.c.*, Table-III) from Western Australia reveal that the present assemblage from the Rajmahal Hills, compares closely with Balme's flora IIa in having all the genera common to both except for the genus *Microreticulatisporites*. Flora I differs in possessing two genera viz., *Exesipollenites* and *Marsupipollenites* which are not represented in the Rajmahal. This flora is regarded as Lower Jurassic in age (Balme, *l.c.*, Table-III) and flora IIa as Oxfordian-Kimmeridian (Balme, *l.c.*, Table-III). Flora IIb regarded as Neocomian which seems to be doubtful as there is no distinct Lower Cretaceous element.

A comparison with the Australian Lower Cretaceous miofloral assemblage described by Cookson and Dettmann (1958) from the Eastern Australian region and Dettmann (1963) from South-East Australia shows that the former can easily be distinguished from the Rajmahal assemblage because of the presence of some characteristic elements like *Radiatisporites*, *Pyrobolosporites*, *Balmeisporites*, *Aequitriradites*, *Styxisporites*, and *Minerisporites*. The latter differs in having genera like, *Stereisporites*, *Biretisporites*, *Cyclosporites*, *Balmeisporites*, *Pyrobolosporites*, *Murospora*, *Contignisporites*, *Kraeuselisporites*, *Minerisporites*, *Crybelosporites*, *Schizosporis*, *Aequitriradites* and *Rouseisporites* etc. A perusal of the existing literature shows that the above mentioned genera have so far not been recorded from any of the known Jurassic sediments.

Amongst the British Mesozoic miospores described by Couper (1958) a fairly close resemblance is seen with those from the Middle and Upper Jurassic horizons. As far as can be judged the components of the two are principally formed of common genera. There may, however, be some genera not common to both but this is quite likely in view of the geographical distance separating the two.

The miofloral assemblage of Kootenay Coal Measures of British Columbia described by Rouse (1959) is composed chiefly of gymnosperm and fern grains. Only a few genera viz., *Deltoidospora*, *Osmundacidites*, *Lycopodiumsporites*, *Podocarpidites*, *Alisporites* and *Cycadopites* are common to both the Kootenay and the Rajmahal assemblages. The British Columbia mioflora however, essentially differs in having angiospermous elements like *Pterocarya* and *Tri-fossapollenites*. Rouse (*l.c.*, p. 308) remarks that the absence of schizaeaceous spores like *Cicatricosisporites* spp. and *Appendicisporites* sp., indicate a Jurassic age for the Kootenay Coal Measures. The vertical range of *Cicatricosisporites* goes down up to Liassic (Couper, 1958) and the presence of angiospermous grains create doubt for its Jurassic dating. Pocock (1964, p. 501) considers this bed to be Cretaceous in age.

It is worthwhile to compare the Rajmahal mioflora with the spores and pollen grains described from the Jurassic-Cretaceous boundary in the Western Canada plains (Pocock, 1962). The Canadian assemblage is characterized by the presence of 46 genera out of which only 19 are common to both, otherwise the rest of them draw a distinct line of demarcation from the Rajmahal mioflora. The important constituent genera of the Canadian mioflora are viz., *Appendicisporites*, *Aequitriradites*, *Rouseisporites*, *Cooksonites* and *Schizosporis* which indicate a definite Lower Cretaceous age.

Age of the Rajmahal Assemblage — The age of the Rajmahal intertrappean beds has been a subject of much controversy. Various workers from time to time have put forth various views based on plant and animal fossils. The views advanced so far, fall under four groups (i) Upper Triassic (Keuper), (ii) Lower Jurassic (Liassic), (iii) Middle to Upper Jurassic and (iv) Lower Cretaceous.

Du Toit (1927, p. 312) while correlating the Upper Karroo beds with Indian Upper Gondwana pointed out that there were some plants common to the Molteno flora and the Rajmahal flora, and suggested for the first time that the Rajmahal beds might possibly include in their lower zones an horizon not younger than Rhaetic. The present miofloral assemblage has no element characteristic of the Triassic viz., *Aratrisporites*, *Lueckisporites* and *Decussatisporites* etc.

A Liassic age for the Rajmahal intertrappean beds was advanced by De Zigno (1861, in Feistm. 1877, p. 16), Ettingshausen (1865, in Feistm. 1877, p. 110), Feistmantel (1877, p. 162), Cotter (1917, pp. 23, 24 & 33) and Fox (1931, pp. 203-204). Their conclusions were based on the plant fossils known till then. After early thirties much has been revised and added to the knowledge of the Rajmahal fossil flora, and in that light the age has been discussed at length by various workers like Sahni (1932, p. 17), Sahni & Rao (1931, p. 185), Ganju (1946, pp. 78-80), Jacob (1951, p. 12; 1952, pp. 154-155), Krishnan (1960, pp. 293), Horn af Rantzien (1957, p. 8), Pascoe (1959, p. 982) and Vakhrameev (1964, p. 108). They regarded the Rajmahal flora as Middle or Upper Jurassic in age.

A comparison of the spore-pollen assemblage from the Rajmahal Hills with comparably contemporaneous miospore assemblage shows a general closeness with the middle to upper Jurassic assemblages.

Lastly a Lower Cretaceous age for the Rajmahal Series advanced by Spath (1933, p. 827), does not seem to be supported by plant fossils. Although the Rajmahal miospore assemblage has certain elements like *Divisisporites*, *Concavissimisporites*, *Ceratosporites*, *Trilobosporites*, *Foveosporites*, and *Ischyosporites*, which have been recorded from the Lower Cretaceous beds. The mioflora as a whole does not have the characteristic Lower Cretaceous aspect. The chief elements like *Appendicisporites*, *Aequitriradites*, *Rouseisporites*, *Schizosporis*, *Pyrobolosporites*, *Contignisporites*, *Murospora* and *Cooksonites* etc. are completely absent in the Rajmahal mioflora.

The general look of the Rajmahal miofloral picture reveals that it is a sort of transitional flora ranging between Lower Jurassic and Lower Cretaceous and possessing a few elements of both but lacking in having the chief spore and pollen constituents of the upper and the lower limits. From the over all composition of the miofloral assemblage we suggest a Middle-Upper Jurassic age for the Rajmahal intertrappean beds (Bajocian-Oxfordian of the European scale).

REFERENCES

Balme, B. E. (1957). Spores and pollen grains from the Mesozoic of Western Australia. *Comm. Sci. Ind. Res. Org.*, **25**: 1-48.

Bharadwaj, D. C. & Singh, H. P. (1964). An Upper Triassic miospore assemblage from the coals of Lunz, Austria. *Palaeobotanist*, **12**(1): 28-44.

Bolkhovitina, N. A. (1956). Atlas of spores and pollen from the Jurassic and Lower Chalk (Lower Cretaceous) layer of Vilveska basin. *Acad. Sci. S.S.R. Work Geol. Inst.*, Pt. 2: 1-132.

COOKSON, I. C. (1947). Plant microfossils from the lignites of Kerguelen Archipelago. B.A.N.Z. *Antarctic Res. Exp.* 1929-31, *Reports* Ser. A, **2** Pt. 8: 127-142.

Idem (1953). Difference in microspore composition of some samples from a bore at Comaum, South Australia. *Aust. J. Bot.*, **1** (3): 462-473.

Idem (1953a). The identification of the sporomorph *Phyllocladidites* with *Dacrydium* and its distribution in Southern Tertiary deposits. *Ibid.*, **1**(1): 64-70.

Idem (1954). A palynological examination of No. 1 Bore, Birregurra, Victoria. *Proc. roy. Soc. Vict.*, **66** (N.S.): 119-128.

Idem (1957). On some Australian Tertiary spores and pollen grains that extend the geological and geographical distribution of living genera. *Ibid.*, **69**: 41-53.

COOKSON, I. C. & DETTMANN, M. E. (1958). Some trilete spores from upper Mesozoic deposits in the Eastern Australian region. *Ibid.*, **70** (2): 95-128.

Idem (1958a). Cretaceous megaspores and a closely associated microspore from the Australian region. *Micropaleontology*, **4**: (1): 39-49.

COOKSON, I. C. & PIKE, K. M. (1953). A contribution to the Tertiary occurrence of the genus *Dacrydium* in the Australian region. *Aust. J. Bot.*, **1**(3): 474-484.

Idem (1953a). The Tertiary occurrence and distribution of *Podocarpus* (Section Dacrycarpus) in Australia and Tasmania. *Ibid.*, **1** (1): 71-82.

Idem (1954). The fossil occurrence of *Phyllocladus* and two other podocarpaceous types in Australia. *Ibid.*, **2**(1): 60-68.

COTTER, G. DE P. (1917). " A revised classification of the Gondwana system ". *Rec. geol. Surv. India*, **48**(1): 23-33.

COUPER, R. A. (1953). Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. *Palaeont. Bull., N. Z.*, **22**: 5-77.

Idem (1954). Plant microfossils from New Zealand — No. 1. *Trans. roy. Soc. N.Z.*, **81**(4): 479-483.

Idem (1955). Supposedly colplate pollen grains from the Jurassic. *Geol. Mag.*, **92**(6): 471-475.

Idem (1958). British Mesozoic microspores and pollen grains. A systematic and stratigraphic study. *Palaeontographica*, **103**(1-3): 75-179.

Idem (1960). New Zealand Mesozoic and Cainozoic plant microfossils. *Palaeont. Bull., N.Z* **32**: 5-81.

CRANWELL, L. M. (1941). Pollen grains of New Zealand conifers. *N.Z.J. Sci. Tech.*, **22**(1 & 2): 1B-17B.

DAUGHERTY, L. H. & STANGNER, H. R. (1941). The Upper Triassic flora of Arizona, with a discussion of its geologic occurrence. *Carnegie Inst. Washington, Pub.*, No. **526**: 90-93.

DE JERSEY, N. J. (1959). Jurassic spores and pollen grains from the Rosewood Coalfield. *Qd. Govt. Min. J.*, **60**: 346-366.

Idem (1960). Jurassic spores and pollen grains from the Rosewood Coalfield. *Geol. Surv. Qd., Publ.* No. **294**.

Idem (1962). Triassic spores and pollen grains from the Ipswich Coalfield. *Ibid., Publ.* No. **307**: 1-18.

Idem (1963). Jurassic spores and pollen grains from the Marburg Sandstone. *Ibid., Publ.* No. **313**: 1-15.

DELCOURT, A. F., DETTMANN, M. E. & HUGHES, N. F. (1963). Revision of some Lower Cretaceous microspores from Belgium. *Palaeontology*, **6**(2): 282-292.

DELCOURT, A. & SPRUMONT, G. (1955). Les spores et grains de pollen du Wealdien du Hainaut. *Mém. Soc. belge Géol.* **4**(5): 5-70.

DETTMANN, M. E. (1963). Upper Mesozoic microfloras from south-eastern Australia. *Proc. roy. Soc. Vict.*, **77**(1): 1-148.

DEV, S. (1961). The fossil flora of the Jabalpur Series-3. Spores and pollen grains. *Palaeobotanist*, **8**(1-2): 43-56.

DU TOIT, A. L. (1927). The fossil flora of the Upper Karroo beds. *Ann. S. Afr. Mus.*, **22**(2): 289-470.

ERDTMAN, G. (1947). Pollen and spore morphology, Plant Taxonomy. *New York.*

FEISTMANTEL, O. (1877). Jurassic (Liassic) flora of the Rajmahal group in the Rajmahal hills. *Palaeont. Indica*, **1**(2).

FOX, C. S. (1931). The Gondwana System and related formations. *Mem. geol. Surv. India*, **58**: 1-241.

GANJU, P. N. (1946). On a collection of Jurassic plants from the Rajmahal Hills, Bihar. M.O.P. Iyengar Commemoration Vol. *J. Indian bot. Soc.* 1946: 51-55.

GROOT, J. J. & GROOT, C. R. (1962). Plant microfossils from Aptian, Albian and Cenomanian deposits of Portugal. *Comm. Ser. geol. Portugal*, **46**:133-171.

GROOT, J. J. & PENNY, J. S. (1960). Plant microfossils and age of nonmarine Cretaceous sediments of Maryland and Delaware. *Micropaleontology*, **6**(2): 225-236.

HARRIS, T. M. (1944). Notes on the Jurassic flora, Yorkshire. *Ann. Mag. nat. Hist.* **2**(11): 661-690.

HUGHES, N. F. & COUPER, R. A. (1958). Palynology of the Brora coal of the Scottish Middle Jurassic. *Nature*, **181**: 1482-1483.

HORN AF RANTZIEN, H. (1957). Nitellaceous charophyte gyrogonites in the Rajmahal Series (Upper Gondwana) of India with notes on the flora and stratigraphy. *Acta Univ. Stockholm*, **1**(1): 1-29.

IBRAHIM, A. C. (1933). Sporen formen des Aegirhorizonts des Ruhr Riviers. Dissertation, Technische Hochschule Berlin. *Priv. Pub. Konrad Trililsche, Wurzbrug.*

JACOB, K. (1951). *Dictyozamites bagjoriensis* sp. nov., from the Mesozoic of Rajmahal hills, with notes on the distribution of the genus. *Proc. nat. Inst. Sci. India*, **17** (1): 7-13.

JANSONIUS, J. (1962). Palynology of Permian and Triassic sediments, Peace River area, Western Canada. *Palaeontographica*, **110** (1-4): 35-98.

KNOX, E. M. (1938). The spores of Pteridophyta, with observations on microspores in coals of carboniferous age. *Trans. Proc. Bot. Soc. Edin.*, **32**: 438-466.

KRÄUSEL, R. & LESCHIK, G. (1955). Die Keuperflora von Neuewelt bei Basel. II Die Iso- und

Mikrosporen. *Palaeontographica*, **72**: 1-70.

KRISHNAN, M. S. (1960). Geology of India and Burma. *Madras.*

LANTZ, J. (1958). Étude palynologique et quelques échantillons Méozoiques du Dorset (Grande Bretagne). *Rev. Inst. Franç. pétrole* **13**(6): 917-929.

LESCHIK, G. (1956). Die Entstchung der Braunkohle der Wetteran und ihre Mikro-und Makroflora. *Palaeontographica*, **100**B: 26-64.

LUNDBLAD, B. (1949). Microbotanical studies of cores from Hollvillen, Scania. *Sverig geol. unders. Ser.* C. No. **506**: 3-16.

MALAWKINA, V. S. (1953). Upper Triassic, Lower and Middle Jurassic spore-pollen complexes in East & West districts of the Ural Mountain regions. (In Russian). *Arb. Erdol. Geol. Inst.*, **75**: 93-147.

MEHTA, K. R. (1944). Microfossils from a carbonaceous shale from the Pali beds of the South Rewa Gondwana Basin. *Proc. nat. Acad. Sci. India*, **14**(4-5): 125-141.

MINER, E. L. (1935). Paleobotanical examinations of Cretaceous and Tertiary Coals. I. Cretaceous coals from Greenland. II. Cretaceous and Tertiary coals from Montana. *Amer. Midl. Nat. Monogr*, **16**(4): 585-625.

NAUMOVA, S. N. (1937). Spores and pollen of the Coals of the U.S.S.R. *Int. Geol. Congr. Absts.*, **17**: 60-61.

NILSSON, T. (1958). Uber des Vorkommen Eines Mesokommen Eines Mesozoischen Sapropelgesteins in Schoneu. *Inst. Min. Palaeont. Quart. Geol. Univ. Lund. Sweden.* No. **53**: 5-112.

OLDHAM, T. & MORRIS, J. (1863). Fossil flora of the Rajmahal Series in the Rajmahal hills. *Palaeont. Indica*, **1**(1): 1-52.

PANT, D. D. (1955). On two new disaccate spores from the Bacchus Marsh Tillite, Victoria (Australia). *Ann. Mag. nat. Hist.*, **12** (8): 757-764.

PASCOE, E. H. (1959). A manual of the geology of India and Burma II. *Calcutta.*

PAUTSCH, M. E. (1958). Keuper sporomorphs from Swierczyna, Poland. *Micropaleontology*, **4**(3): 321-325.

PFLUG, H. D. (1953). Zur Entstehung und Entwicklung des Angiosperiden pollen in der Erdgeschichte. *Palaeontographica*, **95** (4-6): 60-171.

POCOCK, S. A. J. (1962). Microfloral analysis and age determination of strata at the Jurassic — Cretaceous boundary in the Western Canada plains. *Ibid.*, **111**(1-3): 1-95.

Idem (1964). Palynology of the Kootenay formation at its type section. *Bull. Canad. Petroleum Geol.*, **12**: 500-512.

POCOCK, S. A. J. & JANSONIUS, J. (1961). The pollen genus *Classopollis* Pflug, 1953. *Micropaleontology*, **7**(4): 439-449.

POTONIÉ, R. (1956). Synopsis der Gattungen der Sporae dispersae. I. *Beih. geol. J.*, **23**: 1-103.

Idem (1958). Synopsis der Gattungen der Sporae dispersae. II. *Ibid.*, **31**: 1-114.

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

POTONIÉ, R. & KREMP, G. (1954). Die Gattungen der Paläozoischen Sporae dispersae und ihre Stratigraphie. *Geol. Jb.*, **69**: 111-194.

Idem (1955). Die Sporae dispersae des Ruhrkarbons, ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und zeitabschnitte Teil 1 *Palaeontographica*, **98**:1-136.

Idem (1956). Idem Teil II *Ibid.*, **99**:85-191.

RADFORTH, N. W. & ROUSE, G. E. (1954). The classification of recently discovered Cretaceous plant microfossil of potential importance to the stratigraphy of Western Canadian Coals. *Canad. J. Bot.*, **32**: 187-201.

RAMANUJAM, C. G. K. (1957). Microfossils from a Carbonaceous shale near Vemavaram (Jurassic) in the East Coast Gondwanas of India. *J. Indian bot. Soc.*, **36**(3): 348-372.

RAO, A. R. (1943). Jurassic spores and sporangia from the Rajmahal Hills, Bihar. *Proc. nat. Acad. Sci. India*, **13** (3): 181-197.

ROGALSKA, M. (1954). Spore and pollen analysis of the Liassic coal of Blanowice in Upper Silesia. *Bull. Inst. Geol. Warsaw*, No. 89.

ROSS, N. E. (1949). On a Cretaceous pollen and spore bearing clay deposit of Scania. *Bull. geol. Inst. Uppsala*, **34**: 25-43.

ROUSE, G. E. (1957). The application of a new nomenclatural approach to upper Cretaceous plant microfossils from Western Canada. *Canad. J. Bot.*, **35**: 349-375.

Idem (1959). Plant microfossils from Kootenay Coal-measures strata of British Columbia. *Micropaleontology*, **5** (3): 303-324.

Idem (1962). Plant microfossils from the Burrard formation of Western British Columbia. *Ibid.*, **8**(2): 187-218

SAAD, S. I. (1963). Pollen and spores recently discovered in the coals of Sinai region 1. Euone Moussa district. *Palaeontographica*, **112**(5-6): 117-125.

SAH, S. C. D. (1953). Spores and other microremains from a carbonaceous shale (Jurassic) in Andigama, Ceylon. *Spolia Zeylan.*, **27** (1): 1-12.

Idem (1955). Plant microfossils from a Jurassic shale of Salt range, West Panjab (Pakistan). *Palaeobotanist*, **4**: 60-71.

SAHNI, B. (1932). A petrified *Williamsonia* (*W. sewardiana* sp. nov.) from the Rajmahal hills, India. *Palaeont. Indica*, **20**(3): 1-19.

Idem (1938). Recent advances in Palaeobotany. *Proc. 25th Indian Sci. Congr.* (2): 133-176.

SAHNI, B. & RAO, A. R. (1931). On some Jurassic plants from the Rajmahal Hills. *J. Proc. Asiatic Soc. Bengal*, N.S. **27**(2): 183-208.

SINGH, H. P., SRIVASTAVA S. K., & ROY, S. K. (1964). Studies on the Upper Gondwana of Cutch 1. Mio- and Macro spores. *Palaeobotanist*, **12**(3): 282-306.

SITTLER, C. (1954). Présence de formes polleniques dans quelques Sédiments du Kimeridgien en France. *Soc. Geol. Fr. C.R.* 1954: 338-341.

SMITH, A. H. V. *et* COLL (1964). *Verrucosisporites* (Ibrahim) Emend. Report of C.I.M.P. working group, No. 6. *C. R. . geol. Carb.* **3**: 1071-1077

SPATH, L. F. (1933). Revision of the Jurassic Cephalopod fauna of Kachh (Cutch) Pt. VI. *Palaeont. Indica*, **9** (2): 659-945.

SZE, H. C. (1933). Jurassic plants from Shensi. *Mem. nat. Res. Inst. Geol., Academia., Sinica.* 13.

THIERGART, F. (1949). Der Stratigraphische Wert Mesozoischer pollen und sporen. *Palaeontographica*, **89**(B): 1-34.

THOMAS, H. H. (1911). On the spores of some Jurassic ferns. *Proc. Camb. Phil. Soc.*, **16**: 384-388.

THOMSON, P. W. & PFLUG, H. (1953). Pollen und sporen des Mitteleuropäischen Tertiärs. *Palaeontographica*, **94**: 1-138.
VAKHRAMEEV, V. A. (1964). Jurassic floras in the southern region of the USSR and in India; their relations and age of enclosing deposits. *Geol. congr.* **22**: 101-110.
VERBITSKAYA, E. I. (1962). Palynological evidence and stratigraphical subdivision of Cretaceous deposit of Suchansky Coal basin. *Tr. Lab. geol. Ugl. Akad. Nauk* S.S.R. **15**: 165 (in Russian).
VERMA, C. P. & RAWAT M. S. (1964). Note on the age of Dhrangadhra formation (Saurashtra) W. India in the light of pollen and spores recovered. *Mum. nat. Hist.* **6** (1): 233-238.
VISHNU-MITTRE (1954). Petrified spores and pollen grains from the Jurassic rocks of Rajmahal hills, Bihar. *Palaeobotanist*, **3**: 117-127.
Idem (1956). *Masculostrobus sahnii* sp. nov., a petrified conifer male cone producing three-winged and one- and four-winged abnormal pollen grains from the Jurassic of the Rajmahal Hills, Bihar. *Grana Palynologica*, (N.S.) **1**(2): 99-107.
WADIA, D. N. (1957). Geology of India. *London*.
WILSON, S. & YATES, J. (1953). On two Dicksoniaceous ferns from the Yorkshire Jurassic. *Ann. Mag. nat. Hist.*, **12**(4): 929-937.
WODEHOUSE, R. P. (1958). Pollen grains. *New-York*.

EXPLANATION OF PLATES

(*All Spores and Pollen grains magnified* × 500)

PLATE 1

1. *Deltoidospora triangularis* n. sp. Sl. No. 16/7.
2-3. *Cyathidites rajmahalensis* n. sp. Sl. Nos. 4/1, 9/14.
4. *Cyathidites medicus* n. sp. Sl. No. 18/7.
5-7. *Cyathidites trilobatus* n. sp. Sl. Nos. 33/3, 21/5 & 23/1.
8. *Alsophilidites grandis* n. sp. Sl. No. 26/14.
9-10. *Alsophilidites exilis* n. sp. Sl. No. 3/2 & 31/1.
11-14. *Gleicheniidites mundus* n. sp. Sl. Nos. 30/5, 3/5, 37/17 & 27/3.
15-17. *Gleicheniidites microgranulatus* n. sp. Sl. Nos. 23/9, 40/1 & 48/4.
18. *Gleicheniidites* sp. Sl. No. 18/4.
19. *Divisisporites ovalis* n. sp. Sl. No. 15/10.
20. *Callispora baculoexinus* n. sp. Sl. No. 1/2.
21-22. *Converrucosisporites santalensis* n. sp. Sl. Nos. 27/11 & 15/1.
23-24. *Converrucosisporites sinuotectus* n. sp. Sl. Nos. 21/8 & 4/6.
25. *Concavissimisporites minor* n. sp. Sl. No. 45/9.
26-27. *Verrucosisporites dubius* n. sp. Sl. Nos. 47/1 & 28/1.
28. *Baculatisporites clavaeoides* n. sp. Sl. No. 3/4.
29-31. *Baculatisporites emarginatus* n. sp. Sl. Nos. 37/3, 18/8 & 34/4.
32. *Osmundacidites formosus* n. sp. Sl. No. 37/1.
33-36. *Osmundacidites minutus* n. sp. Sl. Nos. 15/9, 44/2, 9/10 & 33/8.

PTATE 2

37-40. *Osmundacidites formosus* n. sp. Sl. Nos. 29/11, 17/5, 23/10 & 105/3.
41. *Osmundacidites microgranifer* n. sp. Sl. No. 16/4.
42. *Forminisporis* sp. cf. *asymmetricus* Cooks. & Dettm. Sl. No. 47/3.
43. *Forminisporis* sp. Sl. No. 28/9.
44-48. *Neoraistrickia truncatus* (Cooks.) Pot. Sl. Nos. 78/1, 2/10, 25/4, 33/2 & 1/16.
49-50. *Foveosporites* sp. Sl. Nos. 26/11 & 26/8.
51-52. *Acanthotriletes baskoensis* n. sp. Sl. Nos. 84/6 & 104/1.
53. *Ceratosporites* sp. Sl. No. 76/3.
54-56. *Paucibaculisporites increbescense* n. sp. Sl. Nos. 22/6, 16/1, & 36/1.
57-60. *Cicatricosisporites australiensis* (Cooks.) Pot. Sl. Nos. 41/4, 47/8, 17/7 & 41/1.
61-63. *Lycopodiumsporites austroclavatidites* (Cooks.) Pot. Sl. Nos. 75/2, 76/2 & 70/5.
64-66. *Ischyosporites irregularis* n. sp. Sl. Nos. 35/1, 41/5 & 44/1.
67-68. *Cingulatisporites notaclarus* n. sp. Sl. Nos. 19/8 & 80/2.

PLATE 3

69-70. Specimens A & B. Sl. Nos. 105/6 & 85/8.
71-74. *Trilobosporites purverulentus* (Verbitskaya) Dettm. Sl. Nos. 30/2, 34/1, 21/1 & 39/3.
75-76. *Callialasporites* (al. *Zonalapollenites*) *dampieri* (Balme) Dev. Sl. Nos. 95/2 & 98/2.
77-78. *Callialasporites* (al. *Zonalapollenites*) *segmentatus* (Balme) Srivastava. Sl. Nos. 105/1 & 47/7.
79-80. *Callialasporites* (al. *Zonalapollenites*) *dampieri* (Balme) Dev. Sl. Nos. 102/1 & 24/5.
81-84. *Callialasporites* (al. *Zonalapollenites*) *trilobatus* (Balme) Dev. Sl. Nos. 105/7, 102/4, 85/1 & 98/3.
85. *Callialasporites grandis* n. sp. Sl. No. 61/2.

PLATE 4

86. *Callialasporites grandis* n. sp. Sl. No. 95/4.
87-89. *Callialasporites* (al. *Zonalapollenites*) *trilobatus* (Balme) Dev. Sl. Nos. 103/4, 101/3 & 105/2.
90. *Callialasporites* (al. *Zonalapollenites*) *segmentatus* (Balme) Srivastava. Sl. No. 104/9.
91-92. *Callialasporites* (al. *Zonalapollenites*) *trilobatus* (Balme) Dev. Sl. Nos. 99/1 & 1/7.
93-94. *Callialasporites* (al. *Zonalapollenites*)

segmentatus (Balme) Srivastava. Sl. Nos. 1/3 & 104/3.

95-96. *Callialasporites monoalasporus* Dev. Sl. Nos. 1/12 & 48/2.

PLATE 5

97. *Alisporites rajmahalensis* n. sp. Sl. No. 102/5.

98-100. *Alisporites hemiglobosaccatus* n. sp. Sl. Nos. 99/3, 104/4 & 84/3.

101-102. *Alisporites baskoensis* n. sp. Sl. Nos. 85/3 & 94/1.

103-106. *Platysaccus indicus* n. sp. Sl. Nos. 1/24, 21/3, 86/7 & 92/1.

107. *Platysaccus* sp. A. Sl. No. 86/4.

108. *Platysaccus* sp. B. Sl. No. 103/1.

109-111. *Podocarpidites cristiexinus* n. sp. Sl. Nos. 96/1, 100/2 & 94/4.

PLATE 6

112. *Podocarpidites cristiexinus* n. sp. Sl. No. 89/1.

113-114. *Podocarpidites novus* n. sp. Sl. Nos. 29/12 & 42/2.

115-117. *Podocarpidites grandis* n. sp. Sl. Nos. 62/7, 61/3 & 29/8.

118-119. *Podocarpidites alareticulosus* n. sp. Sl. Nos. 97/1, 82/7.

120-122. *Podocarpidites typicus* n. sp. Sl. Nos. 93/2, 86/9 & 99/5.

123. *Phyllocladidites florinii* (Cooks. & Pike) n. comb. Sl. No. 100/3.

124-126. *Vitreisporites rajmahalensis* n. sp. Sl. Nos. 20/5, 93/1 & 105/4.

127-129 *Podosporites*. sp. cf. *tripakshii* Rao. Sl. Nos. 103/2, 100/3 & 96/6.

PLATE 7

130-136. *Trisaccites microsaccatus* (Couper) Couper. Sl. Nos. 99/2, 26/6, 103/7, 101/1, 39/9, 103/9 & 30/3.

137-138. *Dacrycarpites australiensis* Cooks. & Pike. Sl. Nos. 84/1 & 94/3.

139-140. *Laricoidites communis* n. sp. Sl. Nos. 29/5 & 61/1.

141. *Araucariacites australis* Cookson. Sl. No. 87/3.

142-143. *Cycadopites crassisulcatus* n. sp. Sl. Nos. 29/25 & 11/6.

144-145. *Cycadopites sakrigaliensis* n. sp. Sl. Nos. 5/2 & 28/8.

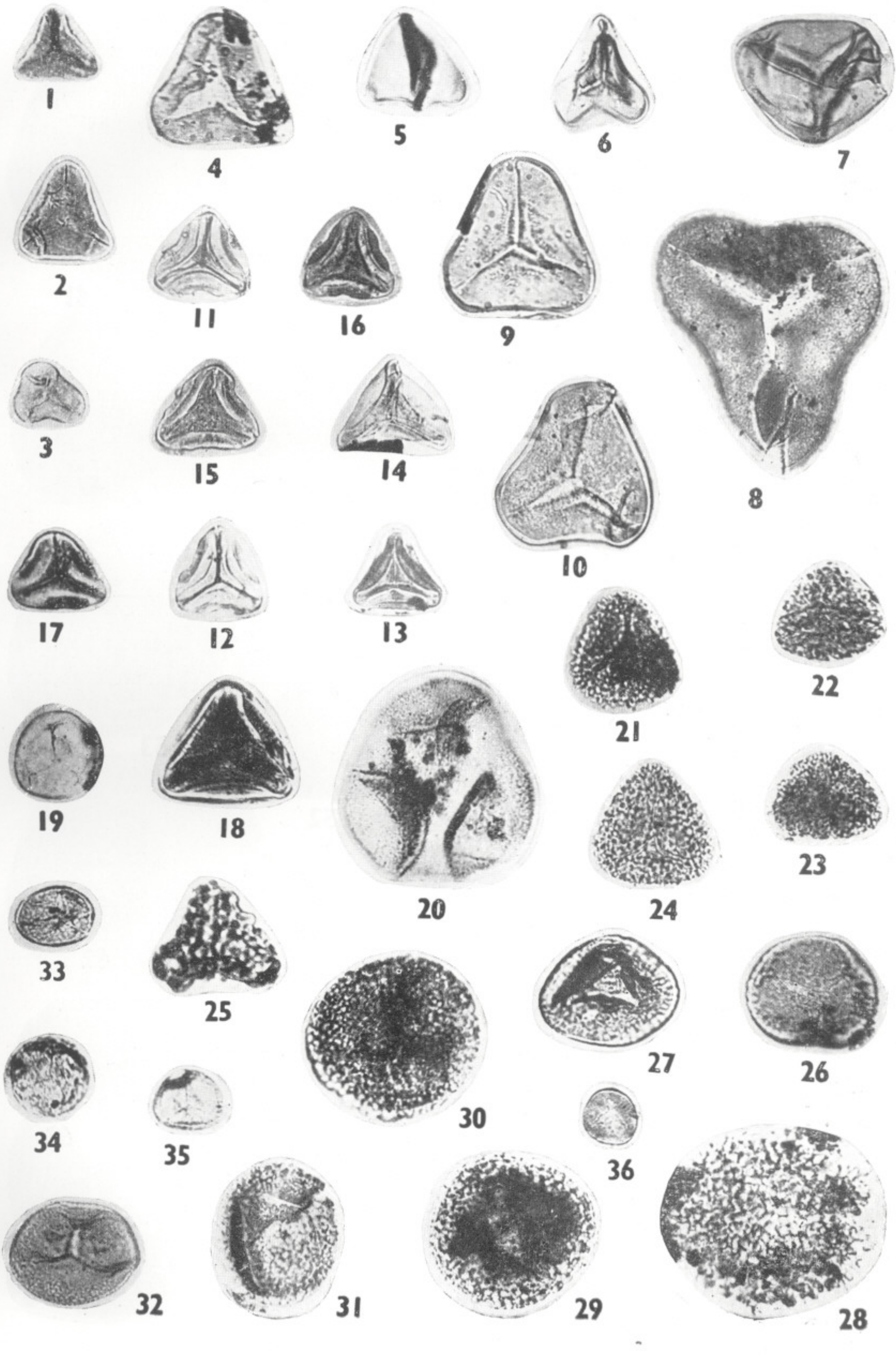
146-149. *Cycadopites gracilis* n. sp. Sl. Nos. 18/6, 29/13, 15/11 & 13/7.

150. *Cycadopites* sp. Sl. No. 17/9.

151-152. *Classopollis* sp. cf. *torosus* (Reiss.) Couper. Sl. Nos. 17/8 & 3/4.

153. *Callialasporites* (al. *Zonalapollenites*) *trilobatus* (Balme) Dev. Sl. No. 104/8.

154. *Laricoidites communis* n. sp. Sl. No. 85/7.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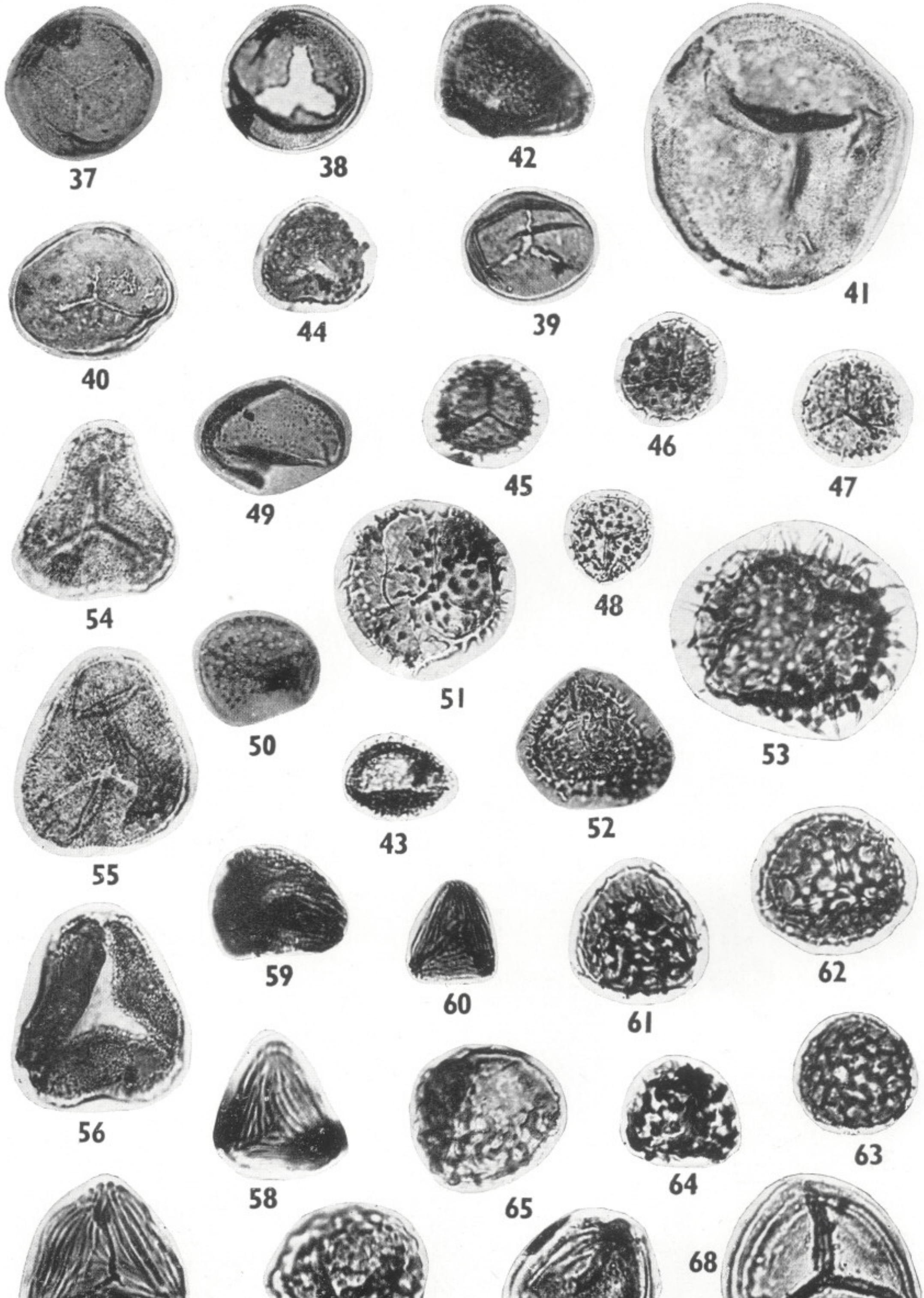
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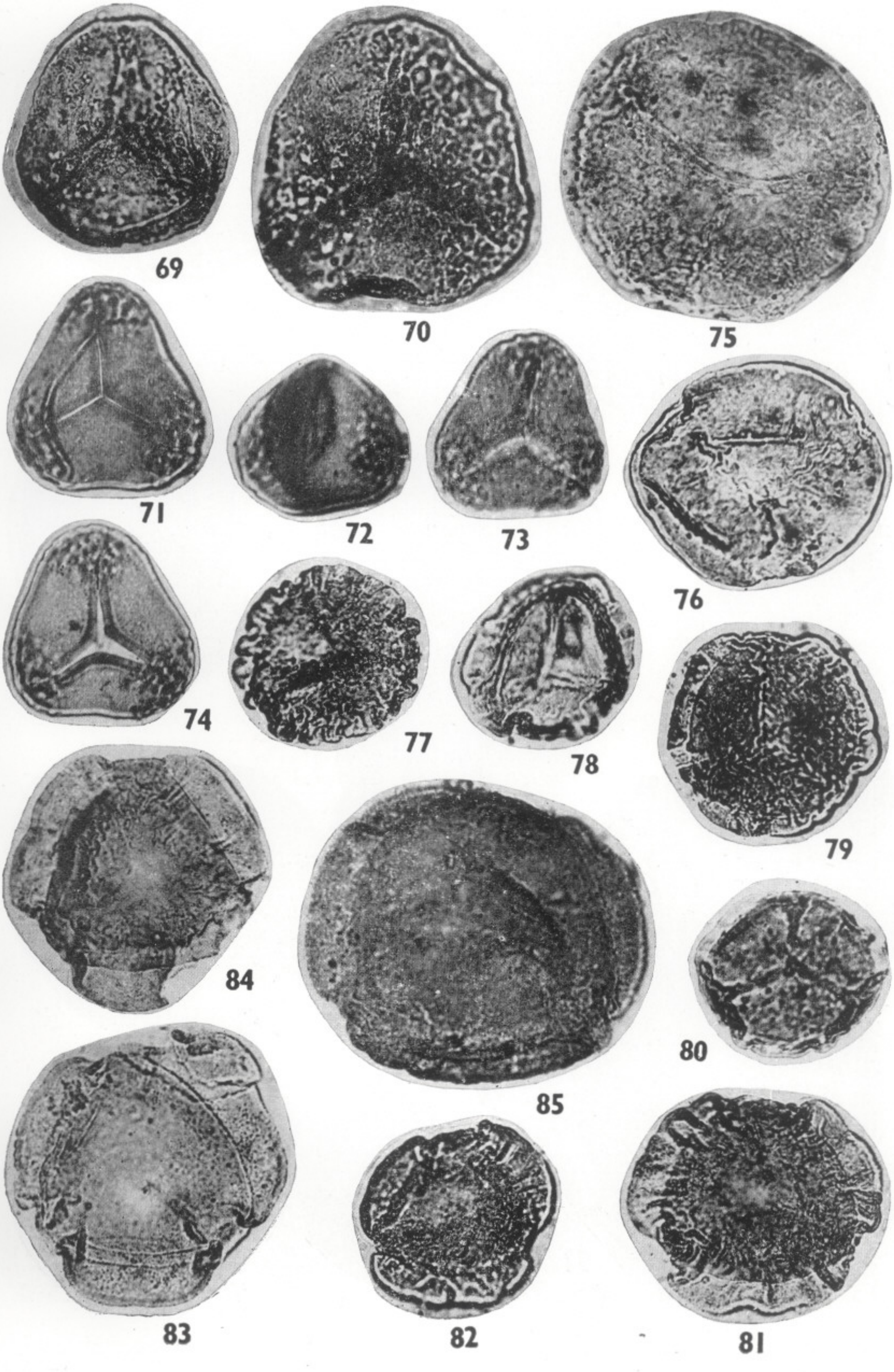
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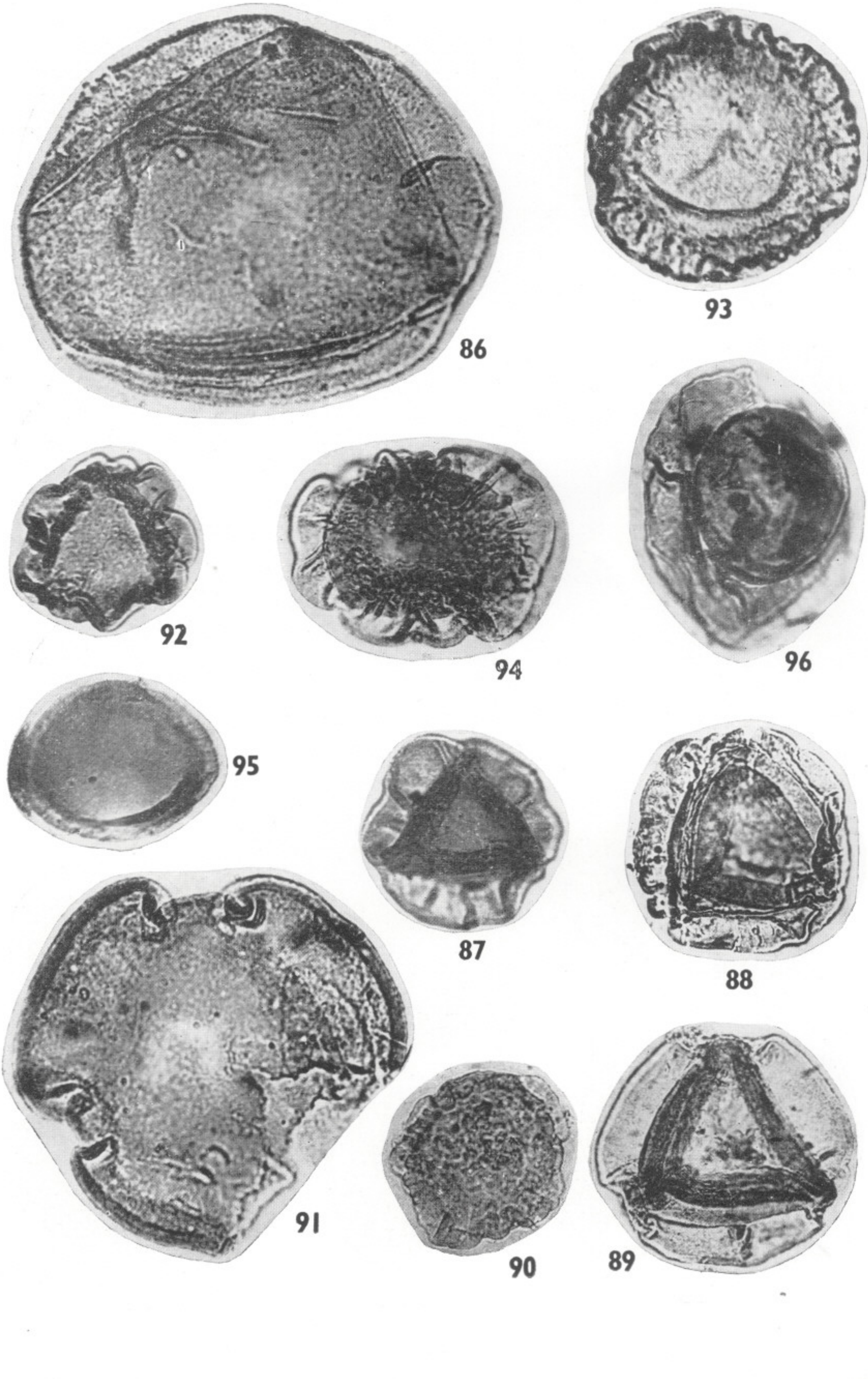
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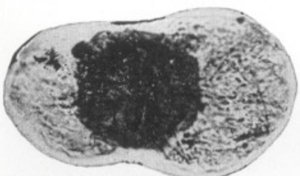

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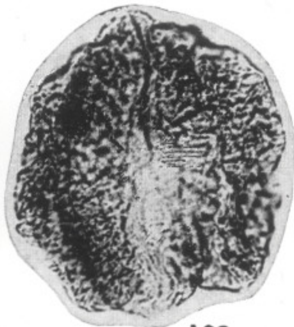

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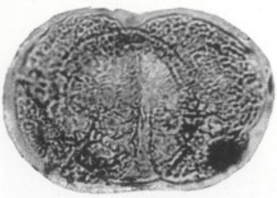

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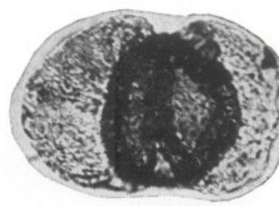

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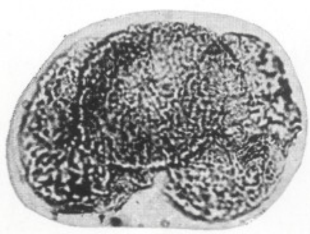

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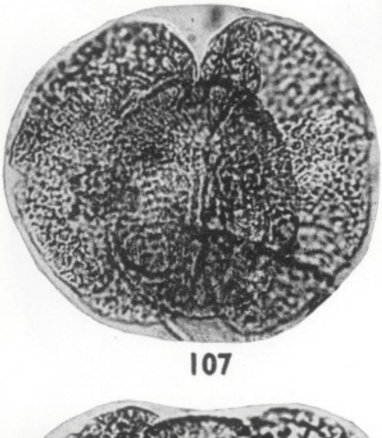

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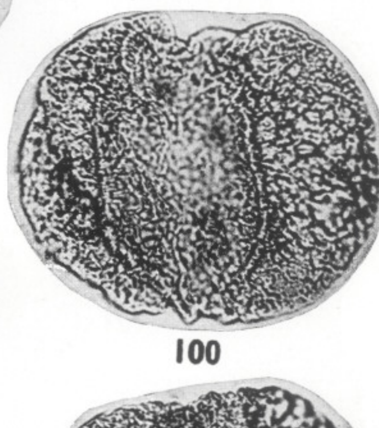

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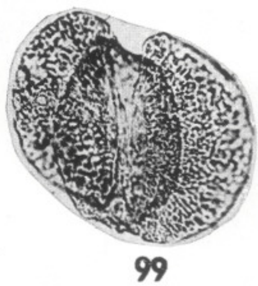

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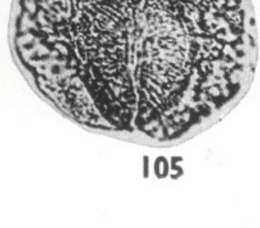

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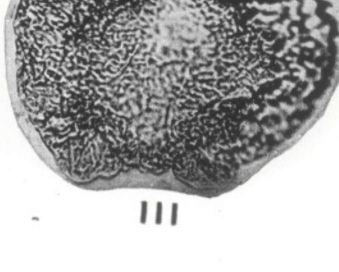

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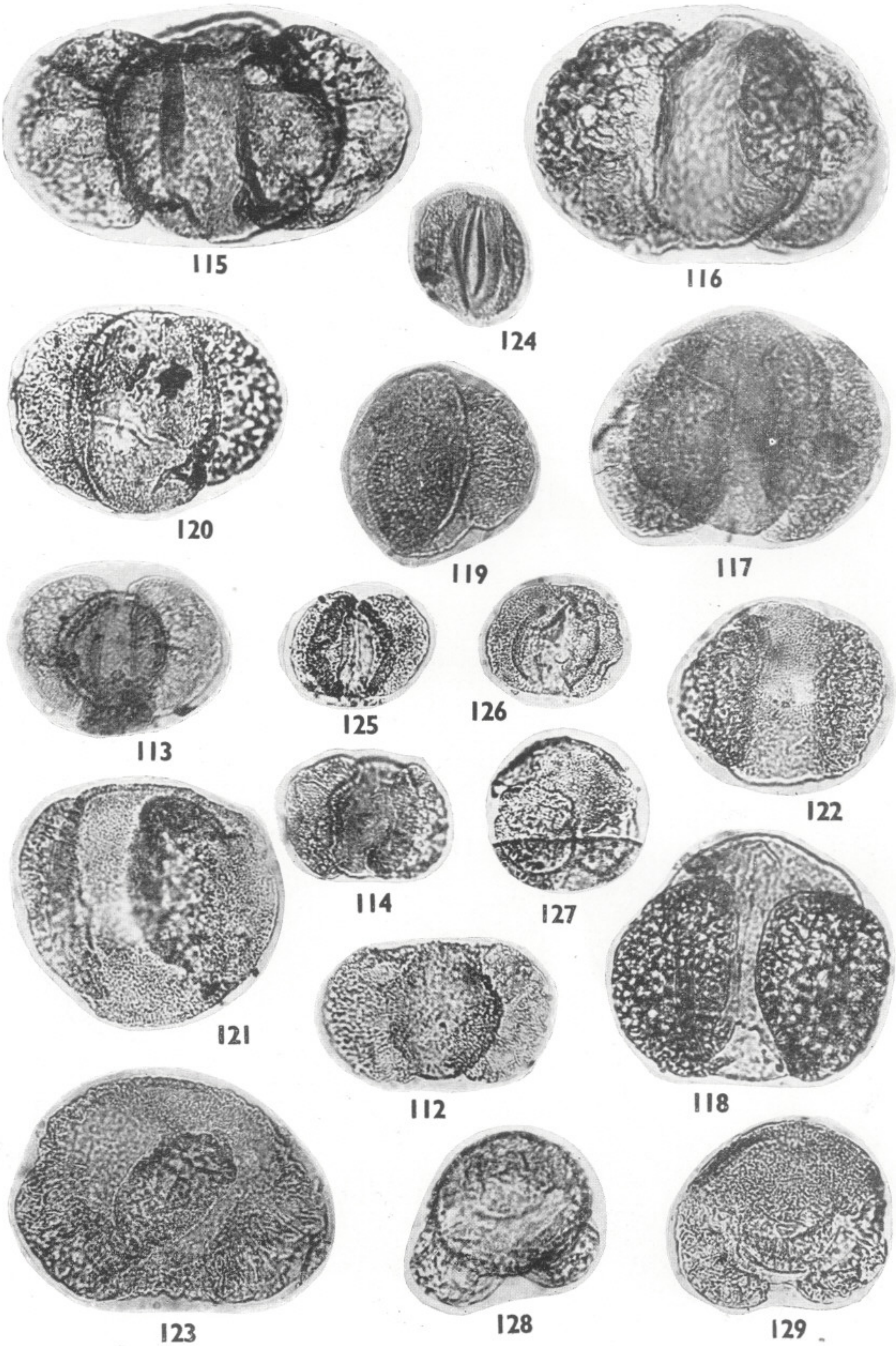
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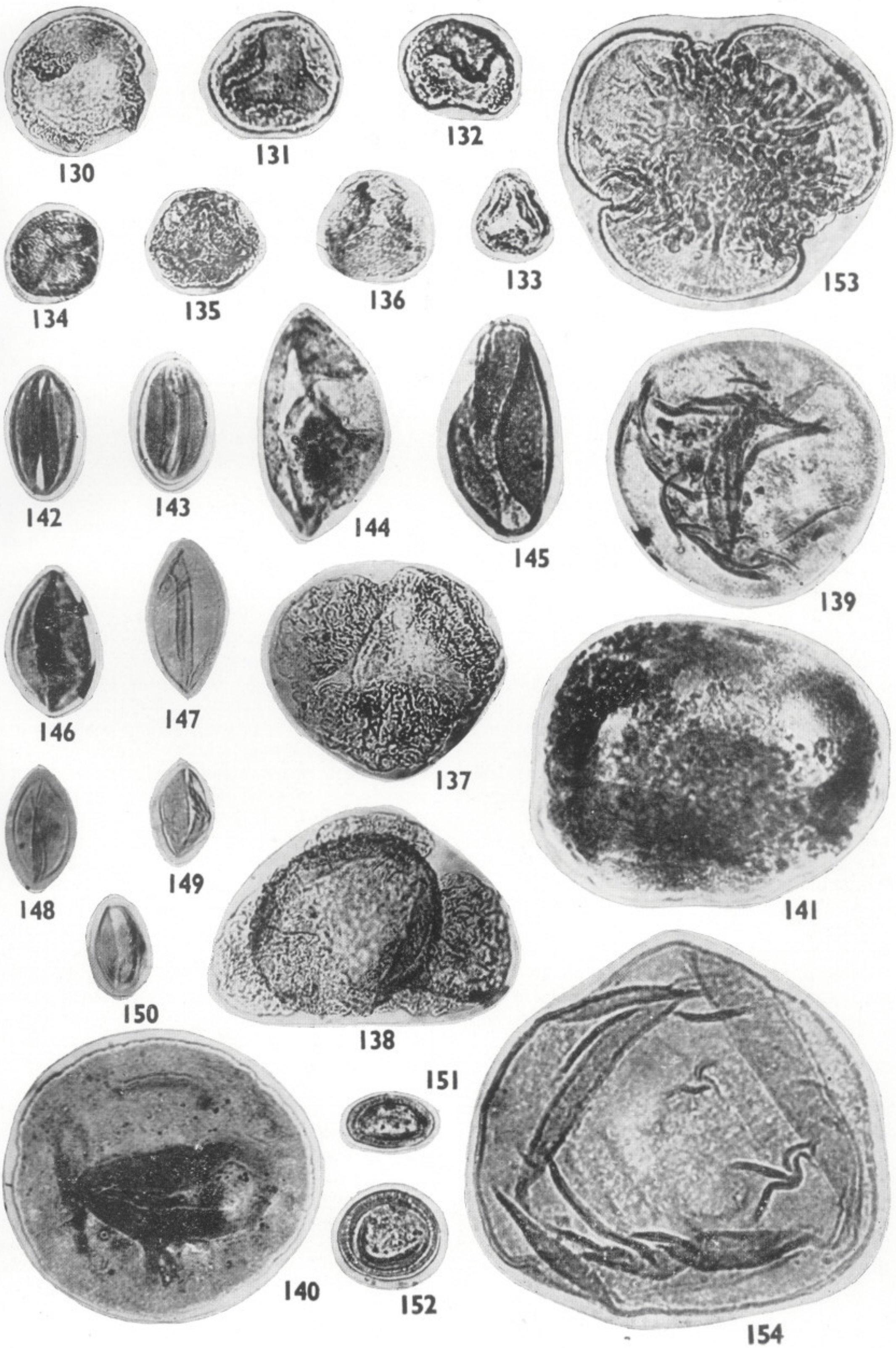
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