ON THE STATUS OF SOME MIOSPORE GENERA FROM THE MESOZOIC ERA

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ABSTRACT

Six miospore genera, viz. *Neoraistrickia* Potonié (1956), *Matonisporites* Couper (1958), *Callispora* Dev (1961), *Boseisporites* Dev (1961), *Densoisporites* Weyland & Krieger (1953) and *Callialasporites* Dev (1961) have been emended in this paper. *Neoraistrickia* Potonié emend., is distally baculate and proximally smooth. *Matonisporites* Couper emend., has thicker corners, membraneous Y-rays and smooth exine. *Callispora* Dev emend., is characterized by having incipiently thickened angles and punctate exine. *Boseisporites* Dev emend., possesses two-layered exine, the outer layer being hyaline and varyingly punctate but the inner one darker, rarely punctate and continuous all round the equator being broader at the angles. *Densoisporites* Weyland & Krieger emend., has two-layered, cavate spore wall, the exoexine being thicker distally and equatorially than on the proximal face and sculptured with very low, free to anastomosing grana. *Callialasporites* Dev emend., is a monosaccate genus having two-layered exine. Exoexine and intexine are separated from each other variably subequatorially on both the faces. Saccus is microsculptured (microbaculate or microverrucose) and has a limboid marginal thickening. The specific diagnoses of nine species, viz. *Neoraistrickia truncata* (Cookson) Potonié (1956), *N. neozealandica* (Couper) Potonié (1956), *Callispora potoniei* Dev (1961), *Boseisporites praeclarus* Dev (1961), *Densoisporites mesozoicus* Singh, Srivastava & Roy (1964), *Callialasporites trilobatus* (Balme) Dev (1961), *C. dampieri* (Balme) Dev (1961), *C. segmentatus* (Balme) Srivastava (1963) and *C. discoidalis* (Döring) comb. nov. have also been emended on the lines of the emended generic diagnoses.

INTRODUCTION

DURING the course of our examination of the mioflora from Upper Mesozoic coaly deposits of India, a critical study of several spore genera revealed that their circumscription needed emendation in the light of the diagnostic characteristics present in their types or specimens similar to the types. The following genera, viz. *Neoraistrickia* Potonié (1956), *Matonisporites* Couper (1958), *Callispora* Dev (1961), *Boseisporites* Dev (1961), *Densoisporites* Weyland & Krieger (1953) and *Callialasporites* Dev (1961) have been emended in this paper. The specific diagnoses of 9 species of the above stated genera have also been emended accordingly.

DESCRIPTION OF SPORES

Anteturma — *Sporites* H. Potonié 1893
Turma — *Triletes* (Reinsch) Dettmann 1963
Suprasubturma — *Acavatitriletes* Dettmann 1963
Subturma — *Azonotriletes* (Luber) Dettmann 1963
Infraturma — *Apiculati* (Bennié & Kidston) Potonié 1956

Genus — *Neoraistrickia* Potonié emend.

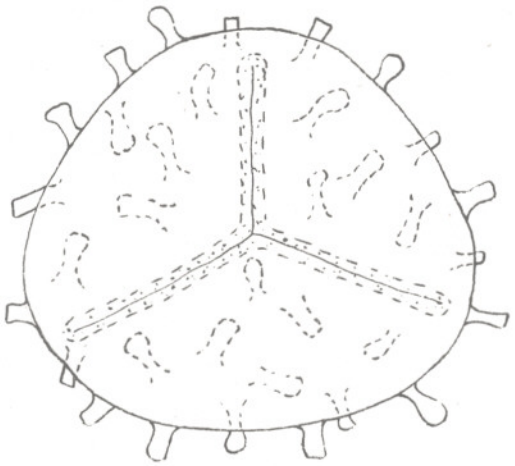
Emended diagnosis — Miospores biconvex, roundly triangular. Trilete, Y-rays extending as far as the periphery, simple. Exine distally ornamented with baculate processes but proximally smooth.

Genotype — *Neoraistrickia truncata* (Cookson) Potonié emend.

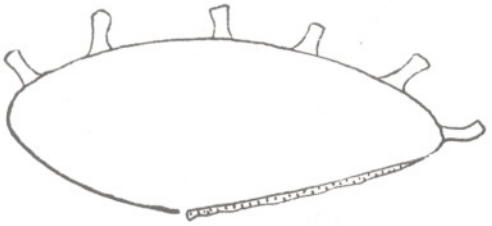
Emended diagnosis — Miospores 31-55 μ. Only distally baculate. Bacula 3·5 μ long.

Reconstruction — See Text-figs. 1a-b.

Remarks — Cookson (1953) illustrated *Trilites truncatus* from the Pre-Tertiary clays of Comaum, South Australia. This new specimen incorporates trilete, subtriangular spores having coarse, evenly spaced, truncated processes as the ornamentation of the exine and they are 3·5 μ long. Later, Potonié (1956) instituted a spore genus *Neoraistrickia* and selected out *Trilites truncatus as its* genotype. He also transferred *Raistrickia neozealandica* Couper into *Neoraistrickia*. The specimen as illustrated by Cookson (1953, PL. 2, FIG. 36) appears to have bacula only on the distal face with proximal face lacking the processes. The occurrence of differential distribution of bacula in the genus is also supported in *Neoraistrickia neozealandica* as described here which is only distally baculate and proximally smooth. Also in the holotype of *N. neozealandica* sketched by Couper (1953, PL. 1, FIG. 8), the presence of a baculum lying over one of the rays suggests that all the bacula sketched



1a



1b

TEXT-FIG. 1a — Diagrammatic sketch of *Neoraistrickia* (Potonié) emend., showing exine smooth on the proximal face but possessing bacula on the distal face only (1,000 ×). 1b. Meridional section of *Neoraistrickia* (Potonié) emend., showing distally baculate exine surface and smooth proximally.

therein are on the distal face. The generic diagnosis of *Neoraistrickia* as based by Potonié on the specific diagnosis of *N. truncata* given by Cookson (1953) as *Trilites truncatus*, does not include a mention of the differential distribution of bacula on the two faces of the spore. Hence, an emendation of the generic diagnosis of *Neoraistrickia* and that of the genotype has been proposed as above. The emended circumscription distinguishes *Neoraistrickia* from the Palaeozoic genus *Raistrickia* (S. W. & B.) Potonié & Kremp (1955) wherein bacula are distributed on both the polar faces.

Neoraistrickia neozealandica (Couper) Potonié emend.

Pl. 1, Figs. 1-2

Emended specific diagnosis — Miospores 24-46 μ. Subtriangular. Trilete, Y-rays may be faintly observed and reaching 3/4 of the spore radius. Exine distally baculate and proximally smooth. Bacula strong, usually slightly curved, broad-based with truncated and often dilated apex and 4-6·5 μ long, 1·5-2·5 μ wide at base and 1-1·5 μ wide at the apices. *Extrema lineamenta* baculate.

Remarks — The specimens of *Neoraistrickia neozealandica* from the Jabalpur Stage exhibit slightly extended range in overall size and longer bacula as compared to those considered by Couper (1953).

Distribution — Couper (1953) has reported *N. neozealandica* from the Jurassic beds of New Zealand. This species is rarely noticed in the deposits of the Jabalpur Stage, India.

Subturma — *Zonotriletes* Waltz 1933
Infraturma — *Auriculati* (Schopf) Dettmann 1963

Genus — *Matonisporites* Couper emend.

Emended diagnosis — Miospores biconvex, triangular with concave sides and ± rounded angles. Trilete, Y-rays enclosed within membraneous raised labra. Exine smooth, thicker at the angles.

Genotype — *Matonisporites phlebopteroides* Couper 1958

Remarks — Couper (1958) described a new spore genus *Matonisporites* from Yorkshire. He compared the genotype with the illustrated spores of *Phlebopteris hirsuta* Sahni & Sitholey (1945), *P. indica* Sahni & Sitholey (1945) and *P. muensteri* (Schenk) Hirmer & Hoerhammer (1936). *Matonisporites* possesses a long trilete mark with raised labra and a thickening along the Y-mark together with a triangular outline and unsculptured exine. Later on, Dettmann (1963) emended the generic diagnosis of *Matonisporites* stating that the exine is differentially thickened, being thickest in the equatorial radial regions than elsewhere and that the exine is smooth or almost smooth. Thereby, she included in it spores having punctate exine as in *M. cooksoni* Dettmann (1963). While

agreeing with Dettmann in restricting *Matonisporites* to auriculate forms it is felt that the smooth character of the exine in *Matonisporites* should be strictly maintained, excluding those species from it which have punctate exine. Hence, *M. cooksoni* has been transferred under *Lametatriletes* Singh & Kumar (1972) because it has puncta (OL pattern) along the Y-mark and on distal exine.

Genus — *Callispora* Dev emend.

Emended diagnosis — Miospores biconvex, triangular with rounded angles and straight to concave sides. Trilete, Y-rays reaching 3/4 of the spore radius or the equator with simple labra. Exine thick, with incipiently thickened angles and punctation on both the faces.

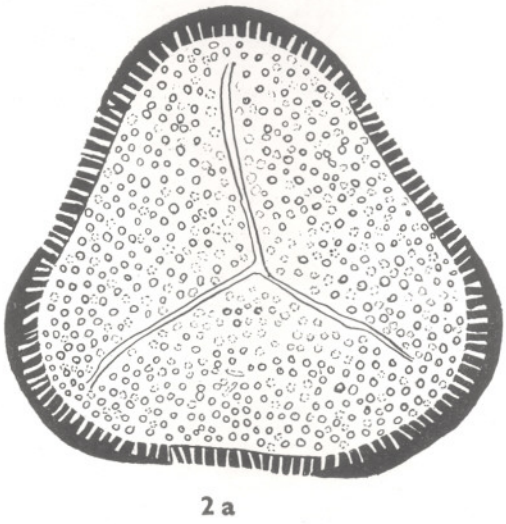
Genotype — Callispora potoniei Dev emend.

Reconstruction — See Text-figs. 2a-b.

Remarks — Dev (1961) circumscribed a spore genus *Callispora* from the beds of the Jabalpur Stage, India. It incorporates triangular, trilete miospores having grana or little pilae as the ornamentation of the exine which may be slightly thicker at the angles. We examined the genotype and our observations based also on the other similar specimens recovered from the coal samples of the same locality, necessitate an emendation of the diagnosis of *Callispora* as given above.

Foveotriletes (Van der Hammen) Potonié (1956) is very much similar to *Callispora* Dev emend., but the former appears to be distally more convex and proximally the three sides are sharply faceted. Hence, it is different from *Callispora*. *Microreticulatisporites* (Knox) emend. Bharad. (1955) possesses triangular outline and finely reticulate exine. The specimens illustrated by Balme (1957, Pl. 4, Figs. 50-51) as *Microreticulatisporites parviretis* and those figured by Dettmann (1963, Pl. 6, Figs. 8-13) under *Foveotriletes parviretus* (Balme) are morphographically closer to *Callispora* rather than *Foveotriletes*. Hence, Balme's and Dettmann's illustrated specimens of *Foveotriletes* have been included under *Callispora* (Dev) emend.

Other species — Callispora parvireta (Balme) comb. nov. Syn. *Microreticulatisporites parviretis* Balme 1957, Pl. 4, Figs. 50-51; Occurrence: Western Australia, Neocomian.



Text-fig. 2a — Diagrammatic sketch of *Callispora* Dev emend., showing incipient thickening at the radial regions and puncta on both the surfaces. (1,000 ×). 2b. Meridional section of *Callispora* Dev emend., showing puncta on both the exine surfaces.

Callispora potoniei Dev emend.

Pl. 1, Figs. 4-6

Emended specific diagnosis — Miospores 70-90 μ, biconvex. Triangular with straight to concave sides and broadly rounded angles. Trilete, Y-rays 3/4 of the spore radius or the equator. Exine variably thickened (2-2·5 μ at the sides and 2·5-3·5 μ at the angles) and prominently punctate. Puncta closely spaced, 0·5-1 μ in diameter and 2-3 μ deep. *Extrema lineamenta* pitted.

Remarks — *Callispora parvireta* (Balme) comb. nov. is different from *C. potoniei* Dev emend. in having smaller size range (37-67 μ). Balme's specimens have thinner exine (1·5 μ) and bigger puncta (1-2 μ in diameter).

Distribution — Dev (1961) reported only two specimens of *Callispora potoniei* from the beds of the Jabalpur Stage, India. In the present study, a number of other specimens of *C. potoniei* have been encountered. Dettmann's (1963, PL. 6, FIGS. 8,13) specimens, now referable to *Callispora* Dev emend., are distinctly smaller in size.

Genus — *Boseisporites* Dev emend.

Emended diagnosis — Miospores biconvex, triangular with straight to concave sides and rounded angles. Trilete, Y-rays reaching 3/4 of the spore radius of the inner margin of the radial thickenings with simple or slightly raised and crumpled labra. Exine two-layered, the outer layer hyaline and varyingly punctate but the inner layer darker and rarely punctate and continuous all round the equator but broader at the angles.

Genotype — *Boseisporites praeclarus* Dev emend.

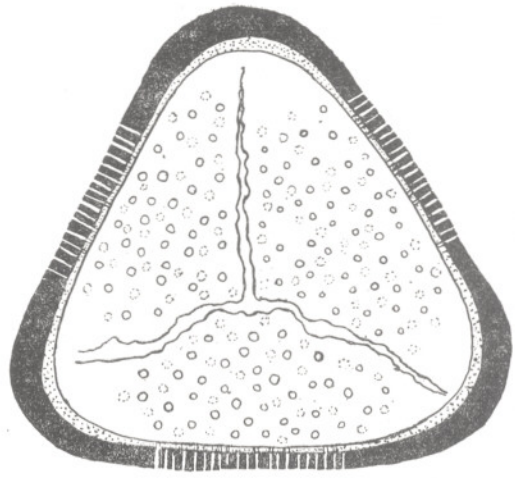
Reconstruction — See Text-figs. 3a-b.

Remarks — Dev (1961) described *Boseisporites* from the sediments of the Jabalpur Stage, India. The genus incorporates those dispersed miospores which are triangular with rounded angles, have straight or rarely concave sides together with smooth cingulum which is slightly thicker on the angles and have a sculptured central body. However, the genotype *B. praeclarus* Dev is said to have laevigate and intragranulate exine. Later on, Singh *et al.* (1964) emended its generic diagnosis to incorporate spores with thin and intrapunctate exine. Dettmann (1963) made a new combination of *B. praeclarus* and put it under the genus *Matonisporties* Couper emend. Dettmann. A re-examination of the genotype (DEV 1961, PL, 2, FIG. 15) and many other specimens, recovered from the coals of the same locality, reveals that the genus *Boseisporites* Dev emend., is noncingulate, auriculate and has two-layered, punctate exine.

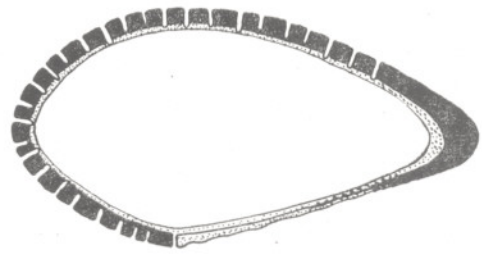
Boseisporites praeclarus Dev emend.
Pl. 1, Figs. 7-9

Emended specific diagnosis — Miospores 78-107 μ. Triangular with straight to slightly concave sides and sharply rounded angles. Trilete, Y-rays 3/4 of the spore radius or extending to inner margin of the radial thickenings. Exine two-layered, differentially thickened (3-6 μ thick at the sides and 4-9 μ thick at the angles). The outer layer hyaline and the inner dark and continuous. Punctate, puncta ± 1 μ in diameter and ± 1·5 μ deep. *Extrema lineamenta* radially striated.

Distribution — *B. praeclarus* Dev emend., has been reported from the beds of the Jabalpur Stage, India. Singh *et al.* (1964) have reported it from the deposits of Trambau, Kutch, India.



3a



3b

Text-fig 3a. Diagrammatic sketch of *Boseisporites* Dev emend., showing punctate and variably thickened two-layered exine with outer hyaline and inner darker, continuous all round the equator and broader at the angles (1,000 ×). 3b. Meridional section of *Boseisporites* Dev emend., showing two-layered punctate exine with more thickened angles.

Supras subturma — *Perinotriletes* (Erdtman) Dettmann 1963

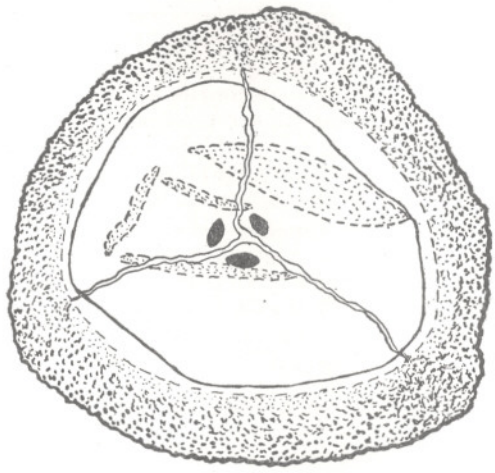
Genus — *Densoisporites* Weyland & Krieger emend.

Emended diagnosis — Miospores subcircular to convexly subtriangular in polar view. Trilete. Spore wall two-layered, cavate, an outer sculptured layer loosely enveloping and proximally attached at the contact area to a thinner inner layer. Distally exoexine thicker than on the proximal face, equatorially thickened and sculptured with very low, free to anastomosing grana giving a wrinkled appearance. Inner layer thin, smooth and may be folded.

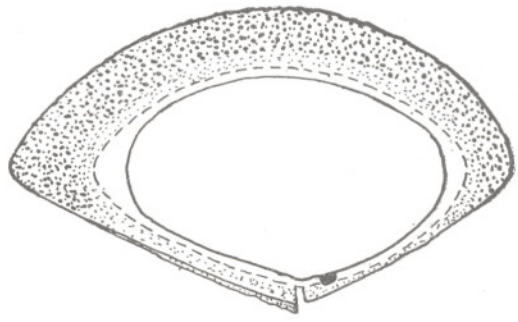
Genotype — *Densoisporites velatus* Weyland & Krieger 1953.

Reconstruction — See Text-figs. 4a-b.

Remarks — *Densoisporites* Weyland & Krieger (*l.c.*) includes trilete miospores with a cingulum which is laminated inside and finely but irregularly wrinkled on outer surface. Couper (1958) described *D. perinatus* which has an outer, thin, scabrate perine. Krasnova (in Samoilovitch *et al.* 1961) merged *D. perinatus* with the type species of the genus. She recognized there the presence of an outer perinal layer enclosing a smooth inner layer with interradial thickenings on the proximal face. However, these characters are not stated in the generic diagnosis of *Densoisporites* as originally circumscribed. Potonié (1956) elaborated upon the original diagnosis and Krutzsch (1959) reworded it including therein the character of weak sculpture. However, Dettmann (1963) emended the generic diagnosis of *Densoisporites* and stated that it includes trilete, cavate miospores having two-layered spore wall (*Sclerine*), of which the outer structural layer (*Sculptine*) is loosely enveloping but proximally it is attached to a thinner inner layer. According to her, *Sculptine* is equatorially thickened with a finely structured surface and the inner layer is thin, smooth, bearing proximal interradial thickening (papillae) near the polar region. However, the present study based on the specimens of the Jabalpur Stage, unmistakably referable to *Densoisporites*, reveals that the exine surface is weakly granulose, i.e. it is sculptured. Moreover, there is no indication of an inner layering in the equatorial thickening although the sculpturing simulates such an appearance. The cavate separation of an inner body from the exoexine is confirmed. The presence of interradial papillae has been substantiated only in the seemingly over macerated specimens. In view of these observations, the diagnosis of the genus has been emended as above.



4a



4b

TEXT-FIG. 4a — Diagrammatic sketch of *Densoisporites* Weyland & Krieger emend., showing lowly granulose exoexine giving a wrinkled appearance, proximally attached at the contact area to a thinner inner layer having polar papillae and folded inner layer (1,000 ×). 4b. Meridional section of *Densoisporites* Weyland & Krieger emend., showing distally and equatorially thickened exoexine.

Distribution — *D. velatus* Weyland & Krieger has been reported from the Middle Senonian of Germany. Delcourt and Sprumont (1955) have recorded *D. triradiatus* from the Wealden strata of Belgium. *D.*

playfordi (Balme) Dettmann has been described from the Lower Triassic of Western Australia. Krasnova (in Samoilovitch *et al.* 1961) has recorded *D. velatus* from Western Siberia. Cookson and Dettmann (1958) have described it from the Upper Mesozoic deposits of Eastern Australia. *D. fissus* Reinhardt (1964) is reported from the Triassic of Thüringen, Basin. *D. caretteae* Visscher (1966) has been reported from the Upper Bunter of Hengelo, the Netherlands. *D. mesozoicus* Singh *et al.* (1964) has been recorded from the Lower Cretaceous beds of Kutch, India.

Affinity — The affinity of the genus is positively not known but Potonié (1956) compared *D. velatus* with the miospores associated with *Selaginellites hallei* Lundblad and also with the recent spores of *Selaginella scandens* Spring. Chaloner (1953 & 1958) found *Endosporites globiformis* a spore comparable to *Densoisporites* in the lycopod cone, i.e. *Polysporia mirabilis* Newberry (= *Lepidostrobus zea* Chaloner). Balme (1963) compared *D. playfordi* with the associated miospores of *Selaginellites polaris* Lundblad and suggested lycopodiaceous affinity, possibly selaginellid organizationally and in our view the presence of the three interradial papillae on the inner body also suggests that this genus is unmistakably of lycopodiaceous affinity.

Densoisporites mesozoicus Singh, Srivastava & Roy emend.

Pl. 1, Figs. 10, 11

Holotype — Singh *et al.* 1964; Pl. 4, Fig. 57.

Emended specfic diagnosis — Miospores 50-86 μ, biconvex. Roundly triangular. Trilete and Y-rays extending ± body outline. Spore wall two-layered and cavate. Inner layer 47·5-58 μ, thin, homogeneous and proximal polar papillae present or may be absent. Exoexine loose, sculptured with low grana simulating a scabrate pattern and variably thickened (4-9 μ wide at the sides and 8-15 μ wide at the angles). *Extrema lineamenta* wrinkled.

Remarks — The specimens (Pl. 19, Figs. 4-8, chiefly Fig. 6) as illustrated by Dettmann (1963) under *D. velatus* closely compare with *D. mesozoicus* Singh *et al.* emend., as illustrated here (Pl. 1, Fig. 10) by virtue of having similar pattern of sculptured elements, similar size range (±72 μ) and inner body range (± 56 μ), and variably thickened exoexine (± 6 μ wide at sides and ± 11 μ wide at radial region, Pl. 19, Fig. 6). Hence, in the present treatise Dettmann's specimens as mentioned above have been incorporated under *D. mesozoicus* Singh *et al.* emend.

Distribution — Singh *et al.* (1964) have recorded *D. mesozoicus* from the Lower Cretaceous beds of Kutch, India.

Anteturma — *Pollenites* Potonié 1931
Turma — *Saccites* Erdtman 1947
Subturma — *Monosaccites* (Chitaley) Potonié & Kremp 1954
Infraturma — *Aletesacciti* Leschik 1955

Genus — *Callialasporites* Dev emend.

Synonyms —
Callialasporites Dev 1961; p. 48
Applanopsis During 1962; p. 112
Triangulopsis Döring 1962; p. 113
Pflugipollenites Pocock 1962; p. 72

Emended diagnosis — Pollen grains monosaccate, circular, subcircular, oval or roundly triangular in equatorial view. Central body varyingly distinct, circular, subcircular to convexly triangular when flattened equatorially. Alete, proximal tetrad mark or triradiate ridge variably seen. Exine two-layered and thick. Exoexine and intexine separated from each other variably subequatorially on both the faces. Exoexine microsculptured and extended to form frilled to smooth, continuous or trinotched monosaccus with a narrow to wide limboid, marginal thickening. Nonsaccate areas varyingly vesiculate, vesiculae sometimes extending on to the polar regions. Distal polar exine slightly thinner than proximal polar exine.

Genotype — *Callialasporites trilobatus* (Balme) Dev emend.

Remarks — Dev (1961) circumscribed *Callialasporites* from the Lower Cretaceous beds of the Jabalpur Series, India. He designated *Callialasporites trilobatus* (Balme) Dev as the type and made two new combinations viz., *C. dampieri* (Balme) Dev and *C. segmentatus* (Balme) Dev. He was of the view that *Zonalapollenites* Pflug (in Thomson & Pflug 1953) is equivalent or synonymous to *Tsugaepollenites* (Potonié) Potonié & Venitz (1934).

Pflug (in Thomson & Pflug 1953) described some pollen grains similar to *Sporo-*

nites igniculus Potonié (1931) under a new genus *Zonalapollenites* as *Z.* (*sporonites*) *igniculus* (Potonié) Pflug. Potonié and Venitz (1934) compared *S. igniculus* with the living pollen grains of *Tsuga* spp., and transferred it to *Tsugaepollenites*. Potonié (1958) finally redefined and described *Tsugaepollenites* Potonié & Venitz and designated *T.* (*al. Sporonites*) *igniculus* (Potonié) Potonié & Venitz (1934) as its genotype. He treated *Tsugapollenites* Raatz (1937) as a synonym of *Tsugaepollenites*. Nilsson (1958) created *Cerebropollenites* and designated its genotype as *C.* (*Tsugaepollenites*) *mesozoicus* (Couper) Nilsson.

Pocock (1962) made a new genus *Pflugipollenites* which is reported to be having a perispore. Döring (1962, wrongly cited as having been published in 1961, see Pocock 1968), instituted two genera, *Applanopsis* having more or less a circular central body with the genotype *A. lenticularis*, and *Triangulopsis* having a triangular central body with the genotype *T. discoidalis*. Both the genera were reported to be planktonic organisms.

Dettmann (1963) restated the diagnosis of *Tsugaepollenites* and clearly indicated, through vertical sections of *T. trilobatus* (Pl. 24, Figs. 9-10) and *Tsugaepollenites* cf. *T. segmentatus* (Pl. 24, Figs, 15-16), that the genus possesses two-layered exine with an equatorially attached monosaccus which is granulose. She merged a number of genera like *Zonalapollenites, Callialasporites, Applanopsis, Triangulopsis, Cerebropollenites, Tsugapollenites, Pflugipollenites* into *Tsugaepollenites*.

Pocock (1968) stated that *Pflugipollenites* Pocock (1962) and *Triangulopsis* Döring (1962) were synonyms of *Callialasporites* Dev (1961) and that *Tsugaepollenites was* synonym of *Zonalapollenites* Pflug which is quite different from *Callialasporites*. He designated *Z.* (*sporonites*) *igniculus* Potonié exPflug (1953) as the genotype of *Zonalapollenites*. He wrongly mentioned *C. dampieri* as the type species of *Callialasporites* Dev, while Dev (1961) clearly designated *C. trilobatus* as its genotype. He further suggested that while the genotype of *Applanopsis*, *A. lenticularis*, might be planktonic organnism, *A. dampieri* could not be so and that, if *Applanopsis* could be proved to be of nonplanktonic origin, *Applanopsis* would become a synonym of *Callialasporites*. He opined that *Cerebropollenites* Nilsson is different from *Zonalapollenites* Pflug.

Recently Jain (1969), Singh and Kumar (1969) and Venkatachala and Kar (1969) have studied the morphology and taxonomy of *Callialasporites*. Jain (*l.c.*) suggested that the genus is perinosaccate which is attached on one side of the body along the triradiate streak and almost free on the other side (Jain 1969, Text-Fig. 1) and is ornamented with minute or coarse granules or bacula. The radial folds may be distinct or absent and extend from the body region towards the periphery. He selected the species *trilobatus* as the type species of *Triangulopsis* Döring, while Döring has designated *T. discoidalis* as the genotype. Singh and Kumar (*l.c.*) followed Dettmann's view partly but they excluded *Triangulopsis* and *Cerebropollenites* from the limits of *Tsugaepollenites*. They considered *Callialasporites* as a synonym of *Triangulopsis* and emended the diagnoses of *Triangulopsis* as well as *Cerebropollenites*. The former has triangular to convexly triangular central body while the latter is circular to oval in shape and has highly vesiculate body exine so that the identity of the saccus appears to be completely obliterated by profuse proliferations. Goubin, Taugourdeau and Balme (1965) considered *Callialasporites* and *Pflugipollenites* as synonyms of *Applanopsis* and emended its diagnosis. This treatment has been accepted by Venkatachala and Kar (1969) regarding the genus *Applanopsis*. They have elaborated the diagnosis of *Applanopsis* whereby it is said to be subsaccate with saccus proximally equatorially and distally subequatorially attached to the body (Venkatachala & Kar 1969, Text-Fig. 1).

Gamerro (1965) studied the *in situ* pollen grains from the male cone of *Apterocladus lanceolatus* Archang., which has probably podocarpaceous affinity from the Lower Cretaceous of Argentina. Gamerro (*l.c.*) stated that these pollen grains are very much morphographically similar to *Zonalapollenites dampieri* Balme and *Z. trilobatus* Balme.

We agree with Pocock (1968) in considering *Callialasporites* as a well established and validly published genus. *Callialasporites* Dev has priority over *Applanopsis* Döring, *Triangulopsis* Döring and *Pflugipollenites* Pocock. However, in view of a

detailed study by us revealing some new features, the circumscription of the genus has been emended as above. The various species of *Callialasporites* described by Balme (1957), Dettmann (1963), Singh, Srivastava and Roy (1964), Sah and Jain (1965), Srivastava (1966), Singh and Kumar (1969) and Venkatachala and Kar (1969) are seemingly morphographically similar to the isolated pollen grains of *Apterocladus lanceolatus* Archang., as figured by Gamerro (*l.c.*). However, it is contended here that while *Zonalapollenites* and *Cerebropollenites* were presumably produced by pinaceous stock, chiefly *Tsuga* (See Potonié & Venitz 1934; Couper 1958), *Callialasporites* belongs to podocarpaceous stock, as evidenced by Gamerro (*l.c.*). Though, Singh and Kumar (1969) suspected araucarian affinity for *Callialasporites* on the basis of morphography of the pollen genus. *Araucariacites cooksonii* Singh *et al.* (1964) the same does not seem to hold good now.

We do not agree with Jain's view regarding the existence of a perinosaccus attached along the triradiate streak and free on the other side. It is no doubt that *Callialasporites* lacks a true saccus but the characters like vesiculation of the exine, presence of an equatorial frill and microsculptured ornamentation of the surface are certainly exinal characters and not perinal characters. The gradually loosening tendency of the exoexine from the intexine is evident variably in all the different species of *Callialasporites*. Dettmann (1963) demonstrated that the saccus is equatorially attached. Later, Venkatachala and Kar (1969) opined that the saccus is proximally equatorially attached and distally varyingly subequatorially attached. But it is observed by us that the saccus is variably subequatorially attached on both the proximal and distal faces.

Callialasporites trilobatus (Balme) Dev emend.

Pl. 1, Fig. 12

Synonyms — See Singh & Kumar 1969; p. 88.

Holotype — Balme 1957; Pl. 8, Fig. 91.

Emended specific diagnosis — Pollen grains 41-101 μ. Subtriangular in flattened condition. Central body triangular, ± convex sides and ± rounded angles. Alete. Exine two-layered, intexine thin. Saccus deeply notched appearing trilobed, ± 2 μ thick limboid margin, microbaculate or microverrucose. *Extrema lineamenta* microsculptured.

Remarks — The specimens of *C. trilobatus* (Balme) Dev emend., are smaller in size range (41-74 μ) in comparison to Balme's specimens of *C. trilobatus* which are 65-91 μ in diameter.

Distribution — *Callialasporites trilobatus* is known widely in the Upper Mesozoic strata of northern and southern hemispheres. In India, Sah and Jain (1965) have recorded it from the Jurassic beds of Rajmahal Hills, Bihar. Singh *et al.* (1964) have also recorded the species from Umia beds of Kutch. Venkatachala *et al.* (1969) have recovered it from the Upper Jurassic beds of Bhuj, Kutch (W. India). Dev (1961), Singh (1966) and Singh & Kumar (1969) have reported the same species from the Jabalpur Series, India. Lantz (1958), Hughes and Couper (1958) have described the species from the Upper Jurassic and Lower Cretaceous of Britain. Döring (1962) has recovered it from Upper Jurassic of Germany. Balme (1957) has reported it from the Upper Mesozoic sediments of Western Australia. Pocock (1962) has also recovered the species from Middle and Upper Jurassic of Canada. Dettmann (1963) has also recovered it from the Upper Mesozoic sediments of S.E. Australia.

Affinity — Gamerro (1965) has studied *in situ* pollen grains from the male cone of *Apterocladus lanceolatus* Archang. The specimen figured (in Pl. 2, Fig. 9) by Gamerro (*l.c.*) is very much comparable to *C. trilobatus*.

Callialasporites dampieri (Balme) Dev emend.

Pl. 1, Fig. 13

Synonyms — see Singh & Kumar 1969; p. 82.

Holotype — Balme 1957; Pl. 8, Fig. 88.

Emendea specific diagnosis — Pollen grains 58-78 μ. Circular to subcircular in flattened condition. Central body circular to subcircular. Alete, but sometimes a faint sinuous or undulating tetrad mark or ridge present which extends from pole to equator. Exine two-layered. Saccus 8-20 μ wide, slightly notched at radial regions,

radially folded, microverrucose and limboid thickening (2-3 μ) present at the margin.

Distribution — *C. dampieri* is widely distributed in the Mesozoic sediments of northern and southern hemispheres. The species is reported from Jurassic rocks of Rajmahal Hills, India by Sah and Jain (1965). Dev (1961), Singh *et al.* (1964) have recorded it from Sehora (Jabalpur Series and Umia Series), India respectively. Recently Venkatachala *et al.* (1969) have recorded the same species from the Upper Jurassic of Bhuj (W. India). In the Australian sediments, Balme (1957) has recorded it from the Jurassic, Cretaceous and Eocene of W. Australia as well as from Aptian-Albian of Papua beds. De Jersey (1959) has recorded it from the Lower Jurassic of Queensland. Dettmann (1963) has also described the species from the Upper Mesozoic deposits of SE. Australia. The species is also recorded from the Upper Mesozoic strata of Canada and Europe by Pocock (1962), Couper (1958) and Döring (1962) etc.

Affinity — Gamerro (1965) has recorded *in situ* pollen grains from the male cone of *Apterocladus lanceolatus* Archang., which are morphographically very much similar to *C. dampieri*. *A. lanceolatus* may be related to Podocarpaceae family as stated by *Gamerro* (*l.c.*).

Callialasporites segmentatus (Balme) Srivastava emend.

Pl 1, Fig. 14

Synonyms — See Singh & Kumar 1969; p. 86.

Holotype — Balme 1957; Pl. 9, Fig. 93.

Emended specific diagnosis — Pollen grains 46-82 μ. Subcircular in flattened condition. Central body subcircular. A faint triradiate ridge. Exine two-layered. Saccus 2·5 μ thick limboid margin, microverrucose and intense radially directed folds. *Extrema lineamenta* undulated and microsculptured.

Remarks — The present specimens of *C. segmentatus* are slightly bigger in size in comparison to Balme's specimens (44-60 μ). In this species it is difficult to measure the saccus attachment areas due to intense vesiculation.

Distribution — *C. segmentatus* was described from the Jurassic sediments of W. Australia by Balme (1957). De Jersey (1959 & 1963) has also recorded it from the Jurassic sediments of Queensland. Dettmann (1963) has also reported the species from Upper Mesozoic of SE. Australia. Sah and Jain (1965) have recorded the species from Bajocian-Oxfordian of Rajmahal Hills, India. Venkatachala *et al.* (1969) have reported it from Bhuj, W. India. Venkatachala and Kar (1969 & 1970) have reported it from the Katrol sediments (Upper Jurassic) of Kutch, India.

Callialasporites discoidalis (Döring) comp. nov.

Pl. 1, Figs. 15, 16

Synonym — 1962 *Triangulopsis discoidalis* Döring, Pl. 17, Figs. 1-3.

Holotype — Döring 1962; Pl. 17, Figs. 1-3.

Emended specific diagnosis — Pollen grains 58-79 μ. Subcircular in flattened condition. Central body triangular with flat corners. Proximally a faint triradiate mark. Exine two-layered. Saccus deeply notched, appearing trilobed, varyingly subequatorially attached, 2·5-3 μ thick limboid margin present and microbaculose. *Extrema lineamenta* microsculptured.

Distribution — Döring (1962) has described the species from the Upper Jurassic beds of Germany. Singh and Kumar (1969) have recorded its presence in the strata of the Jabalpur Series, India.

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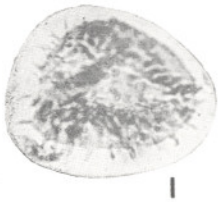
EXPLANATION OF PLATE I

(All photomicrographs are from unretouched negatives, magnified 500 ×).

1-2. *Neoraistrickia neozealandica* (Couper) Potonié emend., Regd. Sl. Nos. 3417/9, 3417/9.
3. *Matonisporites* Couper emend., Regd. Sl. No. 3419/1.
4-6. *Callispora potoniei* Dev emend., Regd. Sl. Nos. 3421/8, 3414/4 & 3416/5.
7-9. *Boseisporites praeclarus* Dev emend., Regd. Sl. Nos. 3416/8, 3414/6, 3416/1.
10-11. *Densoisporites mesozoicus* Singh *et al.* emend., Regd. Sl. Nos. 3421/10, 3421/3.
12. *Callialasporites trilobatus* (Balme) Dev. emend., Regd. Sl. No. 3252.
13. *C. dampieri* (Balme) Dev. emend., Regd. Sl. No. 3417/10.
14. *C. segmentatus* (Balme) Srivastava emend., Regd. Sl. No. 3418/8.
15-16. *C. discoidalis* (Döring) comb. nov., Regd. Sl. Nos. 3231, 3421/8.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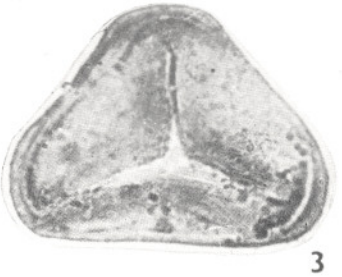
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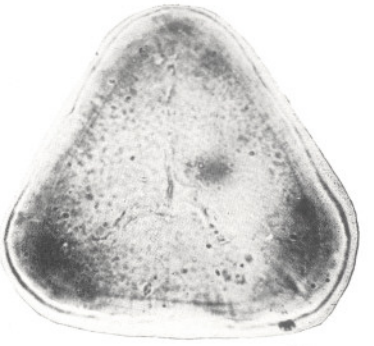
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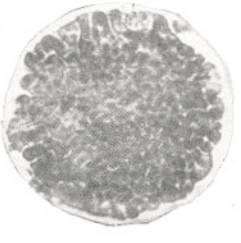
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