

# SOME NEW MIOSPORES FROM BARAKAR STAGE, LOWER GONDWANA, INDIA

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## ABSTRACT

Three new miospore genera, viz. *Callumispora*, *Brevitriletes* and *Pseudoreticulatispora* have been described from the Barakar Stage (Lower Permian) of Lower Gondwana Formations, India. *Callumispora* is a thick and intrapunctate exined, spherical, trilete spore with pits and verrucae in the inter-ray area. *Brevitriletes* is spinose sculptured distally only. *Pseudoreticulatispora* is a trilete, triangular spore with the exine uniformly pitted and the pit bottoms connected with those adjacent, through canals, giving an over all effect of a reticulate pattern to the exine in low magnifications.

## INTRODUCTION

THREE trilete miospore genera occurring characteristically in some horizons of the Lower Gondwanas of India, have been described. Study of the miospores dispersed in the coals of Chirmiri, Sohagpur and Bistrampur Coalfields, M.P., and Talcher Coalfield, Orissa have revealed some new associations of morphographical characters in trilete spores which are described here.

Many workers have described trilete miospores from the Lower Gondwana Formations. Balme and Hennelly (1956) have described trilete miospores from the Permian of Australia. Bharadwaj (1962) and Bharadwaj and Salujha (1964a) have added a number of trilete genera to the miospore assemblage of Permian Age. Tiwari (1965) has described some more trilete genera from the Barakar Stage of India.

## MATERIAL

The material for the present investigation consisted of coal from Chirmiri, Sohagpur and Bistrampur Coalfields, Madhya Pradesh and Talcher Coalfield, Orissa, in India.

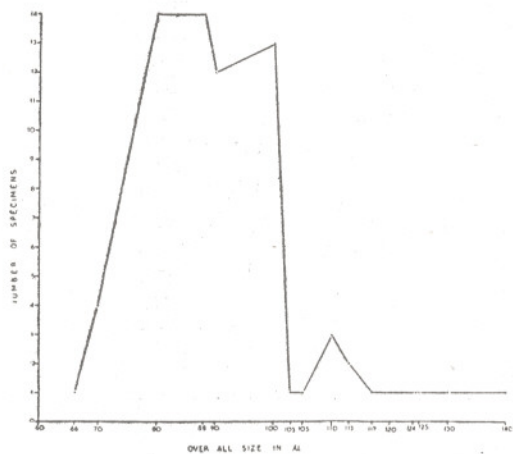
## Genus — *Callumispora* gen. nov.

*Genotype* — *Callumispora barakarensis* sp. nov.

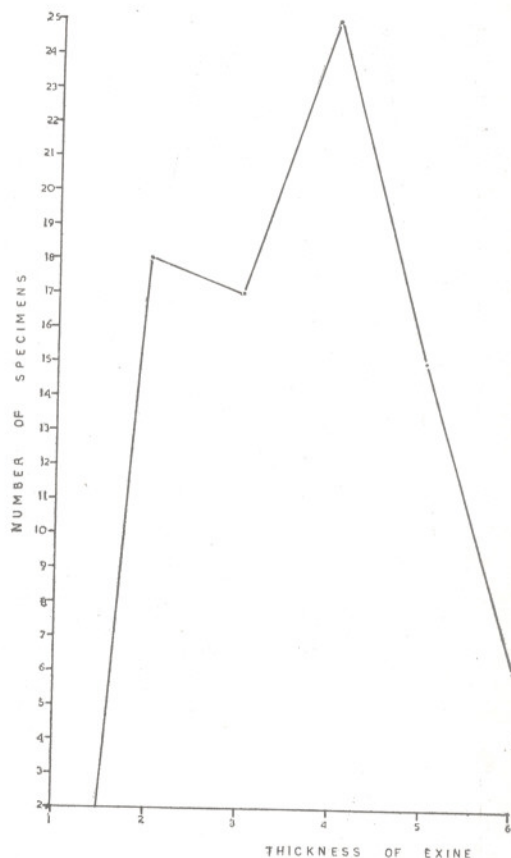
*Diagnosis* — Circular, dark brown miospores; exine laevigate with tendency to become punctate and microverrucose in inter-ray area and elsewhere intrapunctate; exine 2-7  $\mu$  thick; trilete mark present.

*Description* — Amb is circular; subcircular or roundly triangular shapes may be assumed due to folding or flattening. The plane of flattening of the spore is not constant as is apparent from inconsistent position of the trilete mark with reference to the equator of the flattened spore. Trilete mark is well-defined and never reduced or vestigial. Rays are straight and equal to each other in length and are placed at equal angles. Labra are thin and vertex is slightly raised. Exine is fairly thick, the thickness being distinctly visible in optical section along the equatorial margin in flattened specimens. Exine shows various degrees of intrapunctate structure in different part of specimens. In the inter-ray area the structure consists of sparsely distributed puncta but elsewhere it is uniformly, hazily fine or distinctly fine. The exine is normally laevigate but in some forms the inter-ray area is microverrucose sculptured apparently differentiating a contact area of the miospores (Pl. 2, FIG. 1). The exine is usually quite thick. In certain species the exine is stratified into two layers.

A large number of specimens have been studied and variations in their overall shape, size, exine thickness and their ornamentation have been noted. Variations in the overall size have been illustrated in graph 1 which range from 66  $\mu$  to 140  $\mu$ . The curve shows 3 distinct modes; one at 80  $\mu$  and the other two at 100  $\mu$  and 110  $\mu$  respectively. Thus, the curve tends to show more than one taxon. The variation



GRAPH 1—SHOWING THE VARIATION PATTERN IN THE OVERALL SIZE IN THE SPECIMENS OF CALLUMISPORA.



GRAPH 2—SHOWING THE VARIATION PATTERN IN THE THICKNESS OF EXINE IN CALLUMISPORA

in the thickness of exine has been given in graph 2. This curve also possesses more than one mode. The thickness of exine ranges from  $1.5 \mu$  to  $6 \mu$  and the curve attains two maxima ( $2 \mu$  and  $4 \mu$  respectively). In graphs 3 and 4 these curves have further been elaborated, in order to explain the variations with greater exactitude, after separating the curves for a morphologically distinguishable group of specimens which have an exine thickness ranging from  $3-6 \mu$  with a maximum at  $5 \mu$  and its overall size ranging from  $88-140 \mu$  from the rest which still show two modes. The thickness of exine in the latter ranges from  $1.5-3 \mu$  and  $3-5 \mu$  respectively and their overall size ranges from  $66-90 \mu$  and  $80-105 \mu$  in a similar manner (GRAPH 5). In graph 6 the overall size and the thickness of exine of miospores have been bimetrically represented. The figure shows evidence of three distinct taxa in the assemblage. These taxa have been described as two species and a variety.

**Comparison**—*Callumispora* gen. nov. resembles *Punctatisporites* (Ibr.) Pot. & Kr., which as diagnosed by Potonié and Kremp (1954) would normally include the forms presently described here. However, as compared to the genotype of *Punctatisporites*, *P. punctatus* Ibr., *Callumispora* distinguishes by its circular amb, differential intra-punctate structure and the characteristic thickness of exine. *Eupunctatisporites* Bharad. (1962) possesses distinct puncta

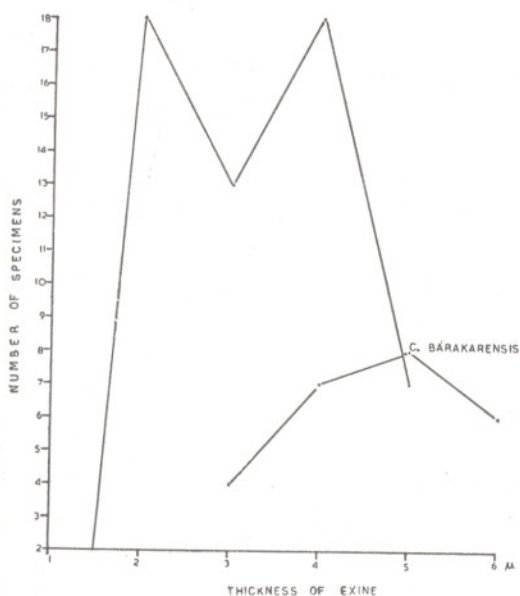
distributed all over the surface and a circular shape with equal rays. *Ricaspora* Bharad. & Sal. (1964) has a thin granulose perispodium around it quite unlike the new genus suggested here. *Retusotriletes* Naum. (1953) possesses a distinct, unstructured contact area.

Spores, similar to *Callumispora* gen. nov., have been described from different localities of Lower Gondwana Formations. These may be referred to this genus as comb. nov.

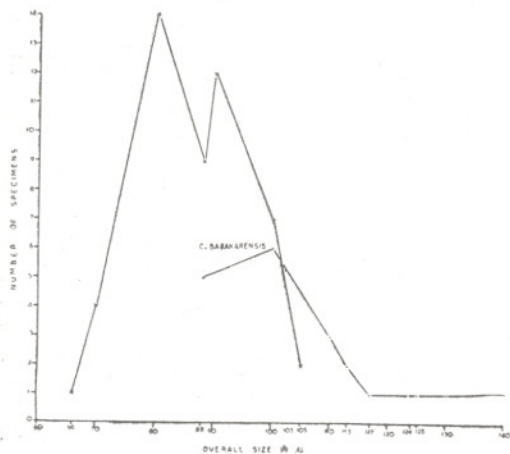
Balme (1963) — *Punctatisporites fungosus*, pl. 4, figs. 10-11; from Lower Triassic, Western Australia.

Balme & Hennelly (1956) — *Punctatisporites gretensis*, pl. 2, figs. 11-13; from Greta Coal Measures, Permian; Australia.

Balme & Hassel (1962) — *Punctatisporites iterabilis*, pl. 1, fig. 3; from Upper Devonian; Western Australia.



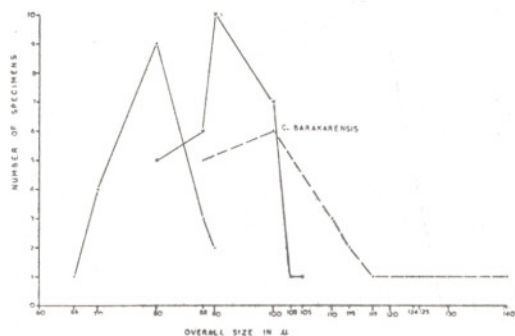
GRAPH 3—SHOWING VARIATION PATTERN IN THICKNESS OF EXINE IN VARIOUS SPECIES OF CALLUMISPORIA



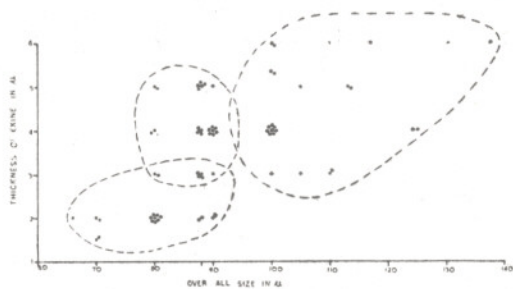
GRAPH 4—SHOWING THE VARIATION PATTERN IN OVER ALL SIZE IN VARIOUS GROUPS OF SPECIES OF CALLUMISPORIA

Datta (1957) — *Punctatisporites* sp., fig. 27; from Jhagrakhand area, Madhya Pradesh; India.

Guennel (1958) — *Punctatisporites* cf. *obesus*, pl. 4, fig. 9; from Potsville coals of Indiana—The exine is thick and the appearance is suggestive of *Callumispora*



GRAPH 5—SHOWING VARIATION PATTERN IN OVERALL SIZE IN VARIOUS SPECIES OF CALLUMISPORIA



GRAPH 6—SHOWING BIMETRIC ANALYSIS OF SPECIES OF CALLUMISPORIA

but a final assignment depends upon the existence of differential structure in the exine especially the sparse intrapunctation in the inter-ray area.

Peppers (1964) — *Punctatisporites* sp. 2, pl. 5, fig. 8; *Punctatisporites* sp. 4, pl. 5, fig. 10; from Late Pennsylvanian Cyclothems, Illinois Basin. These spores appear to belong to *Callumispora*. However, their final assignment needs confirmation of the differential exine structure in them.

*Reconstruction* — See Text-Fig. 1.

*Callumispora barakarensis* sp. nov.

Pl. 1, Figs. 1, 2

*Holotype* — Pl. 1, Fig. 1; Reg. No. 2904; Slide No. 11/2.

*Isotype* — Pl. 1, Fig. 2; Reg. No. 2978; Slide No. V/2.

*Locus Typicus* — India (Orissa); Nandira Colliery, Talcher Coalfield.

*Stratum Typicum* — Lower Barakar Stage (Lower Permian), Lower Gondwana; India.



TEXT-FIG. 1 — Semi-diagrammatic representation of *Callumispora* gen. nov. in polar view.

Number of specimens studied — 25.

**Diagnosis** — Circular, thick-walled trilete, size range 88-140  $\mu$  but mostly 100  $\mu$ . Trilete mark distinct, rays equal, 30-40  $\mu$  in length. Exine golden brown, 4-6  $\mu$  in optical section, stratified and laevigate. Inter-ray area microverrucose sculptured. Exine faintly structured all over but showing sparsely distributed intrapunctation in the inter-ray area.

**Description** — Miospores are circular, holotype is 117  $\mu$  in diameter. Trilete mark is distinctly defined, arms are equal, each being 40  $\mu$  in length, extending more than three fourth of body radius and the rays end abruptly. Labra is thin, simple and is never associated with secondary exinal folds. It is frequently ruptured, the opening showing the exine thickness. Vertex is slightly raised. Exine is fairly thick, 4-6  $\mu$  in thickness, 6  $\mu$  thick in optical section in the holotype. Exine is slightly thicker along the trilete rays than in the inter-ray area, otherwise it is proximally as thick as near the equator just beyond the inter-ray area. In optical section exine appears stratified, divisible into two layers; the inner, thick, darker brown layer and the outer, thin, yellowish brown layer. Inter-ray area is marked sparsely with big intrapuncta and on the surface with microverrucose sculpture, apparently suggesting an *area contagionis*. Exine beyond the contact area is faintly structured. *Extrema lineamenta* is smooth.

*Callumispora tenuis* sp. nov.

Pl. 1, Figs. 3-6

**Holotype** — Pl. 1, Fig. 3, Reg. No. 2930, Slide No. 15/4.

**Isotype** — Pl. 1, Fig. 4, Reg. No. 2937, Slide No. 16/1.

**Locus Typicus** — India (Orissa); Deulbera Colliery, Talcher Coalfield.

**Stratum Typicum** — Lower Barakar Stage (Lower Permian), Lower Gondwana; India.

Number of specimens studied — 34.

**Diagnosis** — Circular, thick walled, dark brown trilete miospores, size range 80-105  $\mu$  but mostly 90  $\mu$ . Trilete mark distinct. Inter-ray area sparsely intrapunctate. Exine 3-5  $\mu$  thick. *Extrema lineamenta* smooth.

**Description** — Miospores are circular to subcircular. Holotype is proximally up and 88  $\mu$  in size. Trilete mark is well-defined, rays are equal in length and placed on equal angles. Each ray is 33  $\mu$  long, more than two third body radius. The ray ends are tapering. Labra are thin and simple, frequently ruptured and vertex is slightly raised. Exine is fairly thick, usually 4  $\mu$  in thickness along the margin in holotype, nonstratified without any recognizable differentiation into two layers and is generally thicker in the inter-ray area which is sparsely intrapunctate but usually more along the rays and in the angles. Contact area is not defined. Exine is elsewhere almost smooth but for sparse and very shallow undulations. *Extrema lineamenta* is smooth.

**Comparison** — *Callumispora tenuis* differs from *C. barakarensis* in having slightly smaller size, nonstratified exine and undifferentiated contact area.

*Callumispora tenuis* var. *minor* var. nov.

Pl. 1, Figs. 5, 6

**Var. Holotype** — Pl. 1, Fig. 5, Reg. No. 2946, Slide No. 18/2.

**Var. Isotype** — Pl. 1, Fig. 6, Reg. No. 2930, Slide No. 15/4.

**Locus Typicus** — India (Orissa); Deulbera Colliery, Talcher Coalfield.

**Stratum Typicum** — Lower Barakar Stage (Lower Permian), Lower Gondwana; India.

*Number of specimens studied* — 24.

*Diagnosis* — Amb circular, known size range 66-90  $\mu$  but mostly 80  $\mu$ ; trilete mark distinct; exine thin, golden brown, non-structured. *Extrema lineamenta* smooth.

*Description* — Miospores are circular to subcircular in outline, holotype is 80  $\mu$  in diameter. Trilete mark is well-defined, rays equal in length, traversing more than three fourth body radius, ending bluntly before the equator and are placed at equal angles. Labra are thin, vertex is slightly elevated, more at the apex as well as at the ends. Inter-ray area are faintly intrapunctate, elsewhere structure is not seen. Exine surface is smooth but with very shallow and sparse undulations. Exine is 2  $\mu$  thick all over. *Extrema lineamenta* is smooth.

*Comparison* — *Callumispora tenuis* var. *minor* is different from the other two taxa described here in being smaller in size. Exine is much thinner as compared to the thicker exine of *C. barakarensis* and *C. tenuis* and it does not show any stratification at the same time. Inter-ray exine is faintly intrapunctate in contrast to the well defined microverrucose-intrapunctate exine of *C. barakarensis*.

#### Genus — *Brevitriletes* gen. nov.

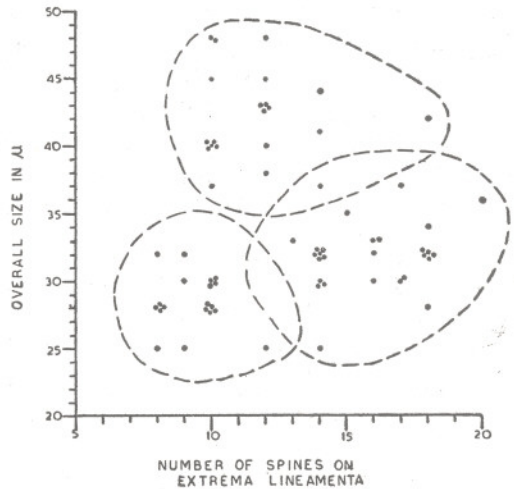
*Genotype* — *Brevitriletes communis* sp. nov.

*Diagnosis* — Amb subtriangular to sub-circular, trilete miospores with compound spines present on the distal face only.

*Description* — Miospores are subtriangular with broadly rounded angles and sides are slightly convex, sometimes bulging out thus rendering the overall shape of miospore subtriangular to subcircular. Trilete mark is distinct, rays extend always more than three fourth the spore radius and are associated with secondary folds. Ray ends are sharply pointed or bifurcating. Labra is thin and vertex is low. Exine is thin to thick, light yellow and is ornamented with sparsely to closely set spines over the distal surface of the miospore. Proximally the exine is smooth. Spines are longer than broad at the base and the apex is rounded, rarely blunt but never attenuated or sharply pointed like true spines. The tips mostly subtend a curved, easily detachable appendage (TEXT-FIGS. 3, 4).

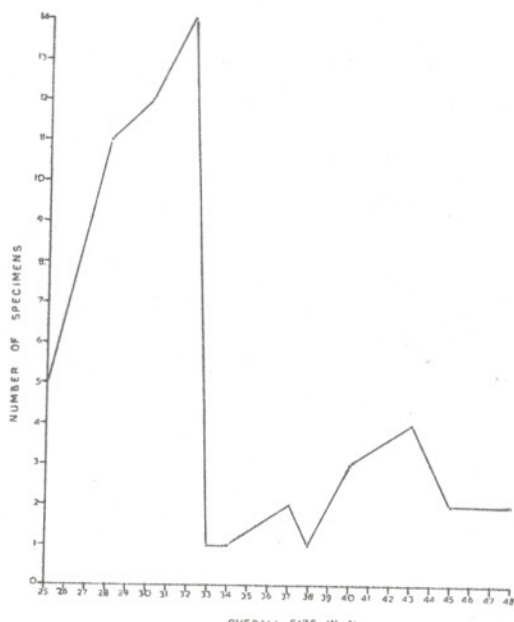
The specimens observed exhibit a large variation in their overall shape, size and distribution of spines. In order to resolve

such differences, numerous specimens have been studied. A bimetric resolution of the specimens is shown in graph 7. There is evidence of three taxonomic groups of miospores. The size of the specimens ranges from 25-48  $\mu$  and the number of spines on the distal surface ranges from 8-20. However, the analysis of their overall size in Graph 8 also shows more than one mode. The curve in this figure attains a maximum at 32  $\mu$ . From here it again rises and attains another maximum at 43  $\mu$ . This curve has been further elaborated in Graph 9 where it becomes evident that it consists of 3 distinct groups; 38-48  $\mu$ , 25-44  $\mu$  and 25-37  $\mu$ . From the present data all the specimens seem to overlap in their overall size, but when it is compared with the distribution of spines it becomes more apparent that three distinct taxa exist in these miospores.

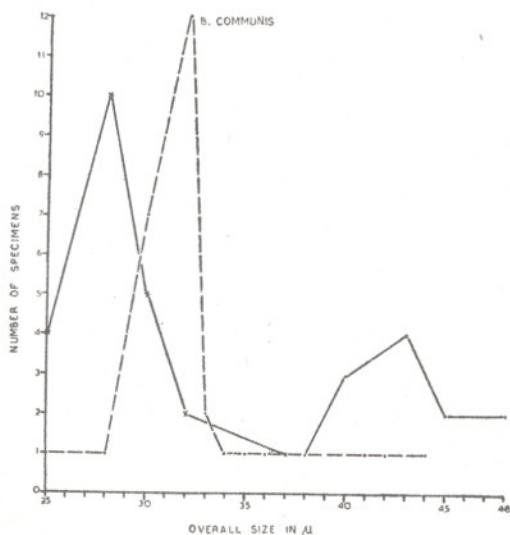


GRAPH 7—SHOWING BIMETRIC ANALYSIS OF SPECIES OF *BREVITRILETES*

*Comparison* — This genus is fairly present in the Lower Gondwana coalfields of India. *Acanthotriletes* (Naum.) Pot. & Kr. differs in having sharply pointed spines. *Lophotriletes* (Naum.) Pot. & Kr. possesses conical spines all over the surface. *Horriditriletes* Bharad. & Sal. is distinctly different from the present genus in being a trilete miospore with slightly curved and long bacula all over the exine. *Neoraistrickia* Pot. is a subcircular spore with thick and baculate exine. *Microbaculispora* Bharad. is organizationally different from this genus in having closely



GRAPH 8—SHOWING COMPOSITE VARIATION PATTERN IN THE SPECIMENS OF BREVI TRILETES



GRAPH 9—SHOWING CLASSIFIED VARIATION WITHIN INDIVIDUAL SPECIES OF BREVI TRILETES

set, fine bacula for sculpture. *Apiculatisporis* Pot. distinguishes itself from *Brevitriletes* gen. nov. in having circular shape with spines distributed all over the surface. *Brevitriletes* is characterized by the presence

of blunt spines restricted to the distal surface of the miospore. *Anaplanisporites* Janson. (1962) seems to compare very closely with *Brevitriletes* due to the restriction of ornamentation  $\pm$  to the distal surface in both. However, the genotype of *Anaplanisporites*, *A. telephorus* (Kl.) Janson. as well as the only other species of the genus, *A. stipulatus* Janson., have a well demarcated, arcuate, area *contagionis* in which the exine is smooth but elsewhere it is ornamented. Actually the ornamentation covers the subequatorial region on the proximal face as well. The nature of ornamentation is also different between *Anaplanisporites* and *Brevitriletes*.

The following specimens are now referable to *Brevitriletes* gen. nov.

Bhattacharya (1959) — *Raistrickia*, figs. 6, 7 from Barakar coals, Kurasia Seam, Kurasia Colliery; India.

Ganguly (1959) — *Raistrickia*, fig. 9 from Barakar coals, Ponri Colliery near Chirmiri, Madhya Pradesh; India.

Tiwari (1965) — cf. *Horriditriletes unicus*, pl. 1, figs. 28-30; *Apiculatisporis levis*, pl. 1, figs. 17, 18 from Barakar Stage (Lower Gondwana); India.

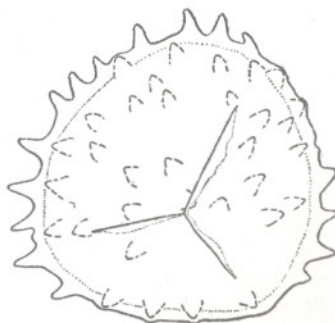
*Derivation of Name* — The name of the genus relates to the smallness of the spines.

*Reconstruction* — See Text-fig. 2.

*Brevitriletes communis* sp. nov.

Pl. 1, Figs. 12-16

1965—*Apiculatisporis levis* Balme & Henn., Tiwari, pl. 1, figs. 17, 18.



TEXT-FIG. 2 — Semi-diagrammatic representation of *Brevitriletes* gen. nov. in polar view.

*Holotype* — Pl. 1, Fig. 12; Reg. No. 2940; Slide No. 16/4.

*Isotype* — Pl. 1, Fig. 13; Reg. No. 2940; Slide No. 16/4.

*Locus Typicus* — India (Orissa); Talcher Coalfield, South Belanda Colliery.

*Stratum Typicum* — Lower Barakar Stage (Lower Permian), Lower Gondwana; India.

*Number of specimens studied* — 19.

*Diagnosis* — Subtriangular to subcircular trilete, known size range 25-44  $\mu$ ; spines short, compactly arranged.

*Description* — Miospores are trilete with subtriangular to subcircular overall shape; sides are usually convex bulging outside, holotype size is 37  $\mu$ . Trilete mark is usually distinct but sometimes may be subdued due to compact arrangement of spines. Arms are equal extending up to the angles but end shortly before the equator and ray ends are arcuate. Contact area is faintly discernible. Labra are thin and simple and vertex is slightly elevated. Exine is up to 3  $\mu$  thick in optical section and equatorial thickening is distinctly defined. Exine is ornamented with compactly arranged compound spines on the distal face. Spines are characteristically shorter than broad at base, with rounded apex and are attached at the tip with a sharply pointed, curved and filiform appendage (TEXT-FIGS. 3, 4). Usually 14-20 spines are present on the *extrema lineamenta*.

*Brevitriletes unicus* (Tiwari, 1965) comb. nov.

Pl. 1, Figs. 7-11

1965 — Cf. *Horriditriletes unicus* sp. nov., Tiwari, pl. 1, figs. 28-30.

*Holotype* — Tiwari, 1965, pl. 1, fig. 30.

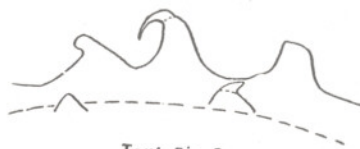
*Locus Typicus* — India (Bihar); Korba Coalfield, [498(D)E Bore-hole G-22].

*Stratum Typicum* — Barakar Stage (Lower Permian), Lower Gondwana; India.

*Number of specimens studied* — 16.

*Diagnosis* (emend.) — Subtriangular trilete miospore, known size range 38-48  $\mu$ , angles broad, sides slightly convex. Exine thin, ornamented with blunt spines only on the distal face. Trilete mark distinct.

*Description* — Miospores are triangular in overall shape, usually subtriangular shape is assumed due to bulging out of the lateral sides; holotype size is 43  $\mu$ , angles are broad



Text Fig. 3



Text Fig. 4

TEXT-FIGS. 3 & 4 — Semi-diagrammatic representation of the structure of spines in *Brevitriletes* gen. nov.

and the sides are slightly convex. Exine is thin to mediumly thick (1-2  $\mu$ ), and is slightly yellow in colour. Proximal surface is marked with a distinct trilete mark, arms are equal in length ending shortly before the equator into the angles, ends being tapering. Labra are thin, vertex is slightly raised and associated with thin secondary exinal folds. Distal surface is ornamented with sparsely set spines (PL. 1, FIG. 8) having rounded tips hereto referred as blunt spines. Spines are longer than the basal width, usually 2-6  $\mu \times$  2-4  $\mu$  in size, sparsely spaced, all spines pointing towards the equator. Usually 10-14 spines are present on the *extrema lineamenta*. Proximally the ornamentation is absent (PL. 1, FIG. 7).

*Comparison* — *Brevitriletes unicus* differs from *B. communis* in having larger size and sparsely set ornamentation.

*Brevitriletes levis* (Balme & Henn.) comb. nov.

Pl. 1, Figs. 17-20

1956 — *Apiculatisporis levis* n. spm., Balme & Hennelly, pl. 2, figs. 19-21.

*Lectotype* — Balme & Hennelly, 1956; pl. 2, fig. 20.

*Locus Typicus* — Main seam, Proprietary Colliery, Collie Horizon, Collie, W. A.

*Stratum Typicum* — Collie Horizon (Lower Permian), Lower Gondwana; Western Australia.

*Number of specimens studied* — 27.

*Diagnosis* — Circular to subcircular, small trilete miospores, size range 25-37  $\mu$ ; trilete mark distinct; exine thin, equatorial thickening well-defined, spines small and sparsely set on the distal face.

*Description* — Miospores are circular to subcircular in overall shape and small in size. Our specimens range in size from 25-37  $\mu$ . Trilete mark is distinctly discernible, rays are pointing towards the angles, ends are arcuate and terminate shortly before the equator. Labra are slightly thick and vertex elevated. Exine is generally thin, equatorially a 1  $\mu$  or less wide thickening is well-defined. Distally the exine is ornamented with small compound spines having an apical appendage. Spines are short, 1  $\mu$  in length and sparsely distributed. Usually 8-13 spines are present on the *extrema lineamenta*.

*Comparison* — *Brevitriletes levis* is different from the other species described in having the smallest size and minute, sparsely set spines on the distal face.

**Genus** — *Pseudoreticulatispora* gen. nov.

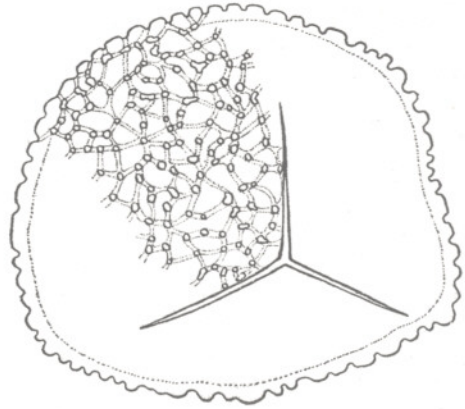
*Genotype*—*Pseudoreticulatispora barakarensis* sp. nov.

*Diagnosis* — Amb triangular, trilete miospore, sides convex, exine punctato-reticuloid giving an appearance of a pseudoreticulum.

*Description* — Miospores are triangular, sometimes subtriangular, angles are broad and sides convex, bulging outside but never assuming a circular shape. Trilete mark is distinctly defined, rays are equal, usually more than three fourth body length and mostly extend into the angles ending shortly before the equator. Labra are thick, vertex is high, generally raised above the body level and is associated with thick secondary folds throughout whole length of the rays. Exine is thick, dark brown in colour, pitted (Punctate; PL. 2, FIG. 2) and the bases of puncta coalesce with those of the adjacent ones inside the exine (PL. 2, FIG. 3). This sculpture when seen in the middle focus gives the idea of a reticulum which in fact is a pseudoreticulum. This sculpture is named herewith as punctato-reticulate.

*Reconstruction* — See Text-Fig. 5.

*Comparison* — Among the trilete miospores described so far no such organization has been illustrated. *Microfoveolatispora*



TEXT-FIG. 5 — Semi-diagrammatic representation of *Pseudoreticulatispora* gen. nov. in polar view.

Bharadwaj differs from the present genus in having a positively reticulate sculpture with low muri and shallow meshes disally on the exine. *Microreticulatisporites* (Knox) Bharad. forms distinct reticulum with well-defined, high muri. *Granulatisporites* (Ibr.) Pot. & Kr. is different in having grana over the exine. *Microbaculispora* Bharad. has distinctly baculate ornamentation.

Balme and Hennelly (1956, PL. 4, FIGS. 42-44) have described a similar miospore as *Verrucosisporites pseudoreticulatus*. The exine character from its photomicrograph appears to be similar to that of our specimens. However, Balme and Hennelly (*l.c.*) have described the same as "Exine 2-3  $\mu$  thick, ornamented with closely packed, low, dome-shaped protuberances, 2-3  $\mu$  in basal diameter and 1-3  $\mu$  high". For our specimens too the sculpture can be similarly described but under oil immersion objective it clearly shows a punctato-reticuloid exine instead. In optical section the puncta cause to give an appearance of verruca or grana. Hart (1960) also described a similar specimen as *V. pseudoreticulatus* which is now referable to *Pseudoreticulatispora* as *P. pseudoreticulata* (Balme & Hennelly) comb. nov.

In this connection one of us (Bharadwaj) wishes to point out the fact that he (BHARADWAJ, 1962; p. 82) considered *V. pseudoreticulatus* as species of *Microfoveolatispora* which is untenable now. Under these circumstances the specimens (BHARADWAJ, 1962; PL. 2, FIGS. 43, 44) then confused for *V. pseudoreticulatus* should



be recognized as a new species of *Microfoveolatispora*, viz. *M. media* Bharadwaj, with the first illustrated specimen as the holotype. The emended diagnosis given for *M. pseudoreticulata* by Bharadwaj (1962; p. 82) is suggested as the diagnosis for *M. media*.

The following synonyms are now referable to *Pseudoreticulatispora* gen. nov.

Bhattacharya *et al.*, 1957 — *Granulatisporites*, pl. 1, figs. 5 & 10 from Raniganj and South Karanpura coalfields.

Ganguly, 1959 — *Granulatisporites*, fig. 2 from Barakar coals of Ponri Colliery near Chirmiri, Madhya Pradesh, India.

*Stratigraphical Range* — So far this genus has been reported from Lower Barakar Stage in India, Greta Coal Measures, N.S.W. (Australia) and Ketewaka-Mchuchuma coalfield, Tanganyika.

*Pseudoreticulatispora barakarensis* sp. nov.

Pl. 1, Figs. 21, 22

*Holotype* — Pl. 1, Fig. 21; Reg. No. 2855; Slide No. 21/1.

*Isotype* — Pl. 1, Fig. 22, Reg. No. 2863, Slide No. 2/3.

*Locus Typicus* — India (Madhya Pradesh), Katkona block, Sohagpur coalfield.

*Stratum Typicum* — Barakar Stage (Lower Permian), Lower Gondwana; India.

*Number of specimens studied* — 18.

*Diagnosis* — Triangular miospore, sides convex, size range 51-88  $\mu$ , angles broadly rounded. Trilete mark distinct, rays extending near the equator, associated with folds. Exine thick, dark brown, punctato-reticulate.

*Description* — Miospores are triangular when normally flattened, angles rounded and sides are convexly bulging outwards, holotype size is 70  $\mu$ . Exine is 2-3  $\mu$  thick in optical section, nonstructured and is

punctato-reticulate ornamented. Puncta are coalescing with one another at the base forming a false reticulum. Puncta along the rays are fused, thus forming a thick surface along the arms of trilete. Trilete mark is well-defined, rays are associated with secondary folds all along its length and ends are tapering shortly before the equatorial margin. It is only perceptible when it is associated with secondary folds or teared open. Labra is thick, vertex is raised highly above the surface of the body.

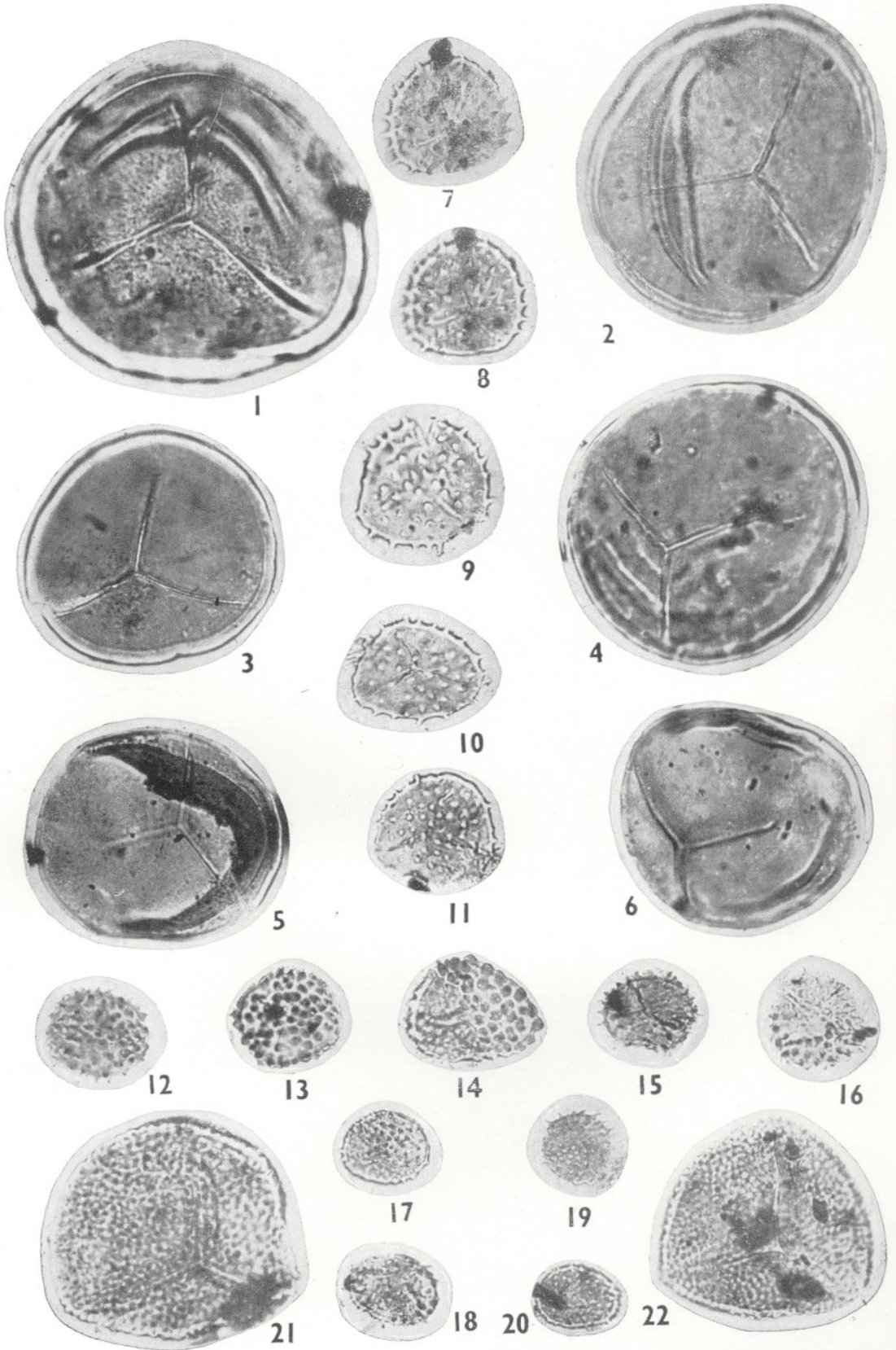
*Comparison* — The only other known species of *Pseudoreticulatispora* is *P. pseudoreticulata* (Balme & Henn.) comb. nov. of which the overall size ranges from 63-115  $\mu$  and the mean size is 81  $\mu$ . On the other hand the overall size of *P. barakarensis* ranges from 51-88  $\mu$  and the mean size is only 70  $\mu$ . We consider this difference coupled with the geographical separation of the loci-typica as sufficient to recognize these as two distinct species.

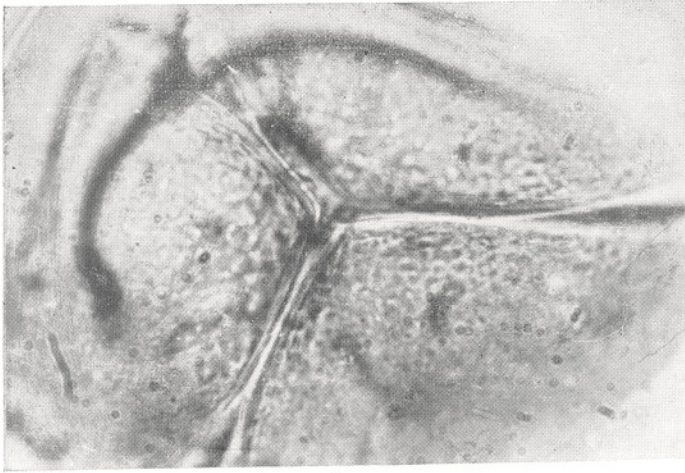
## DISCUSSION

*Brevitriletes* gen. nov., *Pseudoreticulatispora* gen. nov. and *Callumispora* gen. nov., have very frequently been found to occur in the coals of Lower Gondwanas in India, but as they occur in very low percentages they have been neglected so far and were described in some form or the other. Now a detailed study of a number of specimens collected from Chirmiri, Bisrampur, Sohagpur Coalfields, Madhya Pradesh and Talcher Coalfield, Orissa, have been undertaken. This has revealed a number of new morphological characters which allow them to be separated from the described ones. Punctato-reticuloid nature is a new feature observed amongst the sculptural elements of the spore exine.

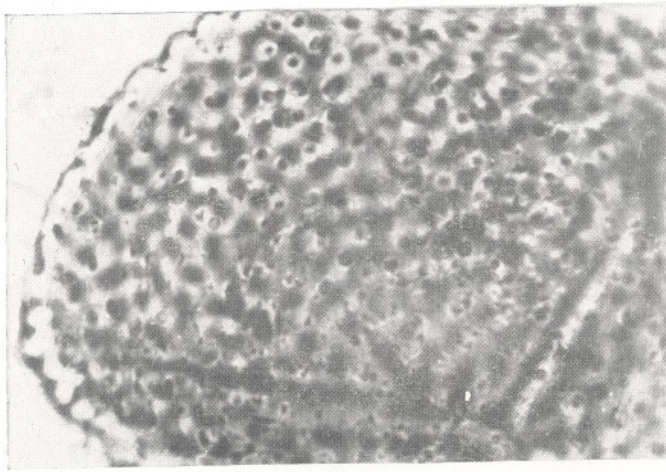
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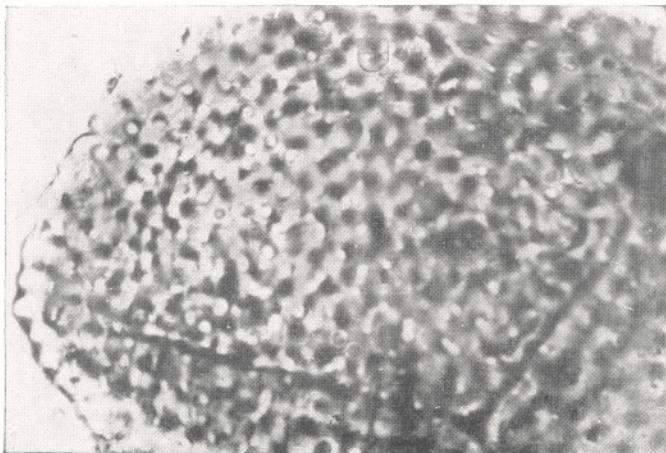


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## EXPLANATION OF PLATES

## PLATE 1

(All magnifications  $\times$  500)

1. *Callumispora barakarensis* sp. nov., Holotype; Slide No. 11/2; Reg. No. 2904.
2. *Callumispora barakarensis* sp. nov., Isotype; Slide No. V/2; Reg. No. 2978.
3. *Callumispora tenuis* sp. nov., Holotype; Slide No. 15/4; Reg. No. 2930.
4. *Callumispora tenuis* sp. nov., Isotype; Slide No. 16/1; Reg. No. 2937.
5. *Callumispora tenuis* var. *minor* var. nov., Holotype; Slide No. 18/2; Reg. No. 2946.
6. *Callumispora tenuis* var. *minor* var. nov., Isotype; Slide No. 15/4; Reg. No. 2930.
7. *Brevitriletes unicus* (Tiwari) comb. nov., Proximal view; Slide No. 2/5; Reg. No. 2854.
8. *Brevitriletes unicus* (Tiwari) comb. nov., Distal view; Slide No. 2/5; Reg. No. 2854.
9. *Brevitriletes unicus* (Tiwari) comb. nov., Isotype — Distal view; Slide No. 15/4; Reg. No. 2930.
- 10, 11. *Brevitriletes unicus* (Tiwari) comb. nov., Distal view; Slide No. 7/10; Reg. No. 2852, Slide No. 16/4; Reg. No. 2940.
12. *Brevitriletes communis* sp. nov., Holotype — Proximal view; Slide No. 16/4; Reg. No. 2940.
13. *Brevitriletes communis* sp. nov., Isotype —

- Proximal view; Slide No. 16/4; Reg. No. 2940.
- 14, 15, 16. *Brevitriletes communis* sp. nov., Slide No. 15/6; Reg. No. 2932; Slide No. 16/4, Reg. No. 2940; Slide No. 16/1; Reg. No. 2937.
  17. *Brevitriletes levis* (Balme & Henn.) comb. nov. Slide No. 16/4; Reg. No. 2940.
  18. *Brevitriletes levis* (Balme & Henn.) comb. nov. Slide No. 16/4; Reg. No. 2940.
  - 19, 20. *Brevitriletes levis* (Balme & Henn.) comb. nov.; Slide No. V/1; Reg. No. 2977; Slide No. 18/1; Reg. No. 2945.
  21. *Pseudoreticulatispora barakarensis* sp. nov., Holotype; Slide No. 21/1; Reg. No. 2855.
  22. *Pseudoreticulatispora barakarensis* sp. nov., Isotype; Slide No. 2/3; Reg. No. 2863.

## PLATE 2

1. *Callumispora barakarensis* sp. nov., Inter-ray area showing the puncta in structure and verrucae in sculpture. 1,000  $\times$ .
2. *Pseudoreticulatispora barakarensis* sp. nov., Exine in top-focus showing puncta. 1,000  $\times$ .
3. *Pseudoreticulatispora barakarensis* sp. nov., Exine in middle-focus showing the bases of puncta interconnected with the adjacent ones and thus forming a false reticulum. 1,000  $\times$ .