MEGASPORES FROM THE WEST BOKARO COALFIELD (LOWER GONDWANAS) OF BIHAR

INTRODUCTION

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PART 1 — MEGASPORES FROM THE PINDRA COAL SEAM

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PART 2—MEGASPORES FROM THE DATMA AND MANGARDAHA COAL SEAMS

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INTRODUCTION

PALAEOZOIC megaspores from Europe and North America have now been known for a long time and in recent years a good deal of literature has been published on them. In India, however, microspores from the Palaeozoic beds were studied by a number of workers, but the study of megaspores has still remained a virgin field. Mehta (1943), Pant (1947), Trivedi (1950) and Goswami (1951) have only put on record the occurrence of megaspores from Singrauli, Talchir, Mirzapur and Vindhya Pradesh coalfields respectively. But no detailed description has so far been published. From the other geological horizons, Sahni *et al.* (1947) have recorded a trilete megaspore from the Tertiary rocks of Assam and Sitholey (1943) described a new species of *Triletes* (*T. Sahnii*) from the Triassic of the Salt Range, Punjab. His specimens were only casts and hence their morphological description could not be a comprehensive one.

Indian Lower Gondwana coal, which, presumably, was formed from the *Glossopteris* flora, is admittedly not so rich in megaspores as European or North American coal, which was formed from *Lepidodendron* flora of the coal measures. From our experience on Indian coal we have found that some coal seams are exceptionally rich in megaspores while others are extremely poor. Nevertheless the megaspores which are present are radially symmetrical and marked by three sutures on their proximal side. The arcuate ridges may or may not be prominent and the spore coat is smooth or variously ornamented. These megaspores, thus, confirm to the diagnosis of the genus *Triletes* Reinsch as emended by Schopf.

According to Schopf (1938, p. 18) all megaspores included in *Triletes* are considered on the basis of their morphology to belong to the heterosporous free sporing lycopods. Harris (1935) also used *Triletes* as a form genus for isolated megaspores of probable lycopod affinity. The name *Triletes* has been used in more or less the same sense by other authors as well. It, therefore, follows that Indian megaspores must have lycopod affinity. However, as far as I know there is no record of fossil lycopods in the Lower Gondwanas of India, except *Bothrodendron* sp., recorded from Barren Measures which intervenes between Barakar and Raniganj stages. If *Triletes* megaspores belong to lycopods, then lycopods must have existed in India as well. It is difficult to explain why they were not preserved along with the other members of the *Glossopteris* flora.

This brings us to the question of lycopods in the southern hemisphere towards the end of the Palaeozoic era. At the end of Carboniferous period an extensive glaciation in southern hemisphere killed out most of the older vegetation which was contemporary to the northern flora. In the wake of this climatic revolution in the south there appeared an almost new type of vegetation — the *Glossopteris* flora (Sahni, 1938). There was a general decline of lycopods in the *Glossopteris* flora. Nevertheless, they have been found in other countries of Gondwanaland (Rao, 1940, p. 206) and at least some of them are quite different from those in the northern hemisphere. In fact Edwards (1952) has recently stated that there are no satisfactory records of northern hemisphere lepidophytes in the *Glossopteris* flora of the southern hemisphere, and that this strengthens Sahni's suggestion that the lycopods

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of the *Glossopteris* flora evolved from pre-Gondwana lycopods of the southern hemisphere. Perhaps it may be too early to say that fossil megaspores from the Lower Gondwanas of India point to the same conclusion. The fossil megaspores described in the following pages are rather quite distinct from those of Europe and North America.

Since the institution of the genus *Triletes* by Reinsch, a number of classifications were proposed by various authors from time to time. Bennie and Kidston (1886) applied the name *Triletes* to lycopod spores. Kidston divided it into three sub-groups: (1) Laevigati, (2) Apiculatae and (3) Zonales. His divisions are based on individual features of spore ornamentation and hence his classification is necessarily artificial.

In 1938 Schopf proposed a new classification which, according to him, is based on broader points of similarity in spore morphology which show a greater likelihood of denoting natural relationship. His section divisions for *Triletes* are: (1) Aphanozonati, in which he placed all big megaspores from larger lycopods; (2) Lagenicula (B. & K.) emend. Schopf; (3) Auriculati; and (4) Triangulati, consisting of small megaspores from herbaceous lycopods. Besides, Schopf constituted a new genus, *Cystosporites*, for seed megaspores.

In 1946 Dijkstra modified this classification and his sections are: (1) Aphanozonati (Schopf) emend. Dijkstra; (2) Zonales (B. & K.); (3) Triangulati (Schopf); and (4) Lagenicula (B. & K.) Schopf. His Aphanozonati includes Laevigati, Apiculati and Auriculati.

Megaspores described here are classified on the lines suggested by Schopf (1938). They have been compared, as far as possible, with the descriptions and figures of most of the known species of *Triletes*. Those megaspores which could not be referred to any of the known species have been described under new specific names.

PART 1—MEGASPORES FROM PINDRA COAL SEAM[1]

MATERIAL AND METHODS

The coal samples were collected by me in the company of Messrs K. R. Surange and P. N. Srivastava from Datma and Pindra seams and two places at Topa and Mangardaha villages near Ramgarh in West Bokaro Coalfield, Bihar. The megaspores included in this paper were obtained by the maceration, in bulk, of coal from Pindra Seam. The coal is of Barakar (Lower Permian) age and has alternating bands of dull and bright coal. The maceration technique is that of Professor Harris for bulk maceration and embodies the following steps:

1. The coal was washed in running water. It was then kept in commercial nitric acid.
2. After the coal had been macerated, the acid was washed off.
3. The material was then treated with dilute (10 per cent) caustic soda solution and allowed to stand at least for an hour.
4. Alkali was removed by repeated decantation and then on different mesh sieves placed under running water. Care is needed as megaspores, when treated with alkali, considerably swell up; often become very delicate and are lost.
5. A part of the material was dried on the sieves in the sun and a paper was placed under the sieve mesh. The dried material was shaken out on the paper. The megaspores were picked out under binocular. Also some material was directly transferred from the sieves to a beaker containing water and megaspores were picked up under a binocular.
6. Individual megaspores which were still black were further treated in nitric acid alone. The silica particles, if any, sticking on the megaspore wall were removed by putting the spores in 20 per cent hydrofluoric acid overnight and then washing off the acid. The spores were mounted in glycerine jelly.

DESCRIPTION

GENUS TRILETES (REINSCH) EMEND. SCHOPF

SECTION LAGENICULA (B. & K.) SCHOPF

Triletes horridus Zerndt

Pl. 1, Figs. 4, 5

Spores oval, cone shaped in outline with a neck-like structure which projects out from the body of the spore. Spore coat dark

1. The author wishes to express his thanks to Dr. K. R. Surange for his guidance and for going through the manuscript, to Prof. O. A. Höeg for many helpful suggestions and to Dr. S. J. Dijkstra for suggestions regarding classification.

brown, 19·2 μ thick, hirsute, hairs pointed at the apex and appear more crowded at the region where the neck-like structure arises, unicellular, translucent, as much as 140 μ long and to a greater part of the length 13 μ wide, hair bases 18 μ broad. Neck-like structure lighter in colour than the spore, lips of the neck 585 μ long. Arcuate ridges present, length of the spore 975 μ excluding the neck-like projection, breadth 1,400 μ approximately (3 specimens present).

These megaspores resemble *Triletes subpilosus* Ibrahim and *Triletes horridus* Zerndt which appear to have very few differences between them. My specimen differs from *T. subpilosus* in having longer hairs, thicker spore coat and a more robust spore body (DIJKSTRA, 1946, pp. 46, 47 and 1950, p. 871). However, my specimen is more broad and its hairs are more like bristles. The breadth of the spore is more, perhaps due to pressing, and the non-spine-like nature of the hairs in my specimen does not appear to me to be of sufficient importance in excluding it from *Triletes horridus*.

SECTION TRIANGULATI SCHOPF

Triletes indica sp. nov.

Pl. 1, Fig. 3

Diagnosis— Spherical spore, spore coat brown, exine appears thickened at some places. Unthickened portion of the spore coat looks more filamentous and delicate. Tri-radiate marking very conspicuous, radii wavy, about 224 μ long and 22 μ wide (approximately), lips visible, 9 μ, broad, width of suture 3 μ. Arcuate ridges present. Spore size varies from 543 to 642 μ (10 specimens present).

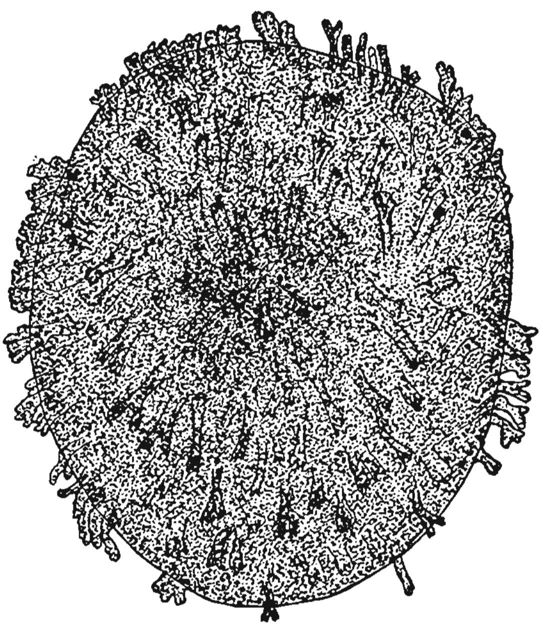
Triletes claratopilosus Wicher (Zerndt's type 24, PL. 7, pp. 174, 175, 1931) resembles to some extent *T. indica* in having thickened outgrowths over the spore coat, but *T. claratopilosus* is much bigger in size than *T. indica* and has very high trilete ridges. Also in *T. indica* the arcuate ridges are very prominent. *T. praetextus* Zerndt (1934, pp. 24, 25, PLS. 26, 27) also has hair-like outgrowths but their distribution is very regular. Thickened processes resembling those on *T. indica* have been shown by Harris on his *Triletes* sp. a. (1935, pp. 163, 164, PL. 25, FIG. 12), but unfortunately his single megaspore is incomplete and thus does not provide sufficient ground for comparison.

Triletes Surangei sp. nov.

Pl. 2, Figs. 7, 8 ; Text-fig. 1

Diagnosis — Rounded spores, spore coat dark brown, hirsute, covered with branched, delicate, fleshy processes. These processes are smooth, translucent, somewhat flattened at the apex, about 16 μ broad and as much as 131 μ long. Arcuate lamellae absent. Triradiate mark not clear. Spore measures 819-643 μ. Spores are sometimes found dehisced and such spores measure as much as 897 μ. (This megaspore is very common.)

Megaspores with forked processes have been described as *T. ales* Harris from Scoresby Sound, East Greenland (1935, p. 163, PL. 25, FIGS. 2, 8 & 9), but these mesozoic megaspores are smaller and have shorter hairs, their triradiate lamellae are very prominent and in them arcuate ridges are also present. In *T. Arnoldi* (Miner) Harris (1932, p. 500, FIGS. 22-25), described from the upper Cretaceous coals of western Greenland, the spore coat bears appendages but, unlike *Triletes Surangei*, these megaspores have rather vermiform papillae which are at the most 70 μ long. The hairs on *T. Surangei* are distinctly forked at the tips, very much like the spores of *Lycostrobus scotti* (HARRIS, 1935, PL. 26, FIG. 7). Hairs



TEXT-FIG. 1 — *Triletes Surangei* (cf. PL. 2, FIG. 7). × 100.

are also found over the spore coat of *Triletes superbus* Bartlett (DIJKSTRA, 1946, pp. 40, 41, PL. 6, FIGS. 86-89; PL. 7, FIG. 60), but *T. superbus* is much bigger megaspore and its hairs are much more longer than those of *T. Surangei*.

Triletes Dijkstrai sp. nov.

Pl. 1, Fig. 2

Diagnosis — Round spore, spore coat dark brown, approximately 13 μ thick with granulose surface. Trilete marking very conspicuous, radii about two-thirds of the body length, somewhat wavy, measure up to 160 μ in length and often 18 μ in breadth. Lips and suture sometimes visible, lips about 6 μ wide. Arcuate ridges absent, facets not clearly distinguished. Spore measures 314-457 × 528-542 μ (4 specimens present).

Somewhat similar megaspores have been described as *Triletes inornatus* (Miner) Harris (1932, p. 505, FIGS. 7, 8) from the Cretaceous coals of western Greenland. *Triletes Dijkstrai*, however, differs from *T. inornatus* in its somewhat wavy radii. Besides, the figures of *T. inornatus* appear to show slight tuberculation while the spore coat of *T. Dijkstrai* is granular. *T. subrotundus* (Miner) Harris (1932, p. 505, FIGS. 4, 5) differs from *T. Dijkstrai* in thicker exine and more deltoid shape. Similarly, *Triletes anurnatium* Harris (1935, pp. 164, 165, PL. 25, FIG. 5; PL. 26, FIG. 5) differs from *T. Dijkstrai* in much thicker spore wall, broader tri-radiate scars and in ill-defined irregular thickenings over the spore coat.

Triletes spinosus sp. nov.

Pl. 1, Fig. 1

Diagnosis — Roundly triangular spore, spore coat dark brown. Verrucose surface, spines often curved at the tips, not very sharp, as much as 9 μ high. Facets clearly distinguished, arcuate ridges conspicuous. Trilete marking distinct, radii about 29 μ broad and often 171 μ long, lips sometimes clearly visible, 13-16 μ wide, size of the spore 456-521 μ. The spores have a body like endosporites in the middle (10 specimens present).

Triletes spinosus resembles *T. subfuscus* Wicher [ZERNDT, 1934, Type 14 (in part) PL. 8, FIG. 4] in the general shape, verrucose ornamentation and in distinctly developed arcuate ridges, but *Triletes spinosus* has a much smaller size, its spines have a more uniform shape and the endosporite-like body is very distinct. It is interesting to note the similarity of *Triletes spinosus* with *Triletes endosporitiferus* which I have obtained from the same material. But the spore coat in *Triletes endosporitiferus* is completely devoid of spines.

Triletes endosporitiferus sp. nov.

Pl. 2, Fig. 6

Diagnosis— These spores have a central body — perhaps endospore. Spore roundly triangular to oval, sometimes nearly spherical, light brown. Spore coat 14 μ thick with punctate texture of the wall. Radial extremities point the angular margin of the spore coat. Endospore-like body present in the centre. Trilete structure very conspicuous, radii sometimes slightly wavy, almost touching the margins, radii as much as 314 μ long and up to 38 μ wide. Lips and suture visible, lips 13-18 μ broad, suture 3 μ wide. Arcuate ridges very prominent. Spore size varies from 714-742 × 828-885 μ (20 specimens observed).

Triletes endosporitiferus somewhat resembles Zerndt's type No. 5 (1931, p. 171, PL. 3, FIGS. 5, 6). But Zerndt's megaspore has smooth spore coat, its shape, as the figures show, is more triangular and no central body appears to be present within the spore. Similarly, *Triletes fulgens* Zerndt (1931, Type 8, p. 171, PL. 3, FIGS. 9, 10 & DIJKSTRA, 1946, p. 36) resembles *Triletes endosporitiferus* in the prominently developed arcuate ridges and in very distinct facets but considerably differs in the absence of the central body and in less broad trilete markings. *Triletes glabratus* Zerndt (1931, Type 9, p. 171 & DIJKSTRA, 1946, pp. 26-28, PL. 1, FIGS. 1-3 & 1950, p. 867, PL. 17, FIG. 2; PL. 18, FIG. 2) bears resemblance to these megaspores in the general shape of the spore body but considerably differs in its usually much bigger size. Besides, the figures of *T. glabratus* do not show any central body within the spore.

Triletes rotundus sp. nov.

Pl. 2, Fig. 9

Diagnosis—Spherical, ball-like spore, dark brown. Spore coat 13 μ thick (approximately), finely granulose surface. Trilete marking fairly conspicuous, radii about 300 μ long and as much as 36 μ wide. Facets not very distinct. Arcuate ridges present. A large round spherical endosporite-like body present, size of the spore 856-877 μ (4 specimens observed).

Triletes rotundus resembles *Triletes endosporitiferus* in shape and in having a central body — perhaps endospore. But the endospore-like body in *Triletes rotundus* is round and much bigger than that of *Triletes endosporitiferus*.

DISCUSSION AND CONCLUSION

This investigation shows that the Lower Gondwana coal is not devoid of megaspores although it may not be so rich as the Palaeozoic coal of Europe and America. Since they are found detached, no light on their affinity is thrown. However, the spores can be grouped under the genus *Triletes* which was widespread during the Upper Palaeozoic times in the northern hemisphere. These megaspores are usually associated with the free-sporing lycopods. Strange enough, we have only a meagre record of lycopodiales in the Damuda fossils from India. The problem of the affinity of these spores, therefore, becomes much more interesting. However, until further information is available, we can only say that some of the megaspores may have belonged to some heterosporous plants and some at least to lycopods.

PART 2 — MEGASPORES FROM THE DATMA AND THE MANGARDAHA COAL SEAMS[2]

DESCRIPTION

The megaspores from Datma and Mangardaha coal seams are described here. All the megaspores except one have been referred to the genus *Triletes* (Reinsch) emend. Schopf. One megaspore in the absence of definite characters has been described under the genus *Sporites* H. Potonié emend. Schopf.

The genus *Triletes* has been divided into sections as suggested by Schopf (1938). Megaspores belonging to the sections Aphanozonati and Auriculati have not been found in these coals. All the megaspores under *Triletes* here belong to the section Triangulati except one which has been referred to the section Lagenicula.

GENUS TRILETES (REINSCH) EMEND. SCHOPF SECTION TRIANGULATI SCHOPF

Triletes Arnoldii (Miner) Harris

Pl. 5, Fig. 22

Spores 518-740 μ in diameter, oval to round. Tri-radiate mark visible as fine line, extending over half the distance to the periphery. Spore wall slightly thick, measuring 15-20 μ; no distinction possible between two separate layers. Exine covered with numerous vermiform appendages with rounded apices, 30-50 μ long and 10-15 μ wide.

Several such spores have been recovered from the coal of Mangardaha village. Spores described by Miner under this species range in size from 465 to 614 μ and in the description of Miner no indication is found about the thickness of the wall; however, from the figures the spore wall appears to be slightly thick. The appendages measure 7-21 μ in breadth and 38-70 μ in length. These measurements are slightly different from those in my spores, but I think these slight differences do not necessitate the spores being placed in a separate species.

Triletes litchi Harris

Pl. 4, Fig. 16

Spore 700 × 870 μ in diameter, almost round, but slightly oblong due to lateral compression. Tri-radiate mark prominent, rays 0·5-0·6 of the length of the radius of the spore. Suture bounded by fairly thick and broad lips. Arcuate lamellae absent, no sign of facets. Exine covered with blunt-ended processes, 20-25 μ long and 15 μ wide. Sparsely scattered processes are either separate from one another or united at their bases. Spore wall 10-15 μ thick, does not separate into two definite layers.

Spores of this type have been recovered from the coal of Mangardaha village. This spore is also comparable to *T. papillosus* (Miner) but differs from that in having longer processes and shorter tri-radiate lamellae.

2. The author is grateful to Dr. K. R. Surange under whose guidance this work has been carried out and to Prof. O. A. Höeg for his many helpful suggestions.

Triletes myrmecodes Harris

Pl. 3, Fig. 15

Spores 503×621 to 547×680 μ in diameter. Shape rounded but the apex is flattened, wall of the spore slightly thick. Tri-radiate lamellae conspicuous, nearly 20 μ broad and 40 μ high. The length of the lamellae nearly 0·9 of the radius of the spore. Arcuate lamellae prominent. Spore wall beset with minute spines, 10-15 μ long and placed at intervals of nearly 50 μ.

This type of spores have been found in the Mangardaha coal. In my spores there is a slight indication of a central body which bears a separate tri-radiate mark. The true nature of this mark is not clear.

Triletes pseudopinguis sp. nov.

Pl. 3, Fig. 11

Spores 570-650 μ in diameter. Shape is essentially rounded with slightly flattened apex. Spore wall quite hard, 20-25 μ thick. Tri-radiate lamellae prominent. Rays 225 μ in length, i.e. 0·7-0·8 of the radius of the spore. Sutures bounded by lips, 20-30 μ wide and 30-60 μ high. Exine perfectly smooth in all parts of the spore.

These spores have been recovered from the coals both of Mangardaha and Datma villages. They differ from the spores described as *T. pinguis* by Harris in being large in size. *T. pinguis* range in size from 350 to 450 μ and my spores range in size from 570 to 630 μ. Moreover, in my spores there is no sign of facets, while in *T. pinguis* the facets are flattened but quite indefinite below. In view of these differences I propose to describe it as a new species.

Triletes gymnozonatus Schopf

Pl. 3, Fig. 13

Spores 500-612 μ in diameter. Rounded to slightly oval. Spore wall 25-30 μ thick. Trilete structure not very conspicuous, thin rays about one-third of the spore diameter. Zonal appendages lacking, arcuate ridges absent. Surface looks somewhat reticulate to matte in texture under strong light. Inside the spore is observed another body about 370 μ in diameter. This may be the shrunken endospore(?) as referred by Schopf.

These spores have been found in the Mangardaha village coal.

Triletes sp.

Pl. 4, Fig. 17

Spore 612×918 μ in diameter. Shape somewhat oblong. Spore wall thick. Trilete mark not distinct. Exine covered with very long fleshy appendages which are flattened and characteristically notched at the free ends. Some well-preserved appendages measure up to 90 μ in length.

These spores are found both in the Mangardaha and Datma village coals. These spores show some resemblance to *T. ales* Harris in the nature of the appendages, but the spores put under *T. ales* range in size from 250 to 350 μ while these spores measure up to about 1 mm. in diameter. In size of the spore body and nature of the appendages these spores compare best with *T. Surangei* Singh.

Triletes mangardahensis sp. nov.

Pl. 5, Fig. 19

Spore having an axis of nearly 600 μ. Shape triangular. Tri-radiate mark prominent, rays extending almost up to the margin. Arcuate ridges present. Within the spore is seen a central body somewhat darker and about half the size of the spore, which may be the shrunken endospore(?). Exine covered with small appendages of hirsute type.

These spores are found in the Mangardaha coal. They are comparable only with *T. triangulatus* Schopf, but differ from them in having no regular equatorial flange. The zonal appendages present in my spores are very feebly developed and do not extend beyond 15-20 μ in length, and there is no clear sign of reticulation on the body of the spore.

Triletes bokarensis sp. nov.

Pl. 5, Fig. 21

Spores with an axis of about 400-450 μ. Shape roundly triangular. Tri-radiate mark present. Suture not conspicuous, rays about one-third of the diameter of the spore. Exine smooth, but covered with fairly stout curved hook-like appendages, 30-45 μ in length. Inside the spore is seen a central body, somewhat darker and triangular in outline, about two-thirds the size of the spore. This most probably can be interpreted as the shrunken endospore(?).

These spores have been found in the Mangardaha coal. These spores may be compared with *T. triangulatus* Schopf, but differ from them in their smaller size, no regular flange and lack of ornamentation on the spore wall.

Triletes gondwanensis sp. nov.

Pl. 3, Fig. 14

Spores 504×640 μ in diameter. Shape rounded to oval with slightly irregular outline. Tri-radiate lamellae prominent. Rays about one-third of the diameter in length. Suture bounded by fairly thick lips. Arcuate ridges conspicuous. Exine covered with very small hirsute appendages, irregular in distribution. These appendages are seen only here and there at the margin of the spore. The broken appendages have left blunt spinous projections on the spore wall.

These spores have been found in the Mangardaha coal and are not comparable with any of the known species of *Triletes*.

Triletes datmensis sp. nov.

Pl. 4, Fig. 18

Spore having an axis of 511 μ. Shape almost triangular, somewhat deformed due to lateral compression. Spore wall is fairly thick, about 15-20 μ. Tri-radiate lamellae prominent, about 35 μ wide, extending almost up to the margin. Sutures not visible. Arcuate ridges quite conspicuous. Inside the spore is seen a central body, roughly triangular in shape, measuring 296 μ along the axis. This may be the shrunken endospore(?). Exine studded with small straight or curved spines visible at the margin.

This spore is found in the Datma village coal. It is comparable to *T. triangulatus* but differs from that in having no equatorial flange and possessing very broad tri-radiate lamellae. Though it is found only in a single specimen, its features, however, are very characteristic and not comparable to those of any of the known species of *Triletes*. I, therefore, feel justified in describing it here, giving it a specific name, although the new species will be based on only a single spore. In many other cases when I have found single spores which could not be identified with any of the known species, I have left them aside in the hope of obtaining more material.

Triletes pubescens sp. nov.

Pl. 5, Fig. 20

Spore 462×544 μ. Shape irregular, somewhat triangular. Spore wall 15-20 μ thick, striated, showing granular structure. Tri-radiate structure quite prominent. Tri-radiate flaps are seen radiating from near the centre of the body. No indication of sutures seen in the flaps. Exine covered with very thin, curved, hair-like appendages forming an entangled mass at the margin.

This spore is recovered from the Datma village coal. It is somewhat comparable to *T. triangulatus* Schopf, but differs from that in having very broad tri-radiate flaps and lacks surface ornamentation.

GENUS TRILETES (REINSCH) EMEND. SCHOPF
SECTION LAGENICULA SCHOPF

Triletes (?) *translucens* Schopf

Pl. 3, Fig. 10

Spore 940 μ in length from the pyramidal apex to the basal margin. Shape oval with characteristic pyramidal apex. Spore wall 10-15 μ thick and somewhat translucent. Trilete structure is not clear. Surface devoid of special ornamentation, only at a few places, which have become more clear due to over-maceration, matte texture is visible. A few folds are also seen on the surface of the body. Zonal appendages lacking.

This spore has been found in a shale associated with Mangardaha village coal. The specimen is comparable with *T. nudus* Nowak & Zerndt, but differs from that in not having so much elongated apex in the absence of the arcuate ridges and in having almost translucent spore wall. The specimen slightly differs from the species *T. translucens* Schopf in having surface ornamentation of the matte texture and in having no trace of trilete structure. In the absence of other spores of this type for a more comprehensive comparison I have included it in *T. translucens* with a query mark.

GENUS SPORITES (H. POTONIE) EMEND. SCHOPF

Sporites sp.

Pl. 3, Fig. 12

Spore 412×495 μ, shape round to oval. Spore wall thick, about 20-25 μ, somewhat translucent. Germination apparatus not clear. Surface smooth, the darker portions exhibit somewhat rugose type of ornamentation. Zonal appendages lacking. Two thick marginal folds are seen running parallel to the long axis of the spore and a thinner fold joins them on one of the margins along the shorter axis.

This spore has been obtained from the Datma coal. In the absence of any definite features it is put under form genus *Sporites*.

DISCUSSION

Various authors from Europe and America have regarded the *Triletes* spores as the isolated megaspores of lycopods. This view of their nature is confirmed by the presence of large number of lycopod types in Arcto-Carboniferous flora.

Although no comprehensive work has so far been done on the megaspores from Indian Gondwanas, yet the authors who have recorded their occurrence ascribed them to *Triletes* and referred them to lycopodiales (SITHOLEY, 1943; MEHTA, 1943; PANT, 1947; TRIVEDI, 1950 & GOSWAMI, 1951). Gondwana flora in India is surprisingly poor in lycopods and only records of lycopods are doubtful specimens of *Bothrodendron* (SEWARD & SAHNI, 1920, PL. 2, FIG. 28) from Permian and *Lycopodites* (SEWARD & SAHNI, 1920, PL. 7, FIG. 77) from Jurassic of Rajmahal Hills. The presence of the isolated megaspores in large numbers in Indian Gondwanas suggests that either the Gondwanas were sufficiently rich in lycopods, of which the other parts have not been found so far, or all the isolated megaspores recovered from the Indian Gondwanas cannot be ascribed to lycopods, but the other heterosporous plants had also their share in contributing to them.

Besides lycopodiales, heterospory has been recorded in other groups of plants as well, viz. Equisetales, Sphenophyllales, Neogerrathiales and Filicales (ARNOLD, 1947, pp. 149-150, 138, 154 & 176-177). The groups Equisetales, Sphenophyllales and Filicales are well represented in the Indian Gondwanas and it is possible that at least some megaspores may have belonged to some of these groups of plants.

From the comparison of the megaspores described in this paper with those from Europe and America, it appears that some of them can very well be compared with the already existing species of *Triletes* and they may belong to lycopodiales. Is it possible that other forms, which are distinct in more than one respect from the known species of *Triletes*, belong to other heterosporous plants?

At present our knowledge of the Lower Gondwana plants is based mainly on impressions and very little is known about the fructifications. It is, therefore, not possible to make any definite statement as regards the affinity of these isolated megaspores. However, with the growing knowledge of the Lower Gondwana plants, it may be possible some day to throw light on their true nature.

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EXPLANATION OF PLATES

PLATE 1

1. *Triletes spinosus.* × 137.
2. *Triletes Dijkstrai.* × 135.
3. *Triletes indica.* × 109.
4. Hairs over the surface of *Triletes horridus* Zerndt. × 176.
5. *Triletes horridus* Zerndt. This specimen has lost most of hair due to over-maceration. × 45.

PLATE 2

6. *Triletes endosporitiferus.* × 73.
7. *Triletes Surangei.* A dehisced megaspore. × 85.
8. Forked processes over the surface of *T. Surangei.* × 235.
9. *Triletes rotundus.* × 60

PLATE 3

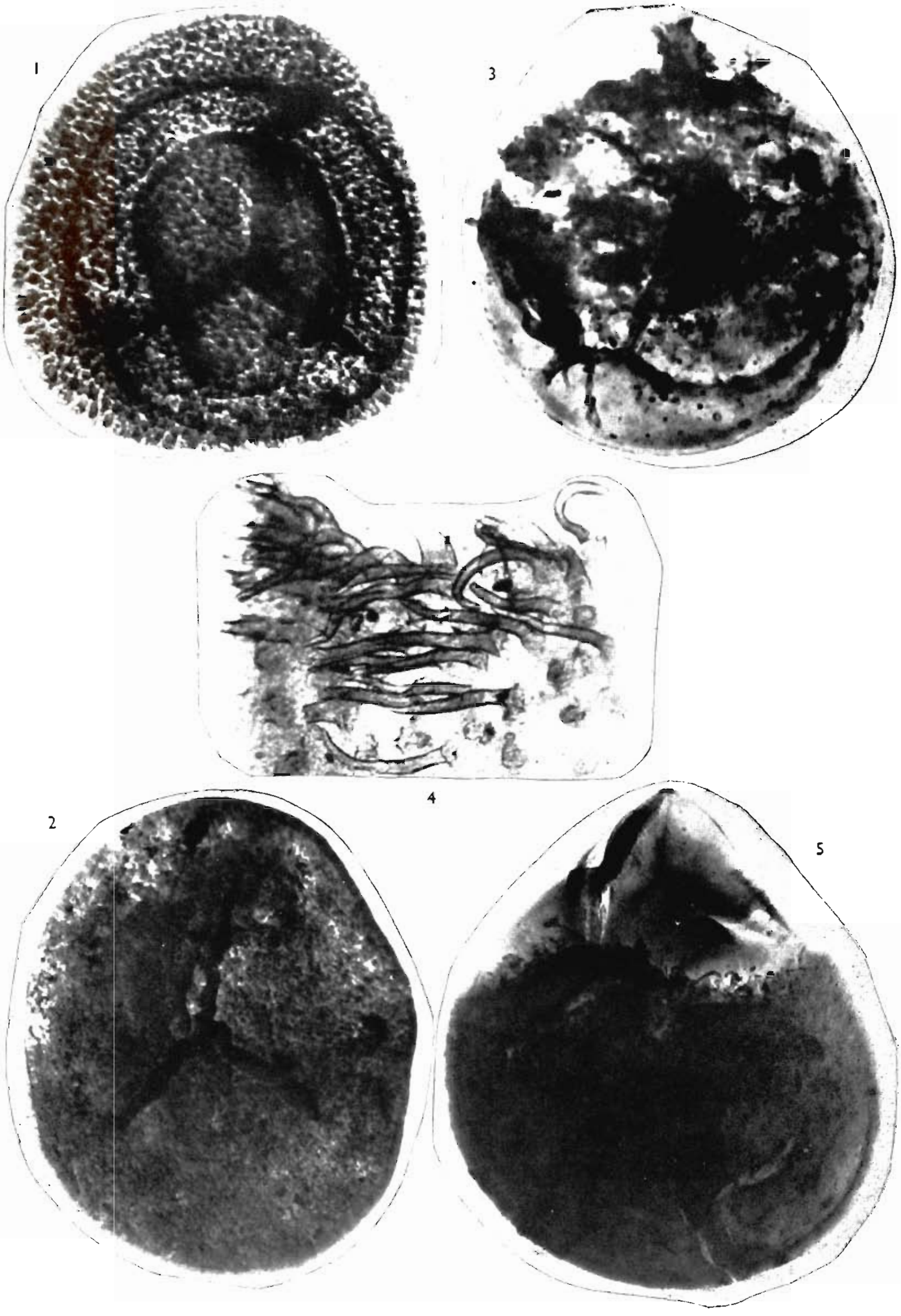
10. *Triletes translucens.* × 80.
11. *Triletes pseudopinguis.* × 100.
12. *Sporites* sp. × 150.
13. *Triletes gymnozonatus.* × 100.
14. *Triletes gondwanensis.* × 100.
15. *Triletes myrmecodes.* × 100.

PLATE 4

16. *Triletes litchi.* × 100.
17. *Triletes* sp. × 100.
18. *Triletes datmensis.* × 200.

PLATE 5

19. *Triletes mangardahensis.* × 134.
20. *Triletes pubescens.* × 120.
21. *Triletes bokarensis.* × 144.
22. *Triletes Arnoldii.* × 115.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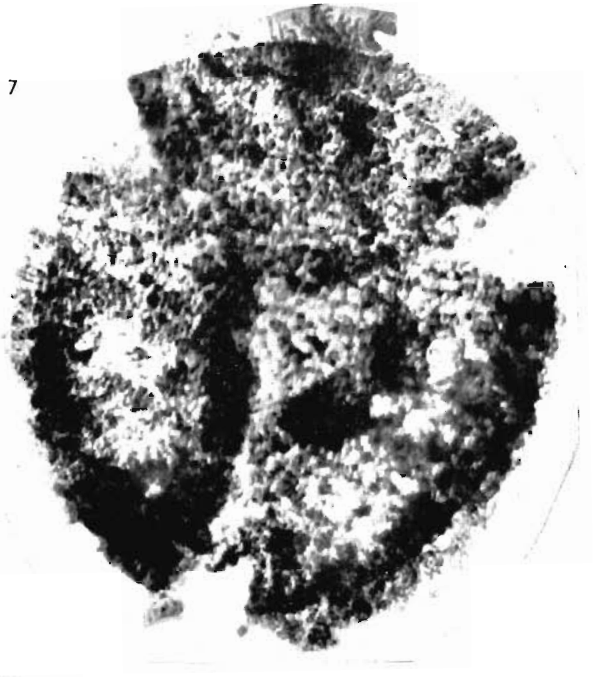

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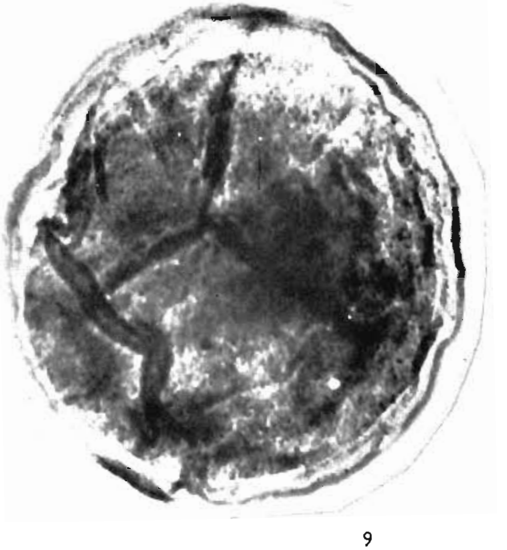

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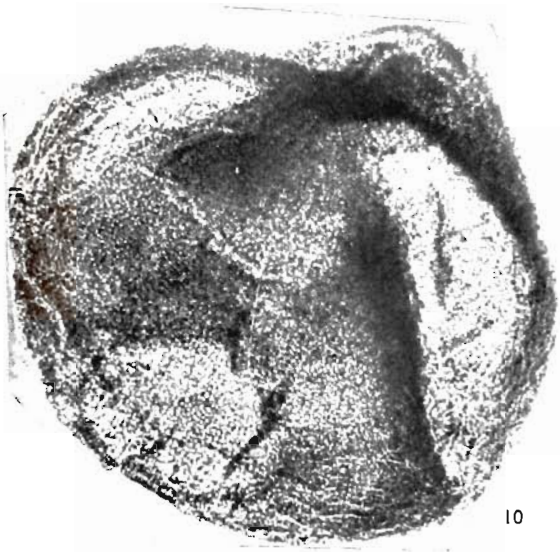

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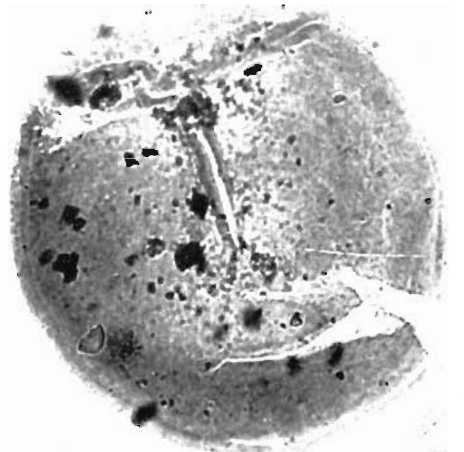

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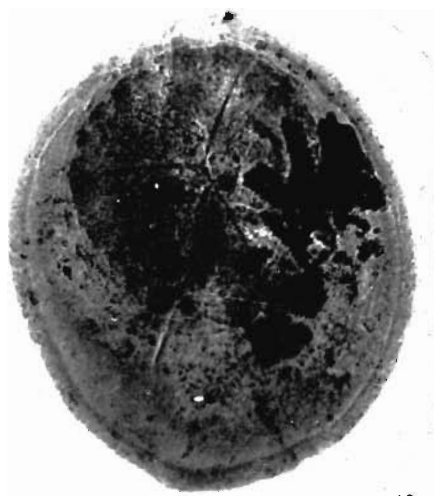

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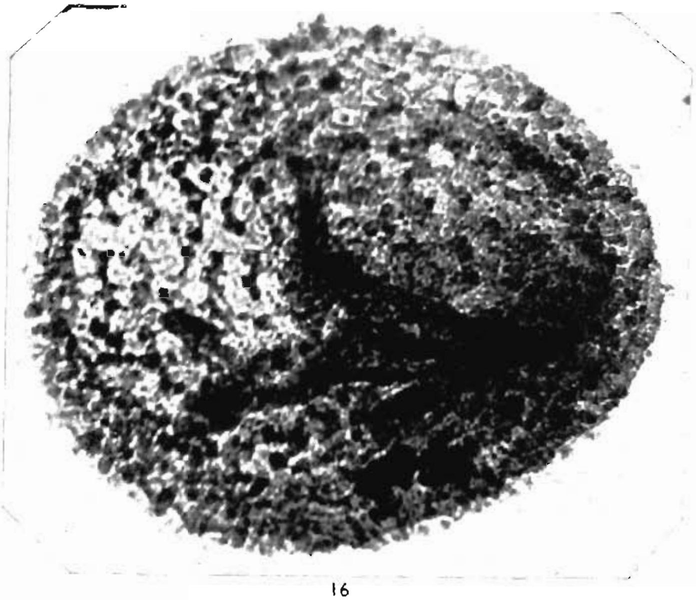

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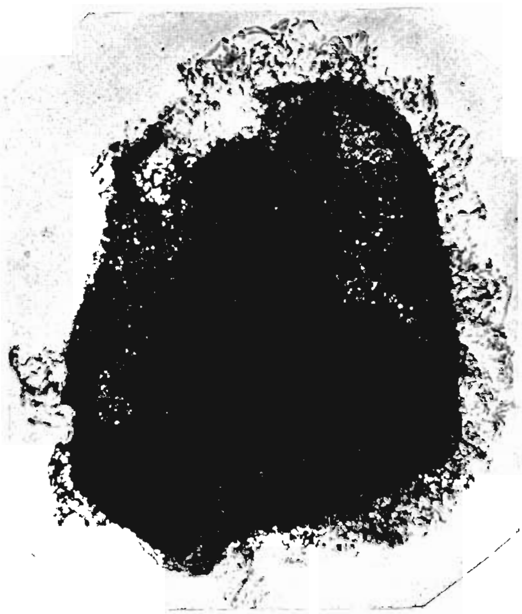

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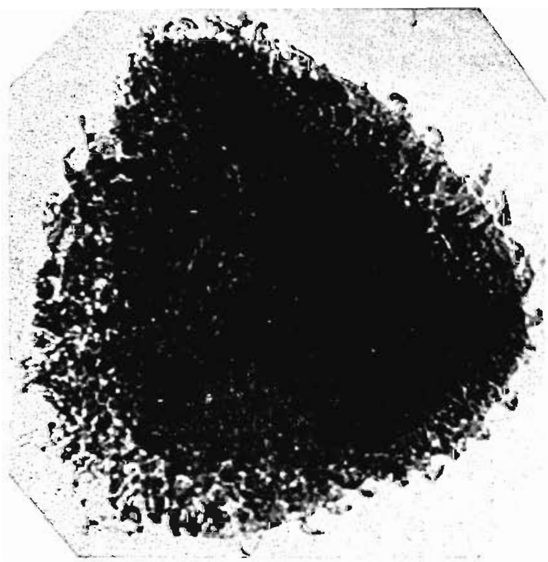

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