# MEGASPORES AND OTHER PLANT REMAINS FROM LOWER GONDWANA OF SINGRAULI COALFIELD, DISTRICT MIRZAPUR, U.P.

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## Introduction

Microspores (Ghosh and Sen, 1948; Mehta, 1942 and 1943; Sitholey, 1943; and Virkki, 1945) and pollen grains (Bose, 1950; Rao, 1936; and Rao and Vimal, 1950) have received far larger attention in this country than the megaspores; there are very few studies of the latter.

Mehta (1942) in his investigations on the microspores from shales of Mirzapur mentions, "Three megaspores (319–388$\mu$) with triradiate marks and warty or granular surface", but these have been neither figured nor fully described. Later, Mehta (1943) published a photograph of a megaspore, but the description was very meagre. The spore is given no name, and no relationship has been established. Sitholey (1943 and 1943 *a*) discovered a large number of megaspore casts from the Triassic of Salt Range, Punjab, which he named as *Triletes Sahnii*. Saxena (M/S) has recorded a few megaspores probably from the Lower Gondwana of South Rewah, Central India, but the details of his studies have not been published so far. From the Dhekiajuli beds of Assam (? Upper Miocene or ? Lower Pliocene) Sahni *et al.* (1947) figure without any description a single megaspore (265$\mu$). Ghosh and Sen (1948) have figured a few bodies about whose affinities (p. 85) they are doubtful (pl. 13, figs. 128, 129, pl. 14, figs. 130, 131, 132, 136; etc.) but from the figures some of them appear to me to be megaspores. Pant (1950) has recovered megaspores from "A micaceous shale from Talchir coalfield (exact horizon not known)." I (Trivedi, 1950) have found a large number of megaspores in some coal samples of Barakar age collected from Singrauli coalfield by Dr. R. C. Misra of Geology Department of this University, as also in a few samples kindly supplied by the Geological Survey of India. The present paper is based on a detailed study of these.

## Material and Method

Macerations were first carried out with Schulze's solution followed by weak ammonia for clearing. Most of the megaspores so treated appeared mutilated. Schulze's solution proved a very strong oxidising agent; consequently as soon as ammonia was applied, the megaspores swelled and some of them completely disorganised. This process could be observed under a microscope. Megaspores are the least

resistant to oxidation, woods and cuticles are a little more and microspores appear to be the most resistant.

In the light of this experience, and at the suggestion of Prof. T. M. Harris, pure concentrated $HNO_3$ (65·3%) at room temperature in winter was substituted for Schulze's solution. Even this proved a very strong oxidising agent during summer months. Each sample prior to maceration was thoroughly washed, sometimes it was soaked in water for 24 hours or more and then kept in $HNO_3$. Each sample requires a different maceration period but during winters, at room temperature, most of the samples needed 2 to 3 days. After maceration, each sample was thoroughly washed in running water for 4–5 hours; then freshly prepared 10% NaOH solution was added; the sample was kept in alkali for about 10 hours. In order to test the efficacy of alkali treatment, in a few samples no alkali was used, megaspores thus obtained were opaque and had a large number of carbon particles adhering to them. The use of alkali makes the megaspores more transparent, and all adhesions disappear. NaOH was preferred to $NH_4OH$ because it is more handy to use and secondly it has no offensive smell.

After alkali treatment, each sample was very thoroughly washed so as to completely remove even the last traces of it. Such a sample was then passed through standard sieves. Each fraction was separately collected and examined.

The best way to pick out megaspores from such fractions is to spread a small quantity in a Petri dish, half full of water underneath which is placed a piece of white paper. The sample is aggregated on one side of the dish leaving the major portion of the Petri dish with water alone. The dish is slightly tilted at 3–5° and kept in this position so that the sample side is higher up and water side downwards. Now, by means of a dropper a slow current of water from sample side towards the empty area is generated. The particles disperse; because of the presence of a white background it is possible to distinguish between the absolutely black objects and dark orange or chocolate coloured, spherical megaspores. These can be easily separated out. This method is simple and quick. The eye has not to be exercised too much by looking constantly into a binocular for searching the megaspores. Even small megaspores and their broken pieces could thus be picked out. A few samples from which the megaspores were thus picked out, did not reveal any megaspores when observed under a binocular microscope.

Material not for immediate use was stored in 90% alcohol and 50% glycerine, mixed in equal proportions. Megaspores to be described were dehydrated, and mounted in Balsam. A few megaspores were mounted in hollowed slides also, but as no proper light reflecting arrangement was available this method for their study was not pursued. All the specimens described below were mounted as flat objects in Canada Balsam.

Glycerine jelly was also used but without a hardener it did not prove a success. It was, therefore, given up.

The coal samples are extremely rich in megaspores. 4½ gms. of coal yielded nearly 430 megaspores, thus giving a ratio of about 95 megaspores per 1 gm. of coal, besides numerous other microfossils.

The megaspores have only the exospore, no endospore was found. A large number of microtome sections of megaspores were cut, these were mounted in glycerine jelly and stained with methyl green (Wodehouse, 1935). Not even in one case was an endospore present. The exosporium takes up a bright green stain.

All the megaspore specimens are, for the present, with the author.

## Locality

The sample of coal was collected by Dr. R. C. Misra from a thin seam of coal, exposed in a small rivulet north of Kotah (24° 6′–82° 45′); district Mirzapur, U.P. Age (Lower Gondwana), probably Barakars. The Geological Survey of India samples also came from a locality very near to this one.

## Description

### *Sectio Aphanozonati* Schopf.

*Triletes kotahensis* sp. nov. (Text-Fig. 1; Pl. III, Photo 1)

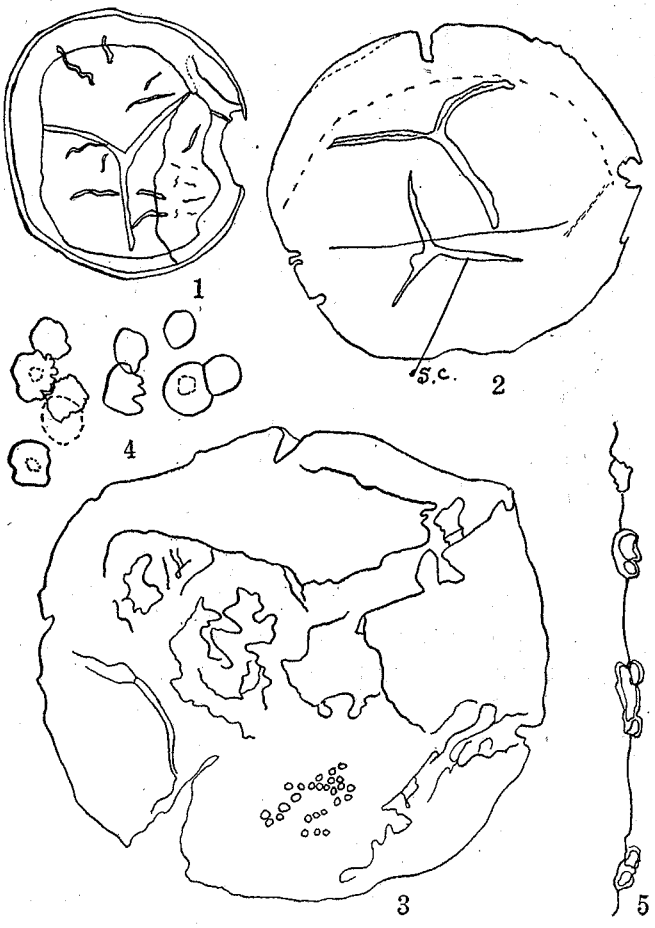
Spores small varying from 700 $\mu$ to 1 mm. in diameter; one of the spores is 679 $\mu$ long and 590 $\mu$ broad; round or oval, folds numerous. Contact areas distinct (a portion of one of the sectors is broken); these occupy about 55% of the proximal half of the flattened spore by planimetric measurements. Surface finely rugose-granulose; light to dark brown by transmitted light. Spore coat 10–12 $\mu$ thick, suture closed, lip not seen, suture line 284 $\mu$ long, 16·6 $\mu$ high and 37·5 $\mu$ broad. The distal portion of the spore is ornamented with small indistinct punctations.

The distinguishing features of these spores are (1) long radii of the suture lines in proportion to the spore diameter, and (2) granulose-rugose ornamentation on the proximal half of the spore.

*Triletes granulosus* sp. nov. (Text-Fig. 2; Pl. I, Photo 2)

Spores round or slightly oval; 950 $\mu$ long, 900 $\mu$ broad; surface granulose, folds may be present. Suture lines about 242 $\mu$, long 370 to 75 $\mu$ high and about 16 $\mu$ broad, closed, lip not seen, spore coat 8 $\mu$ but is difficult to measure in optical section. Arcuate ridges and contact areas indistinct, but shown by dotted line in (Text-Fig. 2). The trilete like mark (S.C.) shown in the photograph and (Text-Fig. 2) is the ruptured spore coat. Distal portion a little more distinctly ornamented than the proximal. Spores light to dark brown in transmitted light.

This species differs from *T. kotahensis* sp. nov. in having (1) a thin spore coat, (2) indistinct arcuate ridges and contact areas, and (3) smaller suture lines, in proportion to the total spore diameter. These features also constitute its distinguishing characters. As this




TEXT-FIGS. 1–5.—Fig. 1. *Triletes kotahensis* sp. nov., ×82. Fig. 2. *Triletes granulosus* sp. nov., the ruptured exine (*s.c.*) simulates suture lines, ×82. Fig. 3. *Triletes* sp., ×82. Fig. 4. Papillæ of above as seen in the surface view, ×490. Fig. 5. Papillæ of above as seen in the optical section, ×490.

form is very distinct, it could not be even compared with any other known form, it is, therefore, placed in a new species.

*Triletes* sp. (Text-Figs. 3, 4 and 5; Pl. III, Photo 3)

Spore 1·22 mm. in diameter, surface finely granular and papillate; suture lines not seen; but judging by its size, it appears likely to belong to the genus *Triletes*. Contact areas and arcuate ridges not preserved, spore flattened and crushed.

Papillæ broader than tall; they are 20–32 $\mu$ broad and 10–12 $\mu$ high. In some of the papillæ a somewhat dark central portion may

be seen. Although this spore superficially resembles *T. brevispiculus* Schopf, yet the two differ from each other in the following characters:

(1) The structure and the size of papillæ, and

(2) *T. brevispiculus* Schopf is larger in size than the present spore.

It resembles *T. mamillarius* Bartlett in that in some forms within this species the papillæ are broader than tall.

Due to bad preservation this spore has not been given a specific name. Spore coat dark orange and thick.

*Triletes singraulensis* sp. nov. (Text-Figs. 4 and 5; Pl. III, Photos 4 and 5, Pl. IV, Photo 6)

Spores large on the average measure 765 $\mu$ long, 658 $\mu$ broad, ornamented, round (Pl. III, Photo 4) or oval (Pl. IV, Photo 6) a few spores are slightly damaged, with or without small folds. Contact areas occupy about 60% (Text-Fig. 6; Pl. III, Photo 5) of the total flattened spore area (Planimetric measurements). Surface dark brown in transmitted light, with numerous papillæ (Text-Fig. 8). Spore coat, deep yellow to dark-brown; 10–12 $\mu$ thick.

Sature lines about 200 $\mu$ long, 27·5 $\mu$ high, and 33·2 $\mu$ broad, suture split open. The surface of the spore near the lip and also the trilete suture is thrown into folds (Text-Fig. 7). Arcuate ridges prominent, sculpturing verrucose; dense on the distal side, sparse on the proximal; apeculi 10 $\mu$ broad at the base and 10 $\mu$ high.

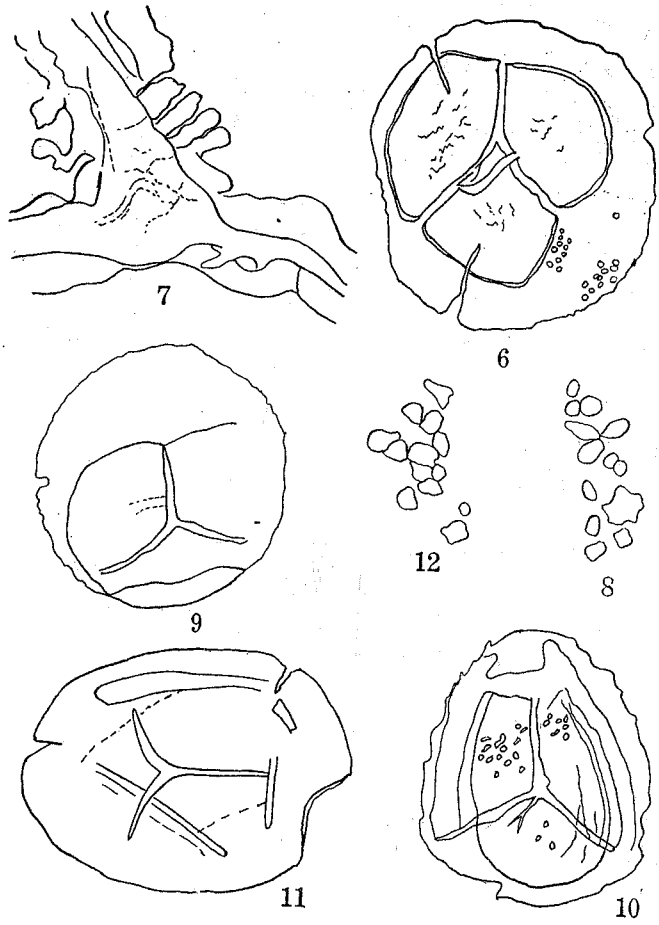
This spore differs from *Trilete* sp. (Pl. III, Photo 3) in that the latter has apeculi which are, (1) broader than tall and (2) the apeculi are uniformaly distributed over the entire surface of the spore. In the present spore the apeculi are as broad as high and are unevenly distributed over the two hemispheres of the spore.

This spore may be compared to *T. brevispiculus* Schopf in being papillate but differs from it in the size of the spore itself and those of the papillæ.

A few spores of almost the same shape and size but without well defined sculputre have also been found. These for want of other differences have been placed under this species. It may be possible to separate them later.

*Triletes elongatus* sp. nov. (Text-Figs. 10, 11, 12 and 13; Pl. IV, Photos 7 and 8)

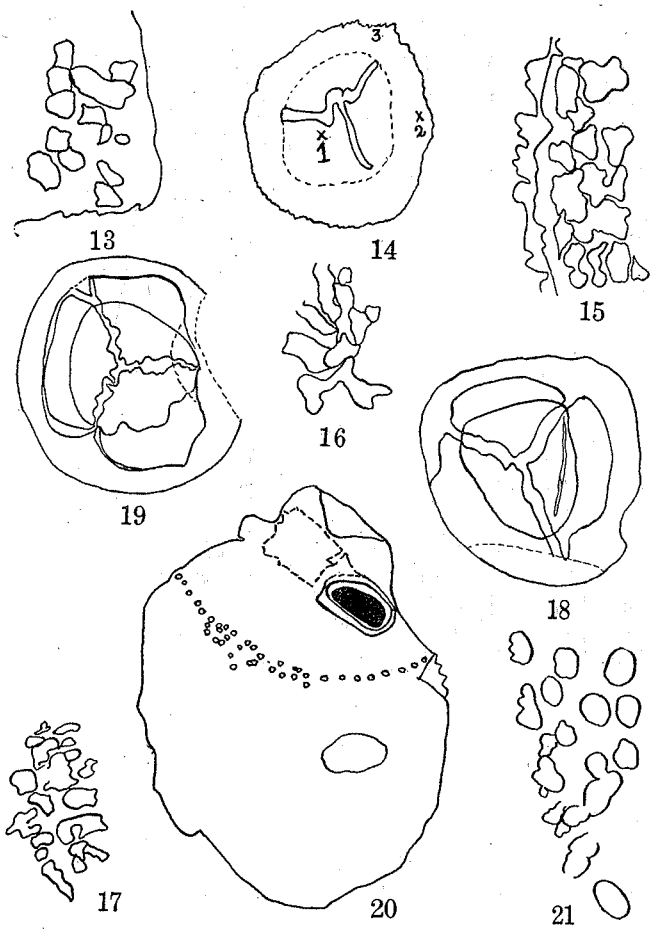
Spores ornamented, shape varying, oval to elongate, 790 $\mu$ long 600 $\mu$ broad, folds present, (Text-Fig. 10, Pl. IV, Photo 8), suture closed and well preserved, longest suture lines 200 $\mu$, the two smaller 145 $\mu$ each, arcuate ridges, and contact faces not preserved. Spore coat 8 $\mu$ thick, dark-brown, covered over by numerous papillæ (Text-Fig. 13) irregularly shaped, and somewhat ill-defined. This spore differs from the others in having a variable shape, a thin spore coat and in having a characteristic ornamentations. It is, therefore, placed as a new species.




TEXT-FIGS. 6–12.—Figs. 6 & 9. *Triletes singraulensis* sp. nov.—The two types of spores constitute only one species, ×82. Fig. 7. A small part of suture of above enlarged, ×490. Fig. 8. Some of the papillæ of above enlarged, ×490. Fig. 10. *Triletes elongatus* sp. nov., ×80. Fig. 11. *Triletes elongatus* sp. nov., ×95. Fig. 12. Some of the papillæ of Fig. 10, enlarged, ×490.

*Triletes papillarius* sp. nov. (Text-Figs. 14, 15, 16 and 17; Pl. V, Photo 17)

Spores slightly oval or round in shape, 543 $\mu$ long, 458 $\mu$ broad, folds absent, suture lines well preserved; unequal, longest about 198 $\mu$, the two shorter 141 $\mu$ each. At the junction of the three lines is present an expanded lobular area which may have been raised like a protuberance as in *T. prætextus* Zerndt, although here it appears to be flat, 213·5 $\mu$. Arcuate ridges indistinct, contact areas clearly defined, occupying about 40% of the total spore area (in planimetric measurements). Spore coat dark-brown, 18 $\mu$ thick, ornamentation dense and




TEXT-FIGS. 13–21.—Fig. 13. Ornamentation of *T. elongatus* sp. nov. from the area marked on the spore, enlarged, ×490. Fig. 14. *Triletes papillarius* sp. nov., ×82. Fig. 15. Papillæ, from the area marked 3 on the spore, enlarged, ×490. Fig. 16. Papillæ of *T. papillarius* sp. nov. from the area marked 2, enlarged, ×490. Fig. 17. Papillæ of above from the proximal hemisphere, marked 1 in Fig. 14, enlarged, ×490. Fig. 18. *Triletes brasserti* Stach et Zerndt, ×82. Fig. 19. As above, an overmacerated specimen, ×90. Fig. 20. *Triletes punctatus* sp. nov., the dark pellet is (?) an abortive spore, ×82. Fig. 21. Ornamentation of above, from the triangular area marked in Fig. 20, enlarged, ×490.

crowded, consisting of numerous sinuous or elongate papillate structures (Text-Figs. 15, 16 and 17). Most papillæ are simple elongate projections while others are composed of two or three projections with the central one slightly higher than the rest. The papillæ at the base measure from 8 $\mu$ to 22·4 $\mu$ in breadth, and 8 $\mu$ in height. Contact areas as also the distal portion of the spore, is densely ornamented.

The ornamentation of the spore is characterised by the presence of numerous crowded papillæ, these occur on the proximal side also.

This character makes this species very distinct. It may be compared to *T. prætextus* Zerndt, in having the junction area between the three suture lines raised but differs from it in that the proximal prominence is not so well marked as in the former. The spore on the basis of these characters is given a new specific name, *viz.*, *Triletes papillarius* sp. nov.

*Sectio Lagenicula* (Binnie and Kidston) Schopf.

*Triletes punctatus* sp. nov. (Text-Figs. 20 and 21; Pl. IV, Photo 12)

Spore preserved flat, 0·806 mm. long exclusive of neck and ·72 mm. broad, neck 0·194 mm. long and broad. Ornamented on distal side only; the proximal side is completely devoid of ornamentation. Suture lines not seen; punctæ well preserved, 12·8 $\mu$ in breadth and 11·2 $\mu$ in height, not very dense, and do not pass beyond the posterior region. On the proximal side is present a dark carbonaceous pellet probably representing one of the abortive spores. Another hollow area contiguous to it may have lodged a second abortive spore. The spore is yellow in colour, and is thin walled.

Dijkstra (1946) believes that *Triletes rugosus* (Loose) Dijkstra *emend*, is constituted by three types of spores, his third type (p. 48, pl. 10, Figs. 104–107) approaches in size the present spore, but differs considerably in spore coat thickness and in punctations. His other two types do not resemble this spore at all. Therefore, although, only a single spore has been found yet because of its sufficiently well characterised features, it has been placed in a distinct species; viz., *Triletes punctatus* sp. nov.

*Triletes* sp. (Text-Fig. 22, Pl. IV, Photo 11)

Spore 1·94 mm. long, 1·74 mm. broad at the broadest point. Trilete suture and arcuate ridges not seen. Spore smooth, spore coat 20–22 $\mu$ thick. On the surface of some of the spores are present a few folds, sometimes numerous carbon particles are also adhering. Preservation is poor. In size, shape and the characters of the spore coat this spore shows some resemblance to *Triletes nudus* (Nowak et Zerndt) Schopf; Schopf *et al.* (1944).

*Secto Triangulatæ* Schopf.

*Triletes brasserti* Stach and Zerndt. (Text-Figs. 18 and 19; Pl. IV, Photos 9 and 10)

Average diameter of the spores varies from 455 $\mu$ to 572 $\mu$ (inclusive of equatorial flange); hemispherical or when pressed slightly triangular in shape. Suture lines well preserved, undulating, joining the arcuate ridges, occasionally as long as the diameter of the spore or shorter; 14 to 14·5 $\mu$ high.

Proximal and distal areas densely or sparsely granulose or papillose (ornamentation varies considerably within this species). Spore coat 12–16 $\mu$ thick, flange rugose, cannot be made out in many spores.

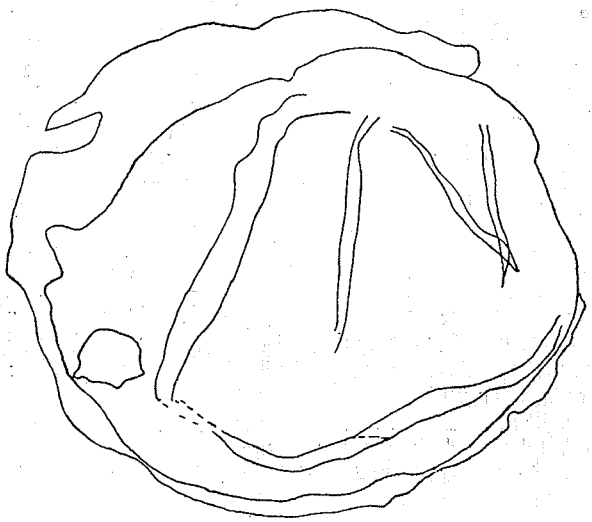
This spore is extremely common and occurs abundantly. It differs from the typical *T. brasserti* Stach and Zerndt (1934) in being a little

smaller and in not having a very pronounced equatorial flange. Further, in my specimens it does not separate out as stated for the type specimen (Dijkstra, 1950: 869).

*Cystosporites* Schopf.

*Cystosporites indicus* sp. nov. (Text-Figs. 23 and 25; Pl. V, Photos 14 and 15)

Spores large, smooth, round 2·6–2·8 mm. in diameter, or oval 2·2 by 1·75 mm. Sac-like, arcuate ridges and suture lines not well



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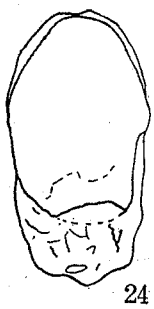

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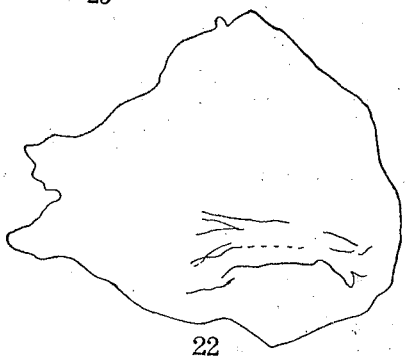

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TEXT-FIGS. 22–24.—Fig. 22. *Triletes* sp., ×40. Fig. 23. *Cystosporites indicus* sp. nov. The area between the two outermost layers represents the membrane, ×40. Fig. 24. *Sporangium A*, with contents, ×40.

preserved, abortive spores sometimes present. Some of these occur in association with the larger spores either detached or in organic

connection (Text-Fig. 25; Pl. V, Photo 15) one of the arcuate ridges can also be seen.

Spore coat plain and smooth, never fibrous as mentioned by Schopf, this spore coat is divisible into two definite zones, *viz.*, (1) The outer membranous transparent "Wing-like outgrowth of the exospore" (Bochenski), and (2) the inner thick dark orange transparent to opaque membranous structure. The distal surface of the spores is almost opaque, the proximal area is more or less transparent.

"The wing-like outgrowth" is not continuous throughout the entire body of the spore but is present only towards the proximal side of the spore and is missing from the distal side (Text-Fig. 25; Pl. V, Photo 15).

In those spores which are flat and round due to preservation this "wing-like outgrowth" can be seen going round only upto about three-fourths of their circumference (Text-Fig. 23; Pl. V, Photo 14) and then stopping short. This "outgrowth" may or may not be prominent. It is probably proximal but this fact could not be definitely ascertained.

The one attached abortive spore (Text-Fig. 25; Pl. V, Photo 15), is opaque and shows no reticulation, while a few unattached ones lying on the surface of the bigger spores show reticulations. Abortive spores measure 240 $\mu$ by 210 $\mu$.

*Cystosporites indicus* sp. nov. differs from the *C. breretonensis* Schopf, in the following characters:

(1) The presence of a well defined and probably a proximal "wing-like outgrowth".

(2) The spore coat is not fibrous; it is plain and smooth.

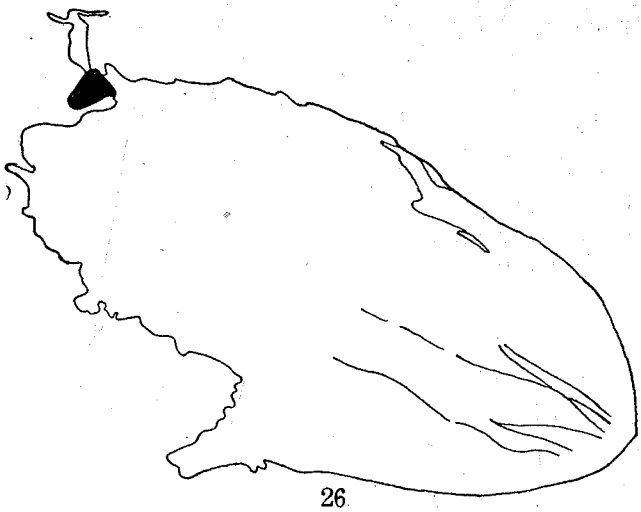
(3) This spore is smaller in size than *C. breretonensis* which is 4–10 mm. long whereas this one is only 2·6 to 2·8 mm. long.

Species of *Cystosporites* described and figured by Dijkstra (1946) also differ from this species in characters 1 and 3 given above. It is difficult to correctly judge the relative merit of these characters. Probably the spore in question may represent a new genus but until more is known I would place it under genus *Cystosporites* Schopf. It is certainly a new species. I, therefore, propose to name it *Cystosporites indicus* sp. nov.

*Cystosporites indicus* sp. nov. occurs in abundance in these coal samples.

*Cystosporites* sp. (Text-Fig. 26)

Spores 3·4 mm. long, 1·7 mm. broad, smooth; no suture lines or arcuate ridges preserved, only elongate in shape, none of them are round. To some of them, dark abortive spores 237 $\mu$ by 140 $\mu$ are attached. "Wing-like outgrowth" absent, the spores are not sufficiently well preserved to deserve a specific name, therefore, no name



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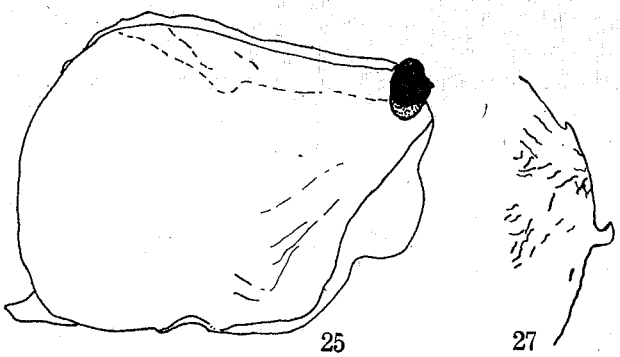

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TEXT-FIGS. 25–27.—Fig. 25. *Cystosporites indicus* sp. nov., showing (?) an abortive spore and the membrane, ×40. Fig. 26. *Cystosporites sp.* with an abortive spore, ×40. Fig. 27. Basal portion of sporangium **B**, enlarged, ×90.

is given. They differ from *C. indicus* sp. nov. in the absence of "wing-like outgrowth" and (2) in that all of them are preserved as elongated bodies, none of them are round. The characters by which this form is separated from *C. indicus* sp. nov., do not seem to be very dependable but in the absence of any other criteria these are presumed to be satisfactory. This form is, therefore, kept as a separate species but because the characters are not well defined, a specific name has not been given.

## SPORANGIA

Two or three sac-like structures have been discovered. In one of them can be seen an ? immature megaspore; in the other two no

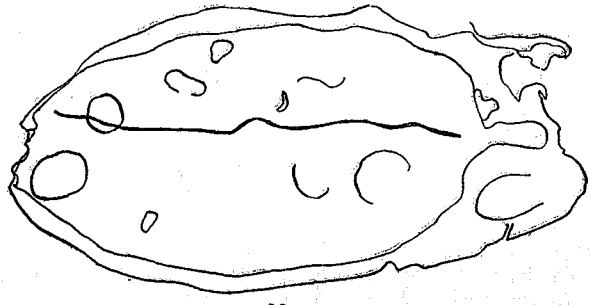
contents are seen. It is likely that they may be sporangia but their nature is not correctly understood.

*Sporangium A* (Text-Fig. 24, Pl. V, Photo 16)

Elongate, 1·45 mm. by ·758 mm.; coat smooth and wrinkled. Enclosed within it is a dark brown body, 970 $\mu$ by 679 $\mu$, it shows a large number of small wrinkles which may be only accidental folds or may be the beginnings of spore sculpture.

*Sporangium B* (Text-Figs. 27 and 28)

An elongated body 2·66 mm. by 1·64 mm. The sporangium has thin outer transparent wall, which is darker than the outer one.



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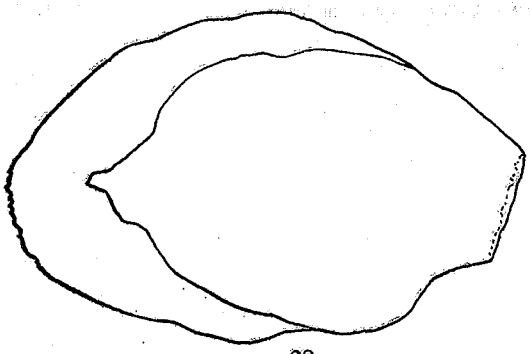

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TEXT-FIGS. 28–29.—Fig. 28. Sporangium B, ×40. Fig. 29. Sporangium C, ×40.

At one of the ends, probably basal (Text-Fig. 27), the cells of the outer membrane are modified, the inner membrane has a small projection towards this side; the other end is flat. The outer and inner membranes are distinct and separated from the basal portion to about the middle of the sporangium after which the two can no longer be seen separately. The outer membrane in texture shows a resemblance to the " wing-like outgrowth" of *Cystosporites indicus* sp. nov.

*Sporangium C* ? (Text-Fig. 29)

This resembles sporangium B but is more elongate. It is 2·75 mm. by 1·45 mm. At one of the ends of the sporangium the outer membrane is more prominent, and continues from this extremity to the other without disappearing as in sporangium B. Cells of neither extremity show any modification. This sporangium is, therefore, separately placed.

*Incertæ Sedis* (Pl. V, Photo 13)

A large, smooth and oval body with neither suture lines nor arcuate ridges, 1·45 mm. to 1·94 mm. long and 1·21 mm. to 1·64 mm. broad. Wall 15 to 16 $\mu$ thick; surface is slightly wrinkled (sometimes with folds). One specimen appears as if it has dehisced. Characteristic features of this body are (1) its large size, (2) its smooth exine, and (3) its oval shape. It is also characterised by the absence of suture lines. Probably a seed; affinities obscure.

## Discussion and Original Observations

Schopf (1938: 17–24) employed the generic name *Triletes* for fossil megaspores with a triradiate mark, which probably belonged to Lycopodiales. *Triletes* has been used in the same sense here also. I consider the presence of clear suture lines as an important character of *Triletes* because otherwise the megaspores of some Hydropterideæ —where this mark in the mature spore is generally obscure—can be classified under section *Lagenicula* of the genus *Triletes* and thus the phylogenetic significance of this genus may be lost.

Dijkstra (1948) has figured and described a megaspore *Triletes lobatus* Dijkstra which to me appears to resemble a megaspore of *Regnellidium* in shape and size and as the suture lines are obscure the resemblance becomes all the more closer. I feel that this megaspore should not be placed under *Triletes* as it does not possess the suture lines.

The vestibule of the Lageniculate megaspores also needs a thorough investigation as it is only imperfectly known. Perhaps it may show some characteristic diagnostic features.

Lycopods in the form of impressions or petrifactions are almost completely absent in the Palæozoic of India with the single exception of a Permian, *Bothrodendron*, (Sahni 1922, Table 2). Our knowledge of fructifications of *Glossopteris* and other allied plants is almost negligible. Therefore, the possibility that some of them could bear spores similar or identical to *Triletes* cannot be absolutely ruled out. According to Schopf (1938: 22), however, the information which has accumulated, only serves to emphasize the relationship of the *Triletes* with the Lycopodiales. I fully share this view. The presence, therefore, of a large number of megaspores, *Triletes spp.*, from the Barakars of Singrauli coalfield strongly suggests the presence of Lycopods in the Palæozoic beds of India. Mehta (1943) also has reported the presence of some *Trilete* spores in the shales of this area. Further, Saxena (M/S) and Pant (1950) have found *Triletes spp.* in Karharbari and

Talchir stages, respectively, from different parts of India. In the light of these finds it can be safely assumed that the Lycopods existed in the Palæozoic of India.

The spatial separation of *Glossopteris* flora on the one hand and flora dominated by *Lepidodendron* and *Sigillaria* on the other, is almost taken for granted (Fox, 1931: 70–77). It is also sometimes suggested that the passage of time permitted a comingling of the two floras in South America in the Upper Palæozoic times. In the light of evidence (*vide* supra) the co-existence of these two floras in the Palæozoic of India is evident. Their co-extension from Talchir to Karharbari and thence to Barakars (Lr. Permian) is also shown. We thus find a consistent and co-extensive record of the *Glossopteris* and *Lycopodiales* from the upper Carboniferous to Lower Permian of India.

While defining the genus *Cystopsorites* Schopf *et al*, (1944: 40) lay stress on the fibrous aspect of the spore coat of these specimens. My specimens have a smooth sporecoat with two distinct zones, but. otherwise resemble those figured and described by Schopf. This difference perhaps does not warrant a generic separation. I have, therefore, included my specimens within the genus *Cystosporites*. Due to the difference in spore coat and because of their smaller size, I have separated my spores from *C. breretonensis* Schopf, and placed some of them under *C. indicus* sp. nov., while a few forms which could not be accommodated here, have been separated, but as these are not sufficiently well preserved no new specific name has been given.

The presence of *Cystosporites* in the Barakars [Lower Permian] (Wadia, 1939: 130) is not only interesting in itself but it also shows that this genus was not confined to Carboniferous as suggested by Schopf *et al.* (1944) but extended to Lower Permian as well. This is also the first record of the genus from this country.

## SUMMARY

(1) *Triletes kotahensis* sp. nov.
(2) *Triletes granulosus* sp. nov.
(3) *Triletes* sp.
(4) *T. singraulensis* sp. nov.
(5) *T. elongatus* sp. nov.
(6) *T. papillarius* sp. nov.
(7) *T. punctatus* sp. nov.
(8) *T.* (*Lagenicula*) sp.
(9) *T. brasserti* Stach et Zerndt.
1. *Cystosporites indicus* sp. nov.
2. *Cystosporites* sp.

A, B, C, three types of sporangia and a doubtful seed have been described in this paper.

The high proportion of new species is significant.

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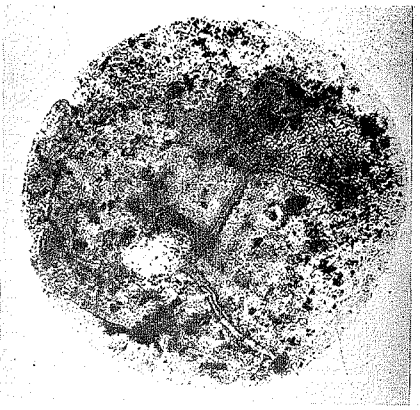

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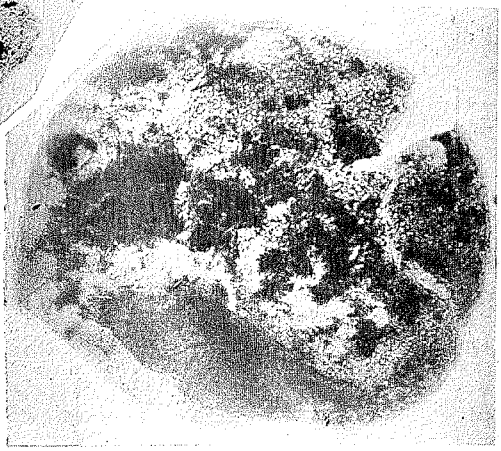

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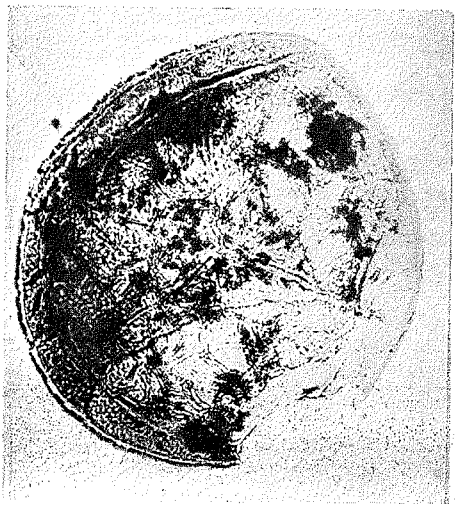

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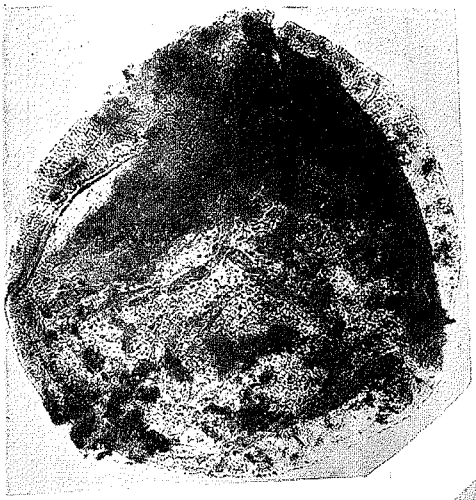

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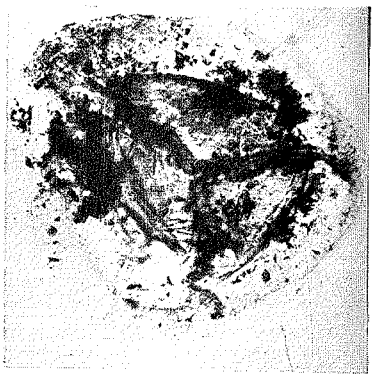

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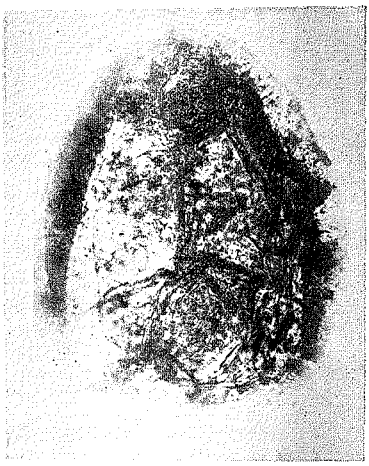

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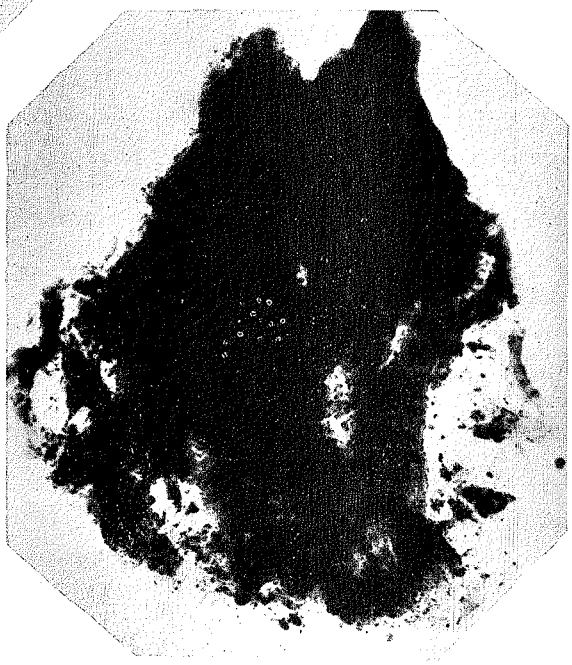

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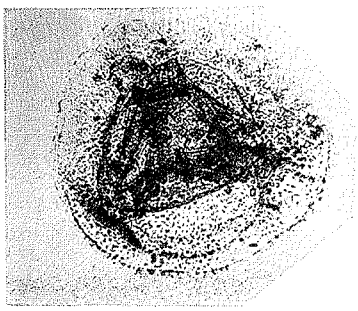

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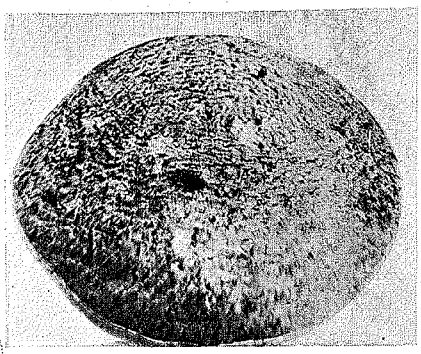

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## EXPLANATION OF PLATES

### PLATE III

Photo 1. *Triletes kotahensis* sp. nov.—Suture lines are clearly visible, ×88.

Photo 2. *Triletes granulosus* sp. nov.—The granular nature of the exine is very clear. The transparent trilete-like suture is due to the rupture of exine, ×88.

Photo 3. *Triletes* sp.—The papillæ in surface view can be clearly seen, at a few places they can be seen in optical section also, ×41.

Photo 4. *Triletes singraulensis* sp. nov.—Verrucose nature of exine is clearly seen, ×76.

Photo 5. *Triletes singraulensis* sp. nov.—Verrucose nature of exine even better than in Photo. 4, contact areas, and suture lines are also discernible, ×75.

### PLATE IV

Photo 6. *Triletes singraulensis* sp. nov.—Another well preserved specimen, ×87.

Photo 7. *Triletes elongatus* sp. nov.—Dark specimen with folds, ornamentation not very clear, ×50.

Photo 8. *Triletes elongatus* sp. nov.—Both proximal and distal ornamentation seen, ×62.

Photo 9. *Triletes brasserti* Stach and Zerndt.—Specimen showing sinuous suture lines, ×77.

Photo 10. *Triletes brasserti* Stach and Zerndt.—An overmacerated specimen, which shows very clearly the sinuous nature of the suture lines, ×75.

Photo 11. *Triletes sp.*—A badly preserved specimen with folds, ×44.

Photo 12. *Triletes punctatus* sp. nov.—Specimen showing ornamentation and the neck with probably two carbonised (?) abortive spores, ×50.

### PLATE V

Photo 13. An unknown form, probably a seed, ×35.

Photo 14. *Cystosporites indicus* sp. nov.—Seed megaspore, the membrane can be seen at a few places, ×256.

Photo 15. *Cystosporites indicus* sp. nov.—The outer membrane can be clearly seen at the proximal side, an abortive dark spore can also be seen, ×24.

Photo 16. Sporangium A.—The dark central area may represent a megaspore, ×50.

Photo 17. *Triletes papillarius* sp. nov.—Specimen showing the papillæ and the flat lobular area at the junction of the three suture lines, ×110.