ON FOSSIL FLORA OF GANJRA NALLA BEDS: PART II — MICROFLORA (A) DISPERSED SPORES AND POLLEN GRAINS

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ABSTRACT

Carbonaceous, micaceous shales from Ganjra nalla beds (Permo-Carboniferous) of South Rewa Gondwana basin Central India, on maceration yielded a very rich microflora consisting of cuticles, tracheids and spores. Single spore mounts of about 375 microspores and 35 megaspores were prepared. These were placed into 66 species under 19 genera. In the first instance the system of classification proposed by Schopf, Wilson and Bentall was followed but later on it was felt that till the accumulation of sufficient data it would be better to arrange the dispersed spores according to their morphographic characters in a purely artificial system. Hence in the present paper many ill defined spores have been left out, and the remaining 102 dispersed spores have been arranged according to the system proposed by Potonié and Kremp (1954) and Potonié (1958, 1960) into 35 genera and 47 species.

The shales are crowded with the leaf impressions of *Noeggerathiopsis hislopi*, and several species of *Glossopteris*, which come next in frequency to *Noeggerathiopsis hislopi*. Impressions of *Gangamopteris cyclopteroides*, *Phyllotheca* and *Samaropsis* are also met with.

Microspores of the genera *Plicatipollenites*, *Parasaccites*, *Florinites*, *Illinites*, *Potonieisporites* and *Cuneatisporites* are in abundance. But I feel that the correlation of megafossils, which are generally arranged in a natural system, with the microfossils arranged in a purely artificial system does not seem to be quite justified, and hence no attempt has been made.

INTRODUCTION AND ACKNOWLEDGEMENTS

THE study of fossil spores has rapidly grown in several parts of the world in recent years. The present work was done in the years 1945-47, but due to some reason or other it could not be given a final shape till now. Every time when an attempt was made to bring the paper up-to-date in order to publish the results of this investigation, it was found that it needed lot of changes because of the rapid pace with which the work on fossil spores was advancing in India and abroad, and with which the author mostly remained out of touch. Good deal of investigation on dispersed spores has been done at the Birbal Sahni Institute of Palaeobotany in India, and this has been a constant source of inspiration and guidance. It is mainly due to this that the present work has been able to see the light of the day.

The author is highly indebted to late Prof. Birbal Sahni for suggesting this line of investigation. He is also thankful to Prof. T. G. Halle and Prof. J. M. Schopf for valuable suggestions and hints. The author expresses his deep sense of gratitude to Dr. D. C Bharadwaj, who is mainly responsible in guiding the author to bring the work up-to-date and in line with the most accepted scheme of classification of fossil spores.

MATERIAL AND METHODS

The material consists of more than 40 pieces of dark gray micaceous, carbonaceous shales collected by the author from the Ganjra nalla bed in South Rewa Gondwana basin in the years 1932, 1944 and 1946. These pieces are crowded with the impressions of *Noeggerathiopsis hislopi* and several species of *Glossopteris*. Impressions of *Gangamopteris cyclopteroides*, *Phyllotheca* and some species of *Samaropsis* have also been found.

The beds at Ganjra nalla locality are situated just below the coal seam of the Johilla coal mines, in the South Rewa Gondwana basin, some 1½ miles South-West of Birsinghpur Railway station on the Katni-Bilaspur branch of the South-Eastern Railway. The micaceous carbonaceous shales are exposed on the left bank of Ganjra nalla, where it takes a turn to the right, some hundred yards before its confluence with the Johilla river.

The coal above these shales is supposed to be of Barakar age (HUGHES, 1881). Virkki (1945) included this locality under the Pali beds, but the name Pali beds has been used (Fox, 1931) for the localities at Daigaon and Karkati, where the fossils are preserved in red ferruginous shales and sand-stones which are above the Barakars (Supra Barakars), while the Ganjra nalla beds, where fossils are in micaceous carbonaceous shales, are below the Barakars (Infra Barakars), and are situated at the bottom of the coal seam. Hence the author prefers to call these beds as Ganjra nalla beds.

These shales easily disintegrate in water and crumble to pieces, but in order to get clear preparations of the micro-fossils Schultze's macerating fluid was used. Small pieces of shale were washed in distilled water and dried over a flame, and then those were kept in the weak macerating fluid for 24 to 36 hours. The macerate was thoroughly washed in several changes of distilled water and then centrifuged. The microfossils were picked up from the centrifuged mass with the help of a micro-pipette and single spore mounts were prepared in Canada balsam.

WORK ON FOSSIL SPORES AND POLLEN GRAINS AND THEIR CLASSIFICATION

The work on fossil spores and pollen has gathered momentum in the second quarter of the present century, when vast amount of literature has been turned out (Erdtman 1927 to 1944, Ibrahim 1933, Wodehouse 1933, Naumova 1937, Knox 1938, Schopf, Wilson & Bentall 1944, Moore 1945). The work on fossil spores and pollen was taken up a bit late in India (Virkki 1945, Mehta 1945, Hsü 1946, Pant 1946) towards the end of the second quarter of 20th century, and the author falls in line with the workers of this time. Later on the B.S. Institute of Palaeobotany became an important centre, where this line of study grew and developed as a distinct branch of Palaeobotanical Research, and lately much work has been published in this branch of science (Potonié & Lele 1961; Bharadwaj 1962; Bharadwaj & Salujha 1964; Bharadwaj & Tiwari 1964, 1964a, 1965; Lele 1964, 1965; Maithy 1965; Tiwari 1964, 1965).

There are two distinct aspects of this line of study Botanical and Geological. The botanical aspect is more or less academic in nature, and its importance lies in the fact that it has added a large number of new forms of spores and other mioflora to our knowledge. This mioflora, besides enriching our knowledge of fossil forms has helped us in assigning several fossil species to their correct systematic position.

The geological aspect of the study of mioflora is connected with its industrial and economic application. It has proved of considerable interest in the correlation of coal seams based on their microscopic floral contents and in stratigraphical correlation work. Many workers are engaged throughout the world in this line of research (Raistrick & Simpson 1933; Raistrick 1934; Naumova 1937; Cross 1944; Bharadwaj 1957; Kosanke 1950; Bharadwaj & Tiwari 1964, 1965).

The two lines of study mentioned here have different methods of grouping and classifying spores. When used for correlation work then we are not concerned much about their exact systematic position in the plant kingdom. But in the case of their botanical study we are required to classify them in a particular way showing their affinities and systematic position in the plant kingdom. These two lines of study have been thoroughly discussed by Bharadwaj (1955a) where he has also made brief comments on various systems of classifications and taxonomy of *Sporae dispersae*. In the case of dispersed spores of particular type unless clear relationship can be established with a particular fossil plant of that age, it is not only difficult but impossible to classify them in a natural system of classification corresponding to that of the plants of that age. In the beginning it becomes necessary to arrange the dispersed spores and pollen grains in an artificial system based on morphographic characters.

The classification of dispersed spores is one of the most tedious and puzzling problems in Palaeobotany. Fossil spores in this collection are so numerous and present such a great diversity of form and structure that many a times it presents great difficulty in an attempt to arrange them in some suitable scheme of classification.

At the time when this work was taken in hand there were several schemes of classification, and different schemes were being followed in different countries. In some schemes one set of characters were given more importance while in other a different set of characters were selected as criteria. Some authors classified spores in a phylogenetic system on the analogy of higher taxa (Schopf 1938, Schopf, Wilson & Bentall 1944), while others classified them in purely artificial systems depending on morphological characters (BENNIE & KIDSTON 1886; IBRAHIM 1933; NAUMOVA 1937; ERDTMAN 1947; KNOX 1950; PANT 1954; POTONIÉ & KREMP 1954 & POTONIÉ 1956, 1958 & 1960).

All the spores found during present investigation were originally arranged on the lines proposed by Schopf, Wilson & Bentall (1944). But now in the present paper only a few distinct forms have been selected from the whole lot and have been arranged according to their morphographic characters as suggested by Potonié and Kremp (1954, 1956) and later extended by Potonié (1956, 1958, 1960) as well as by Bharadwaj (1955b, 1962).

In the case of fossil dispersed spores and pollen grains of Palaeozoic period sometimes the morphographic characters are not clearly seen and present great difficulty in their study due to the method, mode and state of fossilization and preservation. The chemical treatment given to the spores in order to clear them off from the matrix is also liable to destroy some of the important features. Erdtman (1947) has rightly warned that "when studying the microfossils of old deposits, a pollen analyst cannot determine the pollen grains and spores in the same way as when dealing with more recent material."

In the case of some of the morphological characters which are helpful in the classification of spores, it has been shown here that the mode of preservation and the laboratory treatment is liable to bring about changes in them to different degrees, which may lead to deception while assigning them to a species under a genus. The characters usually employed in morphographic classification are:

(1) Shape and size of spores,
(2) Surface sculpturing,
(3) Tetrad mark, aperture, germpore or slit,
(4) Presence or absence of wings or sacs, and their attachment to the body of spore.

(1) *Shape and size of spores* — The shape and size of fossil spores, even when belonging to a single biological species may present considerable variation due to several factors. Spores at different stages of development will be different in size and may also differ in shape. The shape may differ according to the angle of compression, stable side of spore, or the side on which it rests, the angle of rest, the nature of the surface of matrix (rough or smooth), the conditions of deposition and mode of fossilization.

A living spore is a three dimensional object. When preserved as a microfossil it is compressed into a flat structure, very different from what it was in a living state; during flattening caused by compression a spore is considerably distorted out of shape and is also altered in size; the larger and more delicate a spore, the greater is the distortion and change in size. The final shape after compression depends upon its orientation during flattening process. Some spores have preferential orientation and mostly lie either on the proximal or on the distal side unless they are distorted and crumpled due to some other factor. Such spores undergo least alteration in shape. Spores without preferential orientation may present different shapes depending on the side of rest during compression. Thus in an attempt towards natural classification of fossil dispersed spores one is liable to make grave mistakes, it is more so because it is not possible to make a study of the changes taking place in size and shape at different developmental stages of fossil spores.

In fossilized state lot of carbonized matter and sand particles cover a spore. Before such a spore can be studied the sticking foreign matter must be removed with the help of reagents which make further changes in its shape, size and surface markings.

(2) *Surface sculpturing* — In a fossil spore the surface sculpturing is liable to be altered considerably during maceration depending on the duration for which a spore is kept in the maceration fluid, on the concentration of an acid and an alkali, and on the condition and state of preservation of individual spores. The same reagent allowed to react for the same duration may have varied effects on different spores depending upon their state of maturation and the state of preservation. I have found that in the same macerating fluid some spores get completely dissolved, while others do not get even fully macerated, other conditions remaining the same. Besides this the sculpturing in a spore may differ at different stage of its development.

(3) *Tetrad mark* — The tetrad mark is represented in a tetrahedral type of spore by tri-radiate ridges, and in a bilateral type

of spore by a line. The side of a spore having tetrad mark is known as proximal or dorsal side and the one opposite to it is distal or ventral side. In the lower group of plants (Ferns) the tetrad mark takes over the function of a germinal apparatus. A germ pore or slit is a line of dehiscence found in the spores of higher group of plants, and is situated on its distal side. Such spores are better termed as pollen.

In fossil spores only two faces can be examined and many a times due to defective preservation the tetrad mark or slit may be so placed or obliterated that it may not be noticed at all. In some spores it becomes difficult to decide their dorsal and ventral sides. Sometimes a crack in the exine, developed during preservation or maceration, may be confused for a slit. Hence a great deal of caution is necessary when considering a tetrad mark or a slit as a criterion.

(4) *Presence and nature of wings* — The presence or absence of wings, their nature, mode of attachment and their number are used as important characters in morphographic classification of spores. In this case too it is necessary to judge the above factors in correct way in the case of miospores.

KEY TO THE CLASSIFICATION OF SPORES

The system of classification of the dispersed spores followed here is that used by Potonié and Kremp (1954) and later elaborated by Potonié (1956, 1958, 1960) and Bharadwaj (1962).

The spores found in this collection have been arranged according to the following scheme :

I. *Sporites* H. Potonié 1893 — Cryptogamic spores with always proximal germinal exit.

(I) *Triletes* — (REINSCH 1881) Potonié & Kremp — Iso, micro and megaspores with trilete mark, and no other germinal apparatus, and also no auriculae, cingulum, zona or sacci.

(A) *Azonotriletes* Luber 1935 — Without zona.

(1) *Laevigati* (BENNIE & KIDSTON 1886) R. Potonie 1956. Exine smooth, punctate, infragranulate, infra-reticulate.

1. *Trileites* (ERDTMAN 1945, 1947) ex Potonié.

2. *Duosporites* Höeg, Bose and Manum 1955.

3. *Leiotriletes* (NAUMOVA, 1937) Pot. & Kr. 1954.

4. *Punctatisporites* (IBRAHIM 1933) Pot. & Kr. 1954-55.

5. *Calamospora* Schopf, Wilson & Bentall 1944.

(2) *Apiculati* (BENNIE & KIDSTON 1886) R. Potonié 1956. Exine with grana, verrucci, coni, spini, bacula, capilli (Fimbrae).

6. *Verrucosisporites* (Ibr.) Pot. & Kr. 1954.

7. *Beharisporites* R. Potonié 1956.

8. *Acanthotriletes* (NAUMOVA 1937? 1939) ex Pot. & Kr.

9. *Microbaculispora* Bharadwaj 1962.

(3) *Murornati* Pot. & Kr. 1954. Exine with small or long muri, striemen, ridges with uneven top surface peaked.

10. *Reticulatisporites* (IBRAHIM 1933) Pot. & Kr. 1954.

(II) *Zonales* (BENNIE and KIDSTON 1886 von IBRAHIM) emend. Trilete spores with crassitudo, cingulum, zona, corona, auriculae, equatorial apendices or elators.

(A) *Auritotriletes* Potonié & Kremp 1954. Spores with valvae, auriculae, appendices or elators.

(1) *Auriculati* (Schopf) Pot. & Kr. 1954. With valvae and auriculae.

11. *Triquitrites* (WILSON & COE 1940) Pot. & Kr. 1954.

(B) *Zonotriletes* Waltze 1935. with crassitudo, Cingulum, zona or corona.

(1) *Cingulati* R. Potonié and Klaus 1954. Cingulum and crassitudo.

12. *Lycospora* (SCHOPF, WILSON & BENTALL, 1944) Potonie and Kremp 1954.

13. *Densosporites* (Berry) Pot. & Kr. 1954.

(III) *Monoletes* Ibrahim 1933. Spores with one long tectum parallel to the long axis (Monolete mark).

(A) *Azonomonoletes* Luber 1935. Without zona.

(1) *Psilamonoleti* vonder Hammen 1955. Exine smooth.

14. *Laevigatosporites* Ibrahim 1933.

II. *Pollenites* R. Potonié 1931. Pollen grains.

(I) *Saccites* Erdtman 1947. With sac or bladder.

(A) *Monosaccites* (CHITALEY 1951) Pot. & Kr. 1954. Single spore sac.

(1) *Triletesacciti* Leschik 1955. Trilete mark present.

(i) *Apertacorpiti* Lele 1964

15. *Plicatipollenites* Lele 1964.

16. cf. *Virkkipollenites* Lele 1964.

17. *Parasaccites* Bharad. & Tiwari 1964.
18. *Stellapollenites* Lele 1965.
19. *Guthorlisporites* Bhardwaj 1954.
(2) *Aletesacciti* Leschik 1965.
20. *Florinites* Schopf, Wilson & Bentall 1944.
(3) *Vesiculomonoraditi*
21. *Potonieisporites* (BHARDWAJ 1954) Bharad. 1955.
22. *Vestigisporites* Balme & Hennelly 1955.
(B) *Disaccites* Cookson 1947. Spores with two sacs.
(1) *Striatiti* Pant 1954.
23. *Striatites* (PANT 1954) Bharad. 1962.
(2) *Striareticuloiditi* Tiwari
24. *Lunatisporites* (Lesch.) Bharadwaj 1962.
25. *Verticipollenites* Bharadwaj 1962.
26. *Strotersporites* Wilson 1962.
27. *Primuspollenites* Tiwari
(3) *Disaccitrileti* Leschik 1955.
28. *Illinites* (KOSANKE Gribe & Suhweitzer 1962.
(4) *Disacciatrileti* (LESCHIK 1955) Pot. 1958.
29. *Pityosporites* (SEWARD 1914) Potonié 1958.
30. *Alisporites* Duagherty 1941.
31. *Sulcatisporites* (LESCHIK 1955) Bharadwaj 1962.
(5) *Podocarpoiditi* Pot. Thomson & Thiergart 1950
32. *Cuneatisporites* Leschik 1955.
(II) *Polyplicatus* Erdtman 1952.
33. *Welwitschiapitys* Bolchowit.
(III) *Monocolapates* Iversen & Troels-Smith 1950
(1) *Intortes* (NAUMOVA 1937) Pot. 1958.
34. *Vittatina* Luber 1940.
35. *Marsupipollenites* Balme & Hennelly 1956.
III. *Pollenites Insertae.*

DESCRIPTION

I. *Sporites* H. Potonié 1893.
(I) *Triletes* Reinsch 1881.
(A) *Azonotriletes* Luber 1935.
(1) *Laevigati* (BENNIE & KIDSTON 1886) R. Potonié 1956.
1. *Trileites* sp. (ERDTMAN 1945, 1947) Ex. Potonié.

Trileites sp.

Pl. 1, Figs. 1, 2

Trilete megaspore, equator more or less circular, Y rays at least so long as almost reaching up to the equator; exine smooth, finely granulate or weakly wrinkled.

These can be distinguished from species of *Laevigatisporites* due to longer arms of Y rays.

The specimen shown in Fig. 1, Plate 1 shows the side view of a large megaspore, the area contagionis is seen on its right hand side. The wall is thick and looks granular. This is probably due to the sticking particles of sand and coaly matter on the surface of exine in this case. The greatest length of the spore measures 1108 micron.

The other specimen (PLATE 1, FIG. 2) seems to belong to the same species and presents its proximal view. It measures 724 micron. The wall is thick and smooth and the rays of the triradiate mark are equal and long. Area contagionis is very clear and has double outlines, the outer of the two is curved while the inner is more or less straight.

The megaspores of the genus *Laevigatisporties* Ibrahim (1933) are much smaller in size. The genotype of *Triletes* (ERDTMAN 1945) measures 1140 microns (POTONIÉ 1956, PLATE II, FIG. 16), but is reported from Wealden (Lower Cretaceous) of Netherland, while the specimens described here come from Permo-Carboniferous beds of Gondwanas of South Rewa (India), and hence inspite of similarity in several respects, comparison has not been considered advisable.

The microflora from Carbonaceous shales of Ganjra nalla beds (wrongly named as Pali-beds) was first worked out and described by Virkki (1945), but she has not mentioned or described any megaspore. This may be because megaspores are sparsely found in these shales.

These spores resemble *Tuberculatisporites* (BHARDWAJ & KREMP 1955, PLATE 4, FIG. 1) in size, shape, type of triradiate mark and form of area contagionis, but differ in not having the tuberculate exine. Similarly trilete megaspores described from Lower Gondwanas of India by Srivastava (1955) differ widely in the nature of exine. Same is the case with the Megaspore from the Lower Gondwanas of Bihar (SURANGE, SRIVASTAVA and SINGH 1953).

It appears that this species is different from those already described from the Lower Gondwanas of India so far. However, unless fully established, no new specific name is being proposed for these spores.

2. *Duosporites* Höeg, Bose & Manum 1955.

Megaspores with triradiate mark and smooth or nearly smooth surface. Mesosporium detached from exosporium except in an area on the proximal side. Proximal part of mesosporium provided with nipple like projections pointing towards the interior of the spore.

Two spores are described here, one (PLATE 1, FIG. 3) 616 microns and the other (PLATE 1, FIG. 4) is 316 microns. Both the spores are placed under one and the same species *Duosporites multipunctatus* Höeg and Bose (1960, PLATE XXXI, FIGS. 9 to 12).

Duosporites multipunctatus Höeg & Bose 1960.

Pl. 1, Figs. 3, 4

Trilete megaspore with a mesosporium sub-spherical and sub-triangular, diameter, in the macerated state 270-630 μ, triradiate mark prominent. Exine slightly rough. All the arms of triradiate mark surrounded by irregularly scattered, closely packed, small thickened projections, altogether more than 100 in number. In the figures (PLATE 1, FIGS. 3 & 4) the spores have only mesosporium left out showing small thickened projections, irregularly scattered all round the triradiate mark. The mesosporium is thin, hyaline and thrown into fold, and exine has been dissolved out during maceration.

Höeg and Bose (1960) described this species from the Permo-Carboniferous beds of Walikale region of Belgian Congo (Africa) where Glossopteris flora has been found. Megaspores of this species have not so far been described from the Lower Gondwanas of India, and it is at Ganjra nalla locality that these have been found associated with Glossopteris flora of Permo-Carboniferous age.

3. *Leiotriletes* (NAUMOVA 1937) Pot. & Kr. 1954.

Trilete iso- or micro-spores with smooth margin and triangular equatorial contour. The sides are either distinctly concave or somewhat convex. The curvature of the sides can also be rather strong but as long as the triangular shape remains recognizable or the three faces of the proximal pyramid are rather steep the spores belong to *Leiotriletes*. The vertices are more or less rounded or bluntly pointed, sculpture occasionally infrapunctate to finely infrareticulate, Y rays mostly longer than half radius.

In the generic diagnosis mentioned in Potonié & Lele (1961) based on Potonié & Kremp (1955) it is said that in *Leiotriletes* are placed triangular and subtriangular forms with smooth exine even if the equator approaches very much a circle. By looking at the figures in Potonié and Lele (1961, PLATE I, FIGS. 6 & 9) it becomes very difficult to find out as to why the two spores shown in figures 6 and 9 have been kept under two different genera, when the spore described as *Leiotriletes* (POT. & LELE 1961, PLATE I, FIG. 6) is neither triangular nor sub-triangular, nor it has smooth exine. Spore described from Salt-range, Punjab (India) by Virkki (1945, p. 137, PLATE 7, FIG. 101) seems to belong to *Leiotriletes*.

Leiotriletes conspicuous sp. nov.

Pl. 1, Fig. 5

Holotype — Pl. 1, Fig. 5.

Diagnosis — Spore triangular with almost straight walls and rounded apices. Triradiate mark very conspicuous, and all its arms reach the equator and have double wavy outline. Wall is thick and smooth. The spore along its longest axis measures 42 microns. Following species are comparable to some extent.

Leiotriletes sphaerotriangulus (Loose 1952 in Pot., Ibr. & Loose plate 18, Fig. 15) Pot. & Kr. 1954

Leiotriletes adnatoides Pot. & Kr. 1955

Leiotriletes subadnatoides Bharadwaj 1957.

This spore differs from *L. sphaerotriangulus* in shape, and from *L. adnatoides* in having one of the axes of the triangle longer than the two and having prominent double lined wavy arms of the triradiate mark.

4. *Punctatisporites* (IBRAHIM 1933) Pot. & Kr. 1954

Triletes iso- or microspores, equatorial shape circular or nearly circular with only slight indication of triangular form, margin smooth. Exine sculptureless, structure not recognizable or punctate to infrareticulate (not to be confused with granulate sculpture which makes the margin rough), perhaps also only local, e.g. visibly punctate only along the rays. The rays of trilete mark mostly longer than half radius of the spore. Distinguishable from Calamospora through the length of rays and through the wanting area contagionis.

The spores of this genus in the present collection can be placed under two distinct species — *P. punctatus* Ibrahim and *P. gretensis* Balme & Hennelly. Earlier workers have made different species on the basis of size of spores or difference in thickness of exine. Spore Nos. 20, 9 and 25 descibed from Salt Range, Punjab, India, by Virkki (1945, PLATE 4, FIG. 40, and PLATE 6, FIGS. 67 & 75) seem to be species of *Punctatisporites*. These range in size from 50 to 67 microns.

Punctatisporites punctatus Ibrahim 1932

Pl. 1, Figs. 6, 7

There are six specimens of this species, one of them measures 43 microns (Fig. 6) and others 46 microns (Fig. 7). The arms of the trilete mark reach almost the equator, which is circular. Exine thick, smooth and clearly punctate.

P. punctatus has been described by Potonié and Lele (1961) from the Talchir beds of South Rewa Gondwana basin, India.

Punctatisporites gretensis Balme & Hennelly 1956

Pl. 1, Figs. 8, 9

These spores are larger in size than those of the above species and measure 79 to 86 microns. Exine is very thick and smooth. The diagnosis given by Balme & Hennelly (1965 b, p. 245, PLATE 2, FIGS. 11 to 13) of the spores from Australian Permian sediments agrees fully in the case of these spores.

Spores of this species have also been described from Belgian Congo by Höeg and Bose (1960, p. 23, PL. XXVII, FIGS. 1-2; p. 76, PL. XXXI, FIGS. 1-2) and from the coals of Barakar Stage of India by Tiwari (1965, PL. 1, FIG. 5). Fourteen spores of this species are recorded in this collection.

5. *Calamospora* S.W. & B. 1944

Spores trilete, radial, spherical or nearly so; when compressed readjustment to a disc-like form leads to formation of characteristic sharp taper point folds of variously crescentic or narrowly lenticular outline. Sometimes the spores are folded double so that the whole external outline is sharply lenticular. Such folds are the characteristic features of the genus. Exine smooth in general appearance or very minutely granular. Trilete rays notably short, usually not exceeding ½ the length of spore radius. Size 40 to several hundred microns. Spore coat relatively thin, all thickness ranging from 2 to 15 microns in various species. In most cases tetrad mark is not visible.

Two species are present in this collection, but both of these differ from the Palaeozoic species described earlier namely: *Calamospora pallida* (Loose) S.W. & B. and *Calamospora microrugosa* (IBRAHIM) S.W. & B. from the Coal Measures of West Germany (BHARDWAJ 1957, PL. 23, FIGS. 16-18 and 19-20 respectively).

Spore No. 1 (PL. III, FIG. 24) 46 microns; spore No. 2 (PL. X, FIG. 129) 43 microns; spore No. 14 (PL. XIV, FIG. 179) 56 microns and spore No. 23 (PL. IV, FIG. 41) 40 microns of Virkki (1945) from Salt Range, Punjab, India, seem be be species of *Calamospora*.

Calamospora ovalis sp. nov.

Pl. 1, Fig. 10

Diagnosis — The spore size 51 microns. Spore oval in outline. Exine smooth and thick, having longitudinal crescent shaped folds. The inner side of the spore wall seems to be lightly granular. Y mark is not seen. Compare spores from Salt Range, Punjab, India (VIRKKI 1945). 13 spores of this species are recorded.

Calamospora majus sp. nov.

Pl. 1, Figs. 11, 12

Holotype — Pl. 1, Fig 11

Diagnosis — The spores range from 85 to 104 microns. Exine smooth, thin and thrown in crescentic folds. Trilete mark not prominent. Shape oval. One of these spores (Fig. 12) has slightly thicker wall than that of the other two spores, and has clearer indication of triradiate mark.

(2) *Apiculati* (BENNIE & KIDSTON 1886) R. Potonié 1956

6. *Verrucosisporites* (Ibr.) Pot. & Kr. 1954

Verrucosisporites sp.

Pl. 1, Fig. 13

Trilete triangular or more or less circular spores with dense warty ornamentation of the exine. Warts of irregular size with a broader base.

A single spore from this collection has been assigned to this genus. It has more or less circular outline and measures 40 microns. The exine is covered with verrucae. Triradiate mark is not very prominently seen. It is comparable to some extent with *Verrucosisporites bullatus* Balme & Hennelly (1956b, p. 250, PL. IV, FIGS. 45, 46) but differs from it in size and shape of verucae.

7. *Beharisporites* R. Potonié 1956

Spore circular, rays more than 2/3 radius. Area contagionis, sometimes differentiated. Exine densely ornamented with small coni.

Beharisporites rewaii sp. nov.

Pl. 1, Figs. 14-16

Holotype — Pl. 1, Fig. 14

Diagnosis — Large round spores, size 600 to 662 microns. Coni small.

Three spores have been assigned to this species ranging in size from 600 to 662 microns. Trilete mark in one of them is clearly seen. These spores differ from other species described from the Lower Gondwanas.

B. spinosus (*Triletes spinosus*) Singh in Surange, Srivastava and Singh (1953, p. 12, PL. I, FIG. 1) differs from the present species being smaller in size, having clear area contagionis and also in having coni of larger size.

B. datmensis Srivastava in Sur., Sriv. and Singh (1953, p. 15, PL. 4, FIG. 18) has triangular shape with prominent coni.

The closest resemblance is with *B. myrmecodes* (Harris) new comb. in Sur. Sriv. and Singh (1953, p. 14, PL. 3, FIG. 15) but for very clear triradiate mark in *B. myrmecodes*, which is not the case in the present species.

8. *Acanthotriletes* (NAUMOVA 1937?, 1939) ex Pot. & Kr. 1954. Spores triangular. Exine all over ornamented with spinae.

Acanthotriletes sp.

Pl. 1, Fig. 17

A single spore has been assigned to this genus. It has sub-triangular outline. Triradiate mark is not visible. Exine is covered with spines which have triangular base. The height of the spines in general varies, in some it is less and in some it is more than the basal diameter of the spines. It has been kept under this genus as a temporary measure. The spines of *Acanthotriletes* described by Balme & Hennelly (1956) do not compare with this spore, but it is comparable to some extent with *Apiculatisporites* (*Apiculatisporis*) *filiformis* Balme & Hennelly (1956b, p. 247, PL. 2, FIGS. 22-23).

9. *Microbaculispora* Bharadwaj 1962

Miospores, triangular with broadly rounded angles, and outwardly bulging convex sides in polar view. Trilete mark distinct, labra thin, vertex low but usually appearing elevated due to secondary folds accompanying the labra. Exine thin, densely sculptured with thin uniformly spaced and sized bacula (Plate I, Fig. 20).

Microbaculispora indica Tiwari 1965

Pl. 1, Figs. 18, 19

Description — Triangular miospore with clear triradiate mark having all the three arms of unequal length, reaching the equator. Size of the spore 64 microns along the longest axis.

A single spore has been obtained from the Ganjra nalla locality. Figs. 18 and 19 show the same spore at different facus.

(3) *Murornati* Pot. & Kr. 1954

10. *Reticulatisporites* (IBRAHIM 1933) Pot. & Kr. 1954

cf. *Reticulatisporites* sp.

Pl. 1, Figs. 20, 21

Trilete mark often difficult to see. Exine with bold net sculpture. The lumina of the reticulum are bounded by high muri so that the muri in optical section of the exine appear as projections standing vertically on the spore exine outline. If on the other hand muri lie at right angles to the direction of the view they appear as membranes which join these projections together.

Two spore groups and a single spore have been found in the present collection. It has not been possible to assign these to any definite species, though all seem to belong to one and the same species. The spores in the group measure 34 to 36 microns (PLATE I, FIG. 20) and the single spore (PLATE I, FIG. 21) measures 29 microns.

(II) *Zonales* (BENNIE & KIDSTON 1886 VON IBRAHIM) emend.

(A) *Auritotriletes* Potonié & Kremp 1954

(1) *Auriculati* (Schopf) Pot. & Kr. 1954

11. *Triquitrites* (WILSON & COE 1940) Pot. & Kr. 1954

Trilete iso- or microspores of nearly triangular equatorial contour in which the exine of the triangle apices is either only a little thickened and therefore appears darker (valvae) or shows small, pointed or rounded, not very big projections. The latter are termed as small ears (Auriculae).

Triquitrites valvaetus sp. nov.

Pl. 2, Fig. 22

Holotype — Pl. 2, Fig. 22

Diagnosis — Triangular spore with valvae on the rounded angles (apices). Longest axis 35 microns. Exine smooth and thick trilete mark small. One side of the spore straight or slightly convex, and the other two sides slightly concave giving the apex between them an auriculate shape.

This spore does not resemble any of the other species of *Triquitrites*, and is larger than the spores of other species.

(B) *Zonotriletes* Waltze 1935

(1) *Cingulati* R. Potonié & Klaus 1954

12. *Lycospora* (S.W. & B. 1944) Pot. & Kr 1954

Trilete iso- or microspores with cingulum, that means with characteristic equatorial girdle. The cingulum is set on the equator as a ring of wedge like section. The height of the section of the wedge can exceed double its basal width. Through the thinning off of its outer margin the cingulum lends the spore a lens like shape. Y rays distinct and more or less straight, reaching to the equator of the central body. Exine smooth, or granulated.

Lycospora minuta sp. nov.

Pl. 2, Fig. 23

Holotype — Pl. 2, Fig. 23

Diagnosis — Spores round measuring 24 to 35 microns, exine smooth cingulum unifrom. Triradiate mark clear with short rays.

These spores differ from all the other species of *Lycospora* in the size of its rays. Three spores are recorded under this species.

Compaer:

Zonales — sporites pusillus Ibrahim (1933, p. 32, PL. II, FIG. 20). Spore No. 16 of Virkki (1945, p. 119, PL. III, FIG. 36).

13. *Densosporites* (BERRY) Pot. & Kr. 1954

Spores triangular to roundly triangular, tetrad mark visible or not, rays may or may not be extending to equator, exine in polar area thin, but in equatorial area thickened forming equatorial cingulum 1/2 to 1/3 radius broad.

Densosporites splendens sp. nov.

Pl. 2, Fig. 24

Description — Spore triangular with almost straight sides and rounded apices. All the three sides are of equal length (equatorial). The spore measures 50 microns along the axis. Triradiate mark prominent, arms wavy reaching almost the margin. Margin thickened forming equatorial cingulum, about ½ the radius broad, and in the middle of the thickened cingulum a line indicates the portion of the main body of spore, the interior half which is darker than the exterior half. Only one spore has been assigned to this species.

No similar spore has so far been described from the Lower Gondwanas of India. The spore is comparable to *Angulisporites* Bhardwaj (1955b) but differs from it in having straight sides, smooth exine, light coloured body and wavy arms of triradiate mark.

(III) *Monoletes* Ibrahim 1933

(A) *Azonomonoletes* Luber 1935

(1) *Psilamonoleti* van der Hammen 1955

14. *Laevigatosporites* Ibrahim 1933

Spore oval in outline. Surface more or less smooth with a single monolete linear suture. Wall thin and translucent.

? *Laevigatosporites* sp.

A single specimen (not photographed) provisionally assigned to this genus measures 42 microns. It has smooth wall and a single monolete linear suture.

Compare:

Laevigatosporites minimus (Wilson & Coe) S.W. & B. 1944 as mentioned by

Bhardwaj (1957, p. 128, Pl. 25, Fig. 99), Spore No. 10 of Virkki (1945, p. 18, Pl. III. Fig. 34) from Kathwaii in the Salt Range, Punjab, India.

II. *Pollenites* R. Potonié 1931 — Pollen grains.
(I) *Saccites* Erdtman 1947
(A) *Monosaccites* (Chitaley 1951) Pot. & Kr. 1954
(1) *Triletesacciti* Leschik 1955
(I) *Apertacorpiti* Lele 1964
15. *Plicatipollenites* Lele 1965

Circular, meridional section more or less flat lens shaped. Central body more or less circular, monosaccus girdling the body at equator, attachment equatorial proximally but sub-equatorial distally, distal zone of attachment accompanied by infold system of body exine. Y-mark present, rays never reaching the margin of the body.

There are large number of spores with extreme variation of forms, so much so that no two spores are exactly similar, and one form merges unperceptibly into the other; and if each little variation is to be taken into account, then many species will be created. But agreeing with the view of Potonié and Lele (1961) and Lele (1964) the transitional forms have been merged into broader groups. The size varies from 60 to 153 microns.

Plicatipollenites indicus Lele (1964)

Pl. 2, Figs. 26-28; Pl. 3, Fig. 35

Diagnosis — As given by Lele (1964, p. 154). The specimens of this species show the range of variation as given below:

(I) Plate 2, Figs. 26,27 : Specimen in Fig. 26 is larger and shows the trilete mark, fold rim and frilled saccus, while the specimen in Fig. 27 is similar to that shown in Fig. 26 but the saccus is less frilled. Spores vary from 62 microns to 83 microns.

(II) Plate 2, Fig. 28 : Spore 84 microns. The saccus is stronlgy frilled (thrown into folds) and is much darker than the body. Fold rim broad and cover the body equator. Trilete mark clear.

(III) Plate 3, Fig. 35 : Size 118 microns. In this spore the body is oval and the fold rim of the saccus lies adjacent to the equator of the body. Saccus is broad, the breadth being only slightly less than the radius of body. One of the arms of the trilete mark is very short or wanting in some specimen of this type leading to a monolete mark.

Plicatipollenites gondwanensis (Balme & Henn.) Lele 1964

Pl. 2, Figs. 29, 30, Pl. 3, Figs. 36, 37

Diagnosis — See Lele 1964, p. 154.

Remarks — The specimens referred here to this species also show a range of variation in their morphographic characters.

(I) Plate 2, Figs. 29 to 30 : Size 103 to 115 microns. These spores have large body, clear triradiate mark and saccus broad and less frilled. The polygonal zonal fold system is quite distinct.

(II) Plate 3, Figs. 36, 37: Size 148 and 153 microns respectively. These are bigger spores with a definite foldsystem along the zone of saccus attachment, the number of folds being 4 or 5. The fold rim lies adjacent to the equator. The monosaccus is wide, the width being slightly less than the body radius. Intrareticulation fine to mediumly coarse.

Plicatipollenites ganjraensis sp. nov.

Pl. 2, Figs. 31, 32

Holotype — Pl. 2, Fig. 31

Diagnosis — Known size 74 to 122 microns. Central body circular or subcircular. Y-mark well-defined, with generally a ray shorter than the other two. The body infold system is typically circular, the zones of saccus attachment being accompanied by a single, more or less uniformly wide fold. This fold rim is situated almost at half the way between the apex and the equator of the body, giving thereby a concentric appearance. Saccus intrareticulation fine, the uri being somewhat radially arranged.

Comparison — This species shows similar organizational characters as seen in *P. indicus* Lele, but the main consideration to separate it from the latter, is the position of concentirc fold, i.e. the distal invasion of the monosaccus. In *P. indicus* Lele, the distal overlap is less than 1/3 of body radius while here characteristically it is more than 1/3 and sometimes upto 1/2.

16. *Virkkipollenites* Lele 1964

Circular, subcircular or elliptical spores in flattened condition. Central body dark brown and dense to light brown, circular or subcircular with a trilete slit. Exine structured to apparently smooth. Bladder finely to mediumly coarsely intrareticulate, distally inclined, without any body fold system.

cf. *Virkkipollenites zonatus* sp. nov.
Pl. 2, Fig. 25; Pl. 4, Fig. 42

Holotype — Pl. 2, Fig. 25

Diagnosis — Spore elliptical to circular, size 74-88 microns, body subcircular, dark without a distinct, Y-mark. Exine densely granular. Bladder wider than the radius of the body and attached to it near its equator. The difference in the type of reticulation on the bladder is marked by its lighter colour in the inner half and darker in the outer half. Margin of the bladder slightly wavy.

Spore seen on plate II fig. 25 (size 74 microns) does not show trilete mark, and clear subequator attachment zone; the inner portion of the bladder is lighter than the outer portion and hence provisionally it has been kept under *Virkkipollenites* sp.

Compare:

Virkki, (1945) Spore No. 36, Plate I, Fig. 8, size 71 microns. Spore No. 40, Plate 6, Fig. 80, size 121 microns. Spore No. 40, Plate 8, Fig. 108, size 77 microns.

17. *Parasaccites* Bharad. & Tiwari (1962)

Parasaccites diffuses Tiwari 1965
Pl. 2, Fig. 34; Pl. 3, Fig. 39

Description — Central body apparently circular, sub-circular of nearly oval in polar view, outline being ill-defined. Breadth of the saccus usually less than half the radius of the central body equally invading the body on proximal and distal side. Outline of the saccus undulated, sometimes lobed. Breadth of saccus not uniform all round. Two arms of the trilete mark are generally shorter than the third. Spores seen in Figs. 34 and 39 measure 122 and 142 microns respectively.

Parasaccites sp.
Pl. 2, Fig. 33

The spore has a distinct, more or less circular central body. The saccus width is less than half the radius of the body. This spore distinguishes itself by the presence of somewhat thick and distinct body and well defined Y-mark.

18. *Stellapollenites* Lele 1965

Stellapollenites gondwanensis sp. nov.
Pl. 3, Fig. 38

Holotype — Pl. 3, Fig. 38

Diagnosis — The spore is 179 microns. The equator of the central body is not distinct all round but body is more or less circular. The attachment of the saccus to the body on both sides — polar and distal, is triangular and the rims are folded on the three sides of the triangle in such a way that the apices of the two triangles alternate with each other. Saccus is very broad, almost equal to the radius of central body, and has a uniform margin. Trilete mark is clearly seen with one short and two longer and equal arms.

Comparison — The present species differs from *S. talchirensis* Lele, the genotype in having a wider saccus, thicker and smaller body, and in the presence of a disinct Y-mark.

19. *Guthorlispörites* Bharadwaj 1954

? *Guthorlispörites* sp.
Pl. 3, Fig. 40

The size of the spore is 179 microns. The central body is dark circular with secondary folds on the wall. The trilete mark is not clearly seen due to dark folds on the body wall. Saccus is very broad, the breadth is not uniform all round, and varies from half the radius to almost equal to the radius of the body. The saccus has no limbus. It is distinguishable from *Plicatipollenites* due to absence of fold rim and limbus, and from *Endosporites* due to the presence of folds on the body wall and absence of limbus.

Compare :

Bharadwaj (1955b) Plate 2, Fig. 13. The shape of spore and nature of saccus shows great similarity.

Virkki (1954) Plate 5, Fig. 52.

(2) *Aletesacciti* Leschik 1955

20. *Florinites* S. W. & B. 1944

Pollen apparently bilateral, they may nevertheless be derived from tetrahedral tetrads. Broadly elliptical in outline; body somewhat more spherical and nearly entirely body generally marked by numerous sharp angular folds specially around its periphery. Body 20 to 110 microns, and whole spore (with bladder) 50 to 180 microns. Ornamentation similar to *Endosporites* and *Pityosporites*. Hapto-typic features generally not evident. Trilete mark when discernible is wholly vestigial. Bladder membrance internally reticulate and expanded on all sides except for a small distal area (See POTONIÉ 1958, PLATE 5, FIGS. 43 & 44).

Florinites walikalensis Höeg & Bose 1960

Pl. 4, Fig. 45

Large oval spore, 144 microns, body circular or sub-circular, distinctly delimited. Tetrad mark present, exine externally uneven.

Compare:

Höeg & Bose (1960) Plate XXIX, Figs. 2 and 3. Virkki (1945) Plate 4, Figs. 42-44; Plate 7, Fig. 102; Plate 8, Fig. 107; Plate 10, Figs. 103,131,136; Plate 11, Figs. 137, 138; Plate 14, Fig. 187.

21. *Potonieisporites* (BHARADWAJ 1954) Bharad. 1965

Monosaccate miospores with an elliptical or oval outline and a monolete rectilinear slit running parallel to the longer axis. Central body oval to circular. Bladder intrareticulate. The central body is thin walled. Due to flattening, the distal wall of the central body is generally folded secondarily.

Potonieisporites neglectus Potonié & Lele 1959

Pl. 4, Fig. 41

Size 185 microns. Spore and central body both oval, body wall thin. The central body has a characteristic monolete mark. One end of which shows a little bifurcation with two unequal arms. The saccus surrounding the central body is relatively narrower on the lateral sides of the extreme equator, than on the other two sides. The fold rim surrounding the central body is often well seen. Two transverse folds of the body wall are clear and are placed near the equator of the central body. The two vertical folds near the apex of the central body are narrow. In this character this spore shows similarity with *P. novicus* Bhardwaj.

Compare:

Virkki (1945) Plate 5, Fig. 49.
Bharadwaj (1955b) Plate 4, Fig. 13
Potonié & Lele (1961) Plate 3, Fig. 64.

Potonieisporites sp. A

Pl. 5, Figs. 50, 54, 60

There are several spores of the type shown in Figs. 50, 54, 60 measuring 80 to 120 microns. Spores are oval or elliptical, body is spherical, there is a fold rim inner to the equator of the body and a clear monolete tetrad mark. The saccus is broader laterally and almost touches the equator of the body on the two sides at right angles to the laterals.

Potonieisporites sp. B

Pl. 4, Fig. 46; Pl. 5, Fig. 61

The spores measure 144-198 microns. Central body broadly oval, wall thin with distinct folds, and probably with an indistinct monolete mark. Saccus single surrounding the body, and not uniformly broad all around it.

Potonieisporites sp. C

Pl. 6, Figs. 63-65

Size 120-151 microns. Body large, slightly oval side ways, with characteristic folds. Sacci attached to the body almost up to the median line of the body and extending in breadth on the lateral sides almost equal to half the radius of the body.

22. *Vestigisporites* Balme & Hennelly 1955

Spores not always monosaccate. Spore body circular or oval in proximo-distal orientation, exine thin without marked proximal thickening, smooth or faint granulate

Proximal face bearing a short transverse slit or fold which recalls a monolete tetrad scar. Bladders attached to body equatorially and symmetrically placed on either side of the central body, rather variable in size and shape, sometimes joining to form a single air-sac. Bladder ornament granulate or fine reticulate.

Compare:

Balme & Hennelly (1955) Plate 6, Fig. 54.

Vestigisporites densus Tiwari 1965

Pl. 4, Figs. 43, 44

Spores oval, 52 to 73 microns along the longest axis, body spherical, dark, tetrad mark not visible. Bladder of uneven breadth, broader on the lateral sides, and asymmetrical on the two sides of the body. The lighter area in the centre of the body indicates the distal portion of the body which remains free from bladder.

Vestigisporites rudis Balme & Hennelly 1955

Pl. 4, Figs. 47 to 49

Spores 77 to 122 microns (total bladder span), body circular to subcircular. Exine thin, fine, granulate. Short transverse slit on proximal face, passing through proximal pole. Bladders large, unequally broad on two opposite sides of the body and joining to form a single bladder surrounding the central body equatorially. Eladder ornament granulate or fine reticulate. Spore in Pl. 4, Fig. 49 compares very closely to the Australian specimen, Balme & Hennelly (1955), Pl. 6, Fig. 54.

Vestigisporites sp.

Pl. 5, Figs. 51 to 53

There are several spores of the type shown in Pl. 5, Figs. 51 to 53 measuring from 80 to 120 microns. Spore body is more or less spherical with a clear monolete mark. The bladder is broader laterally but almost touches the equator of the body on the two slides at right angles to the laterals. These spores have been placed provisionally under this genus.

(B) *Disaccites* Cookson 1947

(1) *Striatiti* Pant 1954

23. *Striatites* (Pant) Bharad. 1962

Bilateral diploxylonoid pollen with circular to oval central body bearing proximally a number of horizontal striations. Exine in between striations microverrucose. Bladder distally close or widely removed forming a sulcus. Bladder distally inclined.

Striatites ganjraensis sp. nov.

Pl. 5, Fig. 62

Holotype — Pl. 5, Fig. 62

Specific Diagnosis — Spore body oval, large bearing a number of horizontal striations on the proximal side. Two narrow bladders placed laterally and distally, widely apart from each other. Body exine microverrucose, overall size 134 microns.

It distinguishes from all the other species of the genus by its bigger central body and wider distal saccus free area.

Striatites sewardii (Virkki) Pant 1955

Pl. 5, Fig. 55; Text-figs. 1, 2

Bisaccate pollen grains, overall size 110 microns including the sacci. A number of striations on the exine of the central body running parallel to its long axis. Plate 5, Fig. 55 shows the side view of the pollen. Sacci are attached to the body at an angle of 45 degrees to its vertical axis. The two wings vary slightly in size and have fine reticulation. Body wall thick.

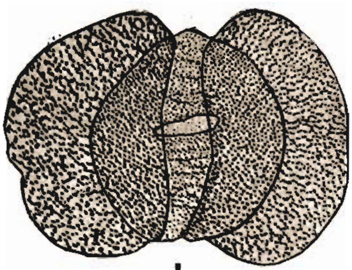
The figured pollen resembles almost completely with the one shown on Plate 6, Fig. 57 by Potonié (1958). It also resembles to a very great extent the pollen figured by Virkki (1937, PLATE XXXII, FIG. 1A) except that the Australian specimen is much smaller in size (57 microns). A large mass of hundreds of spores has been found (TEXT-FIGS. 1 and 2).

Compare:

Virkki (1945) Plate 5, Fig. 58 (80 microns). Höeg & Bose (1960) Plate XXX, Figs. 4-7; Plate XXXV, Figs. 1-3 & 6-8.

24. *Lunatisporites* (Lesch.) Bharad. 1962

Bilateral diploxylonoid pollen with vertically oval central body bearing proximally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TEXT-FIGS. 1, 2 — *Striatites sewardii* (Virkki) Pant 1955. Distal and proximal view. 120 μ. Slide 210 (2). × 365.

a number of horizontal striations. The exine in between being intrareticulate. Bladders inclined distally leaving a biconvex area free from the bladder, usually lined by two linear folds.

Lunatisporites indicus Tiwari 1965

Pl. 7, Figs. 79, 81

Description — Size 110 to 122 microns. Central body oval proximodistally. The lateral sides almost straight and the sides actually bulging. Body with fine transverse striations on the proximal side, and with two vertical folds at the region of attachment of the sacci, and a transverse dark mark similar to the one present in *Limitisporites*. Bladders almost of the size of the body radius.

In *Limitisporites* there are no striations on the body, while in this case the transverse dark ridge may or sometimes may not be distinct.

Compare:

Lueckisporites amplus Balme & Hennelly (1955) Pl.3, Fig. 26. *Lunatisporites* (*Lueckisporites*) *amplus* (BALME & HENNELLY — 1955) R. Potonié

Lunatisporites notabilis Tiwari 1965

Pl. 7, Fig. 78

Description — Size 102 microns. Body small rhomboidal with the two shorter angles on proximo-distal side and the wider one on lateral side. The wings are very large, several times bigger than the body and show broad reticulation over them. At times there may be present a dark bent mark transversely running on the body similar to the one found in *Limitisporites*. The horizontal striations are faint.

Compare:

Lueckisporites fusus Blame & Hennelly (1955) Pl. 1, Figs. 6-10. *Sritaopodocarpites* (*Lueckisporites*) *fusus* (BALME & HENNELLY 1955) new comb. Pot. 1958.

Lunatisporites pityoformis sp. nov.

Pl. 7, Figs. 75, 76

Holotype — Pl. 7, Fig. 75

Diagnosis — Pollen overall 86 to 89 microns. Central body more or less circular to slightly oval laterally; wall thin and thrown into vertical folds on the distal side along the zone of attachment. Wings attached to the body obliquely on the lateral sides leaving the body on the proximal part and a wide sulcus on the distal part. Sacci distally inclined.

This pollen resembles in general structure to a very great extent to *Pityosporites*.

25. *Verticipollenites* Bharadwaj 1962

Bilateral diploxylonoid pollen with circular to vertically oval, usually dense brown oval central body, proximally having criss-cross striations. Bladders laterally separated, distally inclined, and attached to the body closely together, and in area smaller than the vertical diameter of the central body. Bladder more than hemispherical, pitcher-shaped.

Verticipollenites sp.

Pl. 7, Fig. 82; Text-figs. 3-5

The pollen shown in Fig. 82 (PLATE VII) does not show the actual shape, because

3 4 5

TEXT-FIGS. 3-5 — *Verticipollenites* sp. Proximal and distal view of a pollen measuring 66 μ and its camera lucida drawing after it got pressed under a cover slip. 85 μ. Slide 65 (2). × 365.

it was crushed under the coverslip during examination but its actual camera lucida sketch was taken before (TEXT-FIG. 3 & 4) and after (TEXT-FIG. 5 and FIG. 82, PLATE VII) it was crushed.

The size of the pollen is 66 microns and compares closely with the generic description given above except that in this species the body is oval sideways. Text-fig. 3 shows the proximal view and 4 gives the distal view, in which the attachment of the bladders is very clearly seen. The pollen after being crushed measures 85 microns.

26. *Strotersporites* Wilson 1962

Strotersporites sp.

Text-figs. 6-15

Size of pollen 94 to 118 microns. Bladders are widely separated on the proximal side of the body and are close together leaving a narrow area on the distal side. Horizontal striations are present. In the Text-figs. 6-15 different positions of the pollen from a group have been sketched. Text-fig. 6 shows the side view, 8 and 11 show proximal view and 12 and 13 show distal view.

(2) *Striareticuloiditi* Tiwari 1962

27. *Primuspollenites* Tiwari 1964

Disaccate pollen with reticuloid type of striations on the proximal face. Distal saccus attachment zone well defined generally accompanied by body folds.

Primuspollenites levis Tiwari 1964

Pl. 6, Fig. 73

The present specimen measures 75 microns along the longer axis. Body is sub-circularly oval with striations forming more or less reticuloid design. Distal folds along the attachment zones prominent. Saccus bigger than the body height intra-reticulate.

Compare:

This specimen is smaller in size than the range given for the species.

(3) *Disaccitrileti* Leschik 1955

28. *Illinites* (KOSANKE) Grebe & Schweitzer 1962. Y-mark present, small and often with unequal rays.

Illinites delasaucei (Pot. & Kl.) Grebe & Schweit.

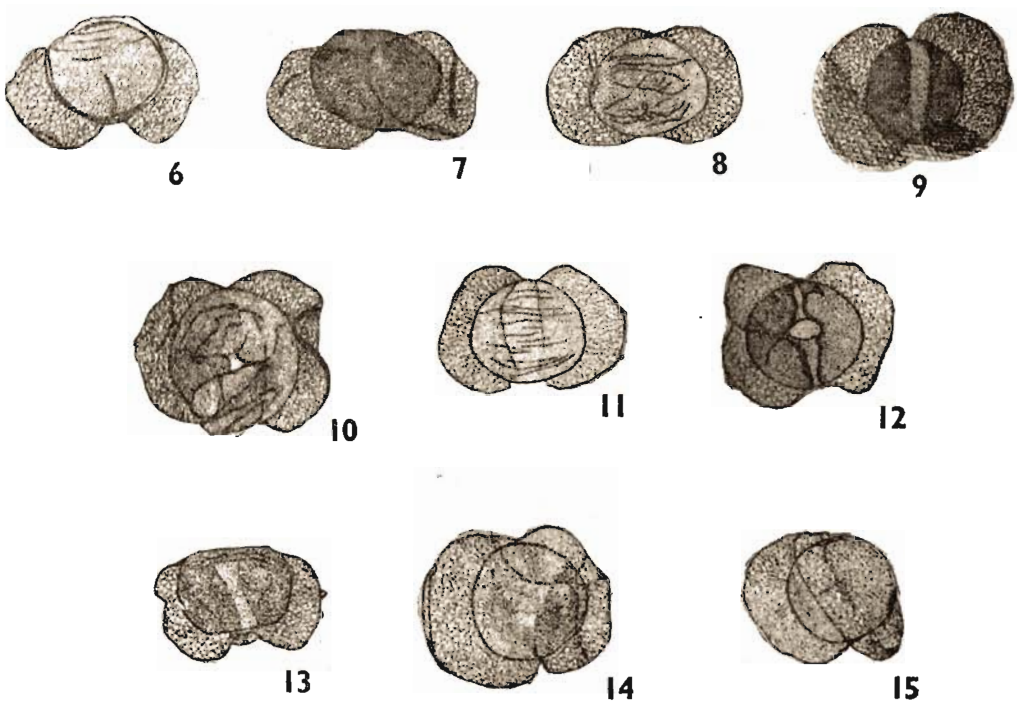
Pl. 5, Figs. 56-59

Remarks — Grebe and Schweitzer (1962) recorded a wide range of variation in the form genus *Illinites*. In the present assemblage a number of such forms are met with, hence they are conventionally kept under this species. However, the range of variation exhibited by these specimens is so great that it is felt necessary to give the details here.

A — Plate 5, Figs. 56, 57: Size 66 to 81 microns, dark round or oval body. The two wings (Sacci) attached to the body laterally on its opposite sides. Without any distal inclination. The two wings are of unequal length and width. Body has a clear or obscure trilete mark.

B — Plate 5, Fig. 58 : Size 57 microns. Body dark elongated sideways and bent, bean-shaped with concave distal and convex proximal side. Sacci attached to the ends of the body, each having a length of about half the length of the body and equally broad.

C — Plate 5, Fig. 59 : Size 66 microns. Body circular with a slightly bent trans-



TEXT-FIGS. 6-15 — *Strotersporites* sp. Camera lucida drawings at different angles of pollens from a single pollen group. 98-118 µ. Slides 208-211. × 250.

verse mark. Wings short and of unequal size.

D — Other specimens (Photo not given): Size 67 microns. Body elongated sideways and bent similar to that of *B*, but lesser in length and more in breadth than it. Body wall thick. Sacci small, slightly bent.

E — Size 100 microns. Body slightly oval along proximodistal axis, with a single dark vertical mark. Sacci almost of the same size as the body and wrinkled in outline.

F — Size 57 to 64 microns (Pl. 6, Fig. 66). Body almost circular, having two vertical fold rims, along which the wings are attached and a dark transverse mark. Wings are slightly bent and small. There are four pollen grains, probably all of these belonging to a single tetrad.

(4) *Disacciatrileti* (LESCHIK 1955) Pot. 1958

29. *Pityosporites* (SEWARD 1914) Pot. 1958

Haploxylonoid, bisaccate with a circular to a horizontally oval central body without any striations. Ridges or triradiate mark on proximal face or a well defined distal channel. Bladder distally inclined, and laterally as well as distally widely separated.

Pityosporites sp.

Pl. 6, Figs. 67, 68; Text-figs. 16-25

The pollen of this species is 47-48 microns. The range of size is from 40 to 51 microns. (TEXT-FIGS. 16 to 25).

Central body horizontally oval without any striations. Bladders two, distally inclined and attached laterally to the central body in such a way that they are wide apart on proximal side while near each other on the distal side leaving well defined channnel.

Compare:

Balme & Hennelly (1955), p. 94, Plate 2, Figs, 21 to 23. Potonié (1958), p. 56, Plate 7, Fig. 67. Potonié & Lele (1961), p. 32, Plate 3, Figs. 75 to 83.

TEXT-FIGS. 16-25 — *Pityosporites* sp. Camera lucida drawing at different angles of the pollens from a group. 40 to 51 μ. Slide 157. × 365.

30. *Alisporites* Daugherty 1941

Bisaccate pollen without Y-mark, haploxylonoid. Distal side with a sharply delimited rather small vertical germinal furrow in between the bladders.

Alisporites grandis sp. nov.

Pl. 6, Figs. 69, 70

Holotype — Pl. 6, Fig. 69

Diagnosis — Size 104 to 139 microns. Body oval proximo-distally with the two ends rather abruptly narrow. Sacci joined to the body near the median line. A small germinal furrow present on the distal side in between the wings.

Compare :

Balme & Hennelly (1955), p. 95, Plate 4, Figs. 39-40. Bharadwaj (1955), p. 135. Potonie (1958), p. 60, Plate 7, Fig. 71.

31. *Sulcatisporites* (LESCHIK 1955) Bharadwaj 1962

Sulcatisporites sp.

Pl. 6, Fig. 71

Circular, haploxylonoid, (Wings smaller than body), grains with vertically oval central body. No striations. Vertically median distal region thinner but without clearly defined sulcus. Bladders distally inclined. The overall measurement of the pollen in 53 microns.

(5) *Podocarpoititi* Pot. Thompson & Thiergart 1950

32. *Cuneatisporites* Leschik 1955

Nearly diploxylonoid, central body without tetrad mark or striations. Range of variation in the present assemblage is very wide.

Cuneatisporites royalensis sp. nov.

Pl. 6, Figs. 72, 74; Pl. 7, Fig. 77

Holotype — Pl. 6, Fig. 72

Diagnosis — Size of pollen 60 to 79 microns. Central body oval along proximo-distal line. Sacci almost double the size of the body, and attached to it along the median line, leaving a straight vertical portion of the body looking like a vertical slit.

Compare :

Lueckisporites phaleratus Balme & Hennelly (1955) Pl. 4, Figs. 36-37.

Cuneatisporites majus sp. nov.

Pl. 7, Fig. 80

Holotype — Pl. 7, Fig. 80

Diagnosis — Size 173 microns, including total wing span, central body elongated proximo-distally, about 1½ times longer than broad. Wings almost circular and bigger than body, and attached to it along the vertical median line marked by vertical folds, leaving a vertical light coloured area.

II. *Polyplicatus* Erdm. 1952

33. *Welwitschiapitys* Bolchowitina 1953

Bilateral oval or elliptical miospores bearing a mono-radiate slit parallel to the longer equatorial axis. Exine smooth, intragranulate and bearing a large number of striations (grooves), running parallel to the largest axis, as well as parallel and equidistant to each other in the middle but occasionally uniting each other nearer the ends.

Welwitschiapitys sp.

Pl. 7, Fig. 83

Size 94 microns along the longest axis. The general description is the same as that of the genus.

Compare — *W. tenuis* Bharad. & Salujha 1964

(III) *Monocolpates* Iversen & Troels-Smith 1950

(I) *Intortes* (Naumova 1937) emend.

34. *Vittatina* Luber 1940

Horizontally oval grains with longitudinal simple or criss-cross striations, with exine densely folded over or thickened into two vertical submarginal ridges.

Vittatina sp.

Size 94 microns along the length. Pollen 2½ times larger than broad. Submarginal vertical ridge of one side more prominent than that of the other. Body with simple and forked striations, and a single broad thick striae formed by the union of 3 to 4 striae. Margin smooth.

35. *Marsupipollenites* Balme & Hennelly 1956

Amb oval or circular, single furrow on the distal face delimited by two longitudinal folds in the exine. These folds may be in contact or overlapping at the distal pole in unexpanded sporomorphs. In ruptured grains an irregular rent occurs in the distal face, bordered by a narrow zone of folded exine. A trilete or monolete tetrad scar may be present on the proximal face. Sexine ornament rugose, granulate, verrucate or striate.

cf. *Marsupipollenites* sp.

Pl. 7, Fig. 84

Description — Pollen size 40 microns. Body circular with a single furrow delimited by two longitudinal folds in the exine. Folds coming in contact at the poles. No trilete or monolete scar present. Exine finely granulate.

This pollen compares with *M. triradiatus* Balme & Hennelly (1956a, p. 60, Pl. 2, Fig. 31), but differs from it in having a circular body and being devoid of trilete scar.

Pollenites Insertae

Pl. 7, Figs. 85, 86

The pollen has oval central body as seen in side view. These belong to Monosaccites as there is a single bladder attached to the body around it along the equator. Body has thick smooth wall and is free on the proximal and distal sides from the bladder. As the pollen is compressed on its sides the tetrad mark is not visible hence the pollen cannot be assigned with certainly to any genus. However it shows greatest similarity to *Vestigisporites*.

CONCLUDING REMARKS

The shales from Ganjra nalla beds are crowded with the leaf impressions of *Noeggerathiopsis hislopi*. Besides this there are leaf impressions of several species of *Glossopteris*, *Gangamopteris cyclopteroides*, some species of *Samaropsis* (Saksena 1963), *Phyllotheca sahnii* and equisetaceous stems. In the flora following groups are represented: Equisetales, Pteridospermae and Cordaitales (Gymnosperms).

On the basis of the flora, which no doubt is a drift flora, found at this locality, one should expect Pteridophytic spores and pollen belonging to Pteridosperms and Gymnosperms, mainly Cordaitales. It must however be noted that in a drift flora many more species and genera of spores and pollen are expected to occur than the number of species, genera and Texa of megafossils.

In the present collection 14 spore genera and 21 pollen genera have been described. Among the spores *Triletes* (megaspores), *Punctatisporites*, *Calamospora* and *Leiotriletes*, and among the pollen genera *Plicatipollenites*, *Parasaccites*, *Stellapollenites*, *Florinites*, *Illinites*, *Pityosporites*, *Cuneatisporites*, *Verticipollenites* and *Lunatisporites* occur in large number. *Plicatipollenites*, *Florinites*, *Illinites* and *Cuneatisporites* are represented by several species, while *Pityosporites*, *Verticipollenites* have only a few species represented, but they are quite abundant in number. *Vestigisporites* is also commonly found. The remaining genera of spores and pollen are less both in number (frequency) and form.

No attempt is made to correlate the microflora with the megafossils of the locality. The microflora is typical of the Lower Gondwana (Lower Permian) flora, and shows much similarity with the lower Gondwana flora of Australia (BALME & HENNELLY 1955, 1956a and b), of Belgian Congo, Africa (HÖEG & BOSE, 1960) and of Lower Coal Measures — Tanganyika (HART 1960).

In the presence of the genera *Plicatipollenites*, *Parasaccites*, *Stellapollenites*, *Potonieisporites* and *Punctatisporites* the present assemblage is comparable to the mioflora described by Potonié & Lele (1961) from the Talchir Stage of India. Similarly the present flora shows some resemblance with the Barakar mioflora described by Tiwari (1965), in the presence of *Plicatipollenites*, *Parasaccites*, *Potonieisporites*, *Punctatisporites*, *Microbaculispora*, *Lunatisporites*, *Strotersporites*, *Welwitschiapites* and *Vittatina*. However, no quantitative analysis has been attempted in the present work and hence such comparisons are not being given.

REFERENCES

BALME, B. E. & HENNELLY, J. P. F. (1955). Bisaccate sporomorphs from Australian Permian Coals. *Aust. J. Bot.* **3**(1): 89-98.

Idem (1956a). Monolete, Monocolpate and Alete Sporomorphs from Australian Permian sediments. *Ibid.* **4**(1): 54-67.

Idem (1956b). Trilete sporomorphs from Australian Permian sediments. *Ibid.* **4**(3): 240-260.

BHARADWAJ, D. C. (1955a). An approach to the problem of taxonomy and classification in the study of Sporae dispersae. *Palaeobotanist.* **4**: 3-9.

Idem (1955b). The spore genera from the Upper Carboniferous coals of the Saar and their value in stratigraphical studies. *Palaeobotanist.* **4**: 119-149.

Idem (1957). The spore flora of Velener Schichten (Lower Westphalian D) in the Ruhr Coal Measures. *Palaeontographica* **102B**: 111-138.

Idem (1962). The miospore genera in the coals of Raniganj Stage (Upper Permian) India. *Palaeobotanist.* **9**: 68-106.

BHARADWAJ, D. C. & KREMP, G. (1955). Die Sporenfuhrung der Velener Schichten des Ruhrkarbons. *Geol. Jb.* **71**: 51-68.

BHARADWAJ, D. C. & SALUJHA, S. K. (1964). Sporological study of seam VIII in Raniganj Coalfield, Bihar (India) — Part 1 — Description of *Sporae dispersae*. *Palaeobotanist.* **12**(2): 181-215.

BHARADWAJ, D. C. & TIWARI, R. S. (1964). On two monosaccate genera from Barakar Stage of India. *Ibid.* **12**(1): 139-146.

Idem (1964a). The correlation of coalseams in Korba Coalfield, Lower Gondwanas, India. *C.R. 5th internat. Congr. Carbonif. Stratigr. Geol. Paris.* **3**: 1131-1143.

Idem (1965). Sporological correlation of coalseams in Bachra Area of North Karanpura Coalfield Bihar, India. *Palaeobotanist.* **15**: 1-10.

CROSS, A. T. (1944). Correlation of some coals in Southern West Virginia by use of plant microfossils. *Bull. geol. Soc. Amer.* **55**: 1474.

ERDTMAN, G. (1943). An introduction to Pollen Analysis. *New York.*

Idem (1947). Suggestions for the classification of fossil and recent pollen grains and spores. *Svensk. bot. Tidskr,* **41**(1): 104-114.

FOX, C. S. (1931). The Gondwana system and the related formations. *Mem. geol. Surv. India.* **58**.

GREBE, H. & SCHWEITZER, H. J. (1962). Die Sporae dispersae des niederrheinishen Zechsteins. *Fortschr. Geol. Bheinld. Westf.*: 1-21.

HART, G. F. (1960). Microfloral investigation of the Lower Coal Measures (Kr.) Ketewaka-Mchuchuma Coalfield, Tanganyika. *Bull. geol. Surv. Tanganyika.* **30**: 1-18.

HÖEG, O. A. & BOSE, M. N. (1960). The Glossopteris flora of the Belgian Congo. *Annls. Mus. r. Congo belge. Ser.* **32**: 1-106.

HUGHES, T. W. H. (1881). Notes on the South Rewa Gondwana basin. *Rec. geol. Surv. India* **14**: 126-138.

KNOX, E. M. (1938). The spores of Pteridophyta, with observations on microspores in coals of Carboniferous age. *Trans. Proc. bot. Soc. Edinb.* **32**(3): 438-466.

KOSANKE, R. M. (1950). Pennsylvanian spores of Illinois and their use in correlation. *Bull, Ill. geol. st. Surv.* 74: 1-128.

LELE, K. M. (1964). Studies in the Talchir Flora of India: 2. Resolution of the spore genus *Nuskoisporites* Pot.& Kl. *Palaeobotanist.* **12**(2): 147-168.

Idem (1965). Studies in the Talchir flora of India: 3. *Stellapollenites,* a new genus from the South Rewa Gondwana basin. *Ibid.* **13**(1): 109-113.

MAITHY, P. K. (1965). Studies in the Glossopteris Flora of India-27. Sporae dispersae from the Karharbari beds in Giridih Coalfield, Bihar. *Ibid.* **13**(3): 291-307.

MOORE, L. R. (1945). On the spores of some Carboniferous plants; their development. *Quart. J. geol. Soc. Lond.* **102** 3): 251-298.

NAUMOVA, S. N. (1937). The spores and pollen of the coals of the U.S.S.R. *17th int. Geol. Congr. Absts.* U.S.S.R.: 60-61.

Idem (1939). Spores and pollen of the coals of the U.S.S.R. *17th int. Geol. Congr.* **1**: 363-364. Moscow.

PANT, D. D. (1954). Suggestions for the classification and nomenclature of fossil spores and pollen grains. *Bot. Rev.* **20**: 33-60.

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

Idem (1958). Synopsis der Gattungen der Sporae dispersae. Part II. *Sporites, Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates. Ibid.* **31**: 1-114.

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

POTONIÉ, R. & KREMP, G. (1954). Die Uattungen der Palaozoischen Sporae dispersae und ihre Stratigraphie. *Geol. Jb.* **69**: 111-193.

Idem. (1955). Die Sporae dispersae des Ruhrkarbons. *Palaeontographica.* **98** (B): 1-136.

POTONIE R. & LELE, K. M. (1961). Studies in the Talchir Flora of India. 1. Sporae dispersae from the Talchir beds of South Rewa Gondwana basin. *Palaeobotanist.* **8**(1 & 2): 22-37.

RAISTRICK, A. (1934). The correlation of coal seams by microspore contents. *Trans. Instn. Min. Engrs. London.* **88**(3): 142-153.

RAISTRICK, A. & SIMPSON, J. (1933). The microspores of some Northumberland coals, and their use in the correlation of coal seams. *Trans. Instn. Min. Engrs. Trans. London* **85**(4): 225-235.

SAKSENA, S. D. (1963). On fossil flora of Ganjra nalla bed, South Rewa. Part I — Macrofossils. *Palaeobsthnist.* **11**(1 & 2). 23-29.

SCHOPF, J. M. (1938). Spores from the Herrin (No. 6) coal bed in Illinois. *Rep. Invest. Ill. St. Geol. Surv.* **50**. 1-78.

SCHOPF, J. M., WILSON, L. R & BENTAL, R. (1944). An annotated synopsis of Palaeozoic fossil spores and the definition of generic groups. *Ibid.* **91**. 5-66.

SEWARD, A. C. (1914). Antarctic fossil plants. *Nat. Hist. Rep. Br. Antarct. (Terra Nova) Exped.* 1910. *Geolog.* **1**(1). 1-49.

SRIVASTAVA, P. N. (1955). On some Lower Gondwana megaspores and seeds from Mangardaha Coal, West Bokaro, Bihar. *Palaeobotanist.* **3**: 113-115.

SURANGE, K. R., SRIVASTAVA, P. N. & SINGH, P. (1953). Megaspores from the West Bokaro Coalfield (Lower Gondwanas) of Bihar. *Ibid.* **2**: 9-17.

TIWARI, R. S. (1964). New miospore genera in the coals of Barakar Stage (Lower Gondwana) of India. *Ibid.* **12**(3): 250-259.

Idem (1965). Miospore assemblage in some coals of Barakar Stage (Lower Gondwana) of India. *Ibid.* **13**(2 & 3).

VIRKKI, C. (1937). On the occurrence of the winged-spores in the Lower Gondwana rocks of India and Australia. *Proc. Indian Acad. Sci.* **6**(6)B: 428-431.

Idem (1945). Spores from the Lower Gondwanas of India and Australia. *Ibid.* **15**(4-5): 93-176.

EXPLANATION OF PLATES

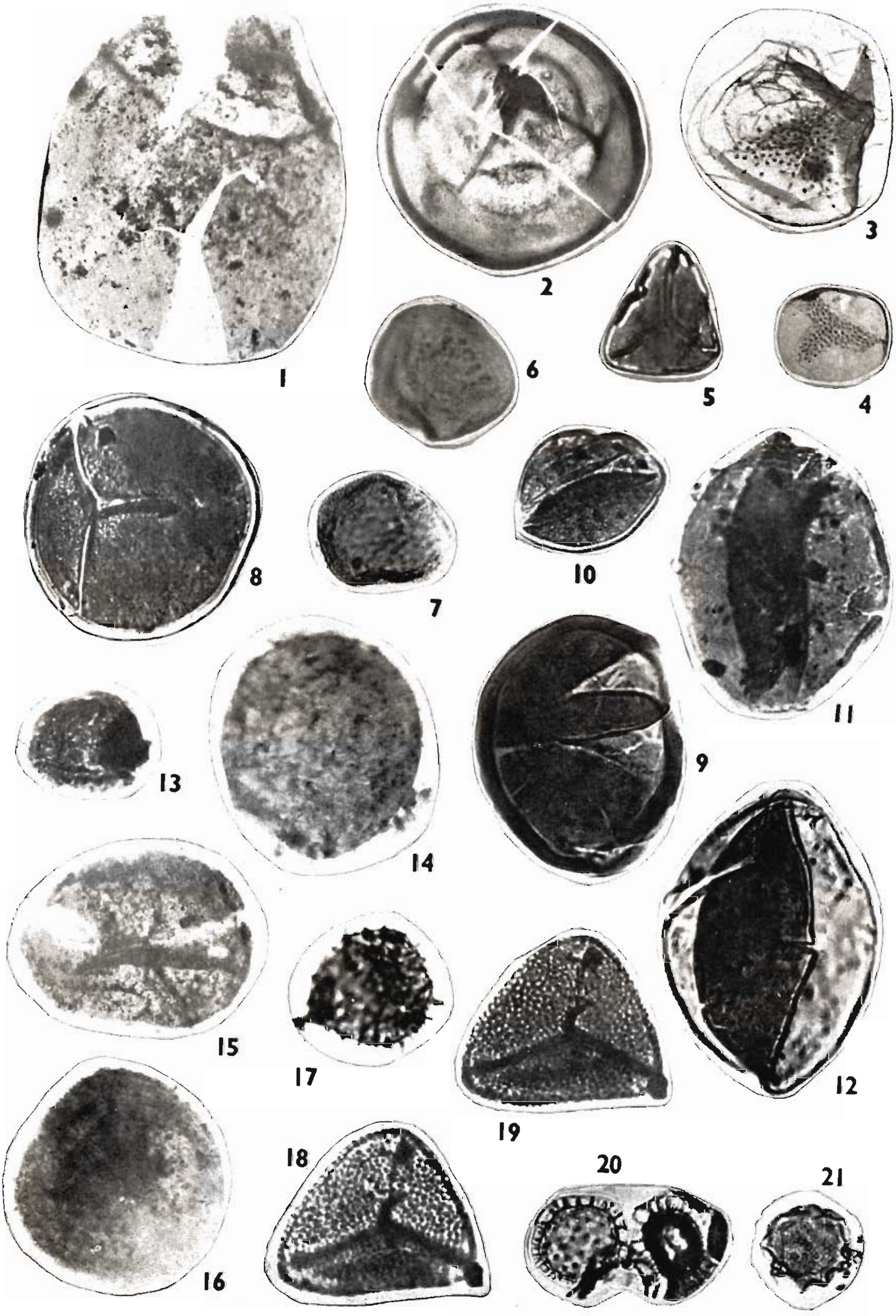
The microphotographs of the spores are taken on the process Panchromatic plates, and all the prints are made from unretouched negatives. The photographs marked cl. are taken from the Camera lucida sketches of the spores. Text-figures are also photographs of the Camera lucida sketches.

The figured specimens are preserved at the Institute of Palaeobotany, Lucknow, India.

Unless otherwise stated all the microphotographs of the spores are magnified × 500.

PLATE 1

1. *Trileites* sp. (Megaspores) 1108 microns. Slide 212. × 55.
2. *Trileites* sp. (Megaspore) 724 microns. Slide 141(1). × 58·5.
3. *Duosporites multipunctatus.* 616 microns. Slide 469. × 58·5.
4. *Duosporites multipunctatus.* 316 M., slide 186. × 58·5.
5. *Leiotriletes conspicua* sp. nov. 42 M., slide 35(1).
6. *Punctatisporites punctatus.* 43 M., slide 63.
7. *Punctatisporites punctatus.* 46 M., slide 49(2). The spore shown in Fig. 7, at a different focus.
8. *Punctatisporites gretensis.* 79 M., slide 164(1).
9. *Punctatisporites gretensis.* 86 M., slide 194 (3).
10. *Calamospora ovalis* sp. nov. 51 M., slide 133(1).
11. *Calamospora majus* sp. nov. 90 M., slide 194(2).
12. *Calamospora majus* sp. nov. 104 M., slide 114(2).
13. *Verrucosisporites* sp. 40 M., slide 6(2b).
14. *Beharisporites rewaii* sp. nov. 600 M., slide 108(1). × 58·5.
15. *Beharisporites rewaii* sp. nov. 662 M., slide 146(1). × 58·5.
16. *Beharisporites rewaii* sp. nov. 600 M., slide × 58·5.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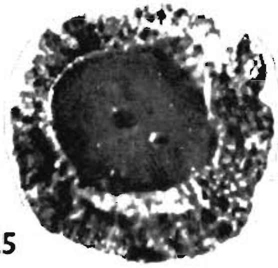

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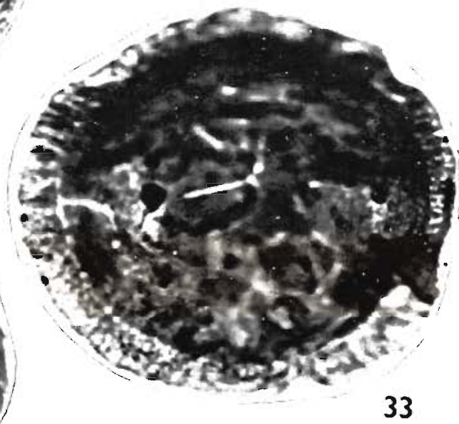

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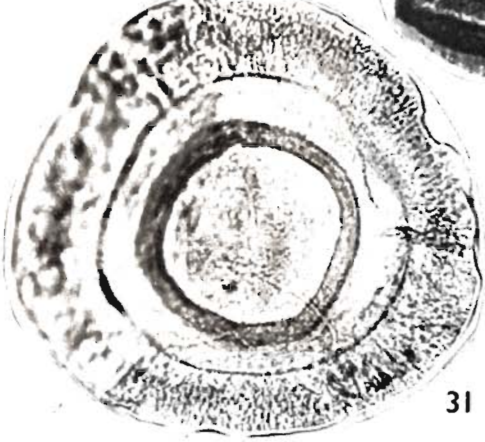

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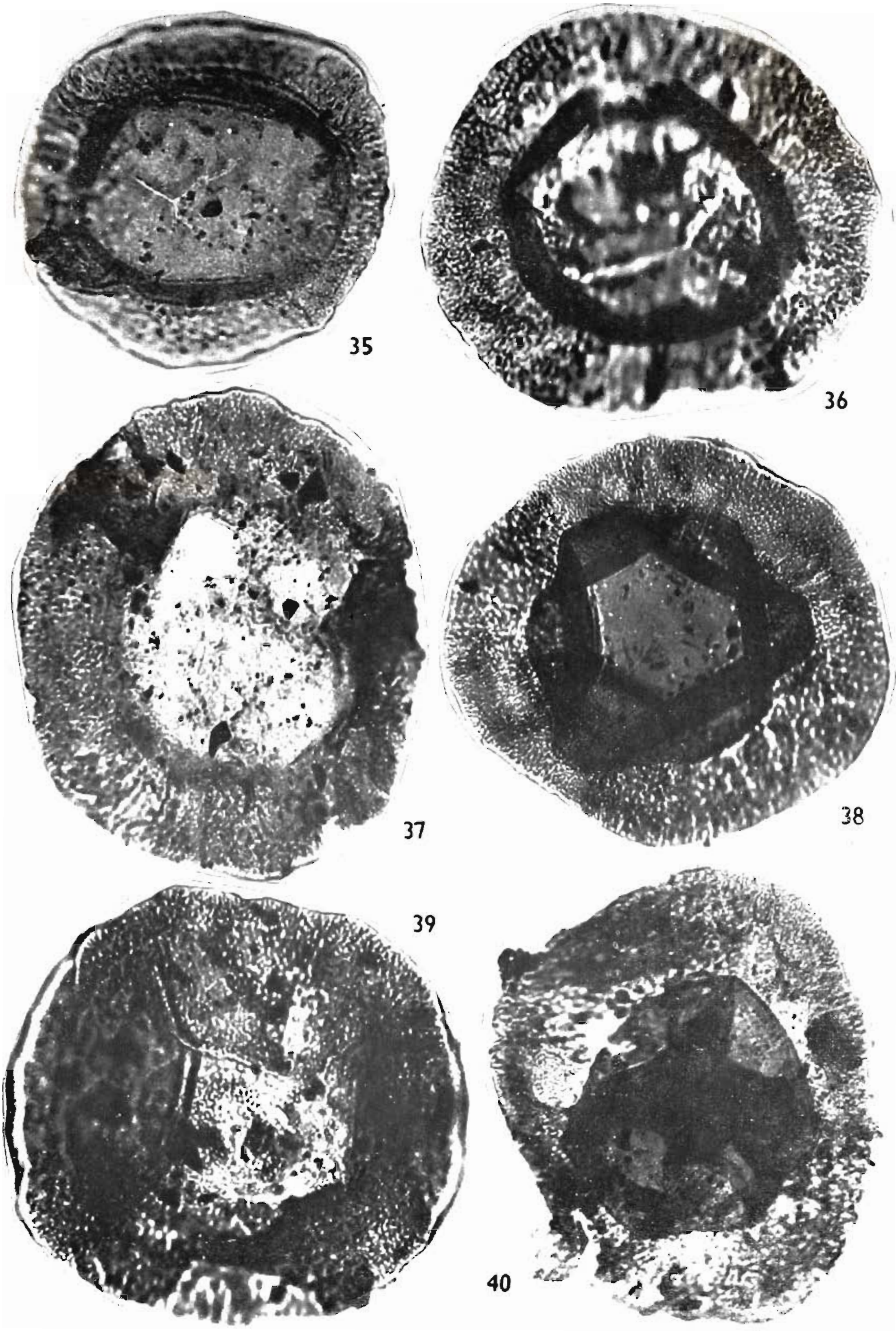
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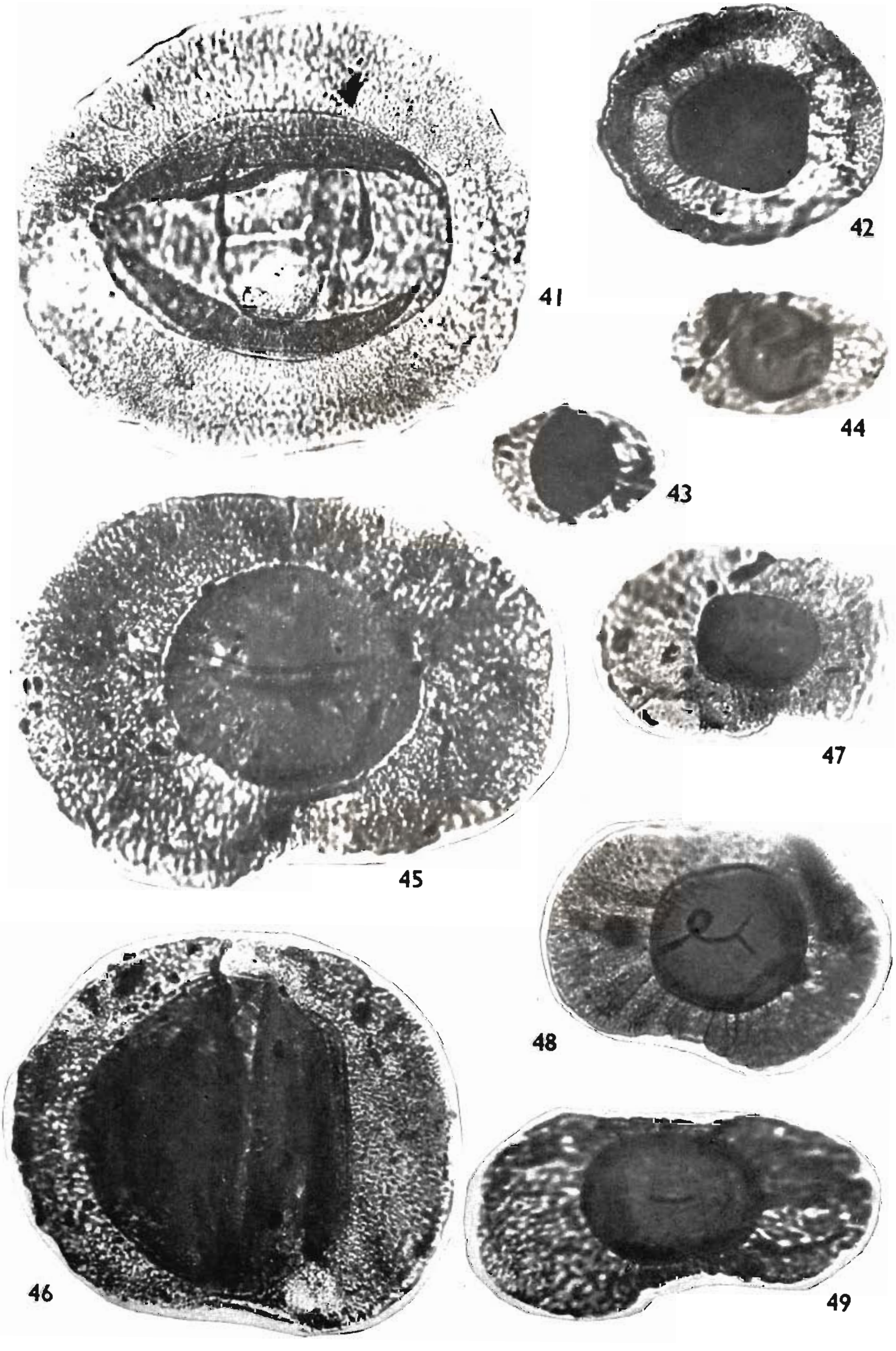
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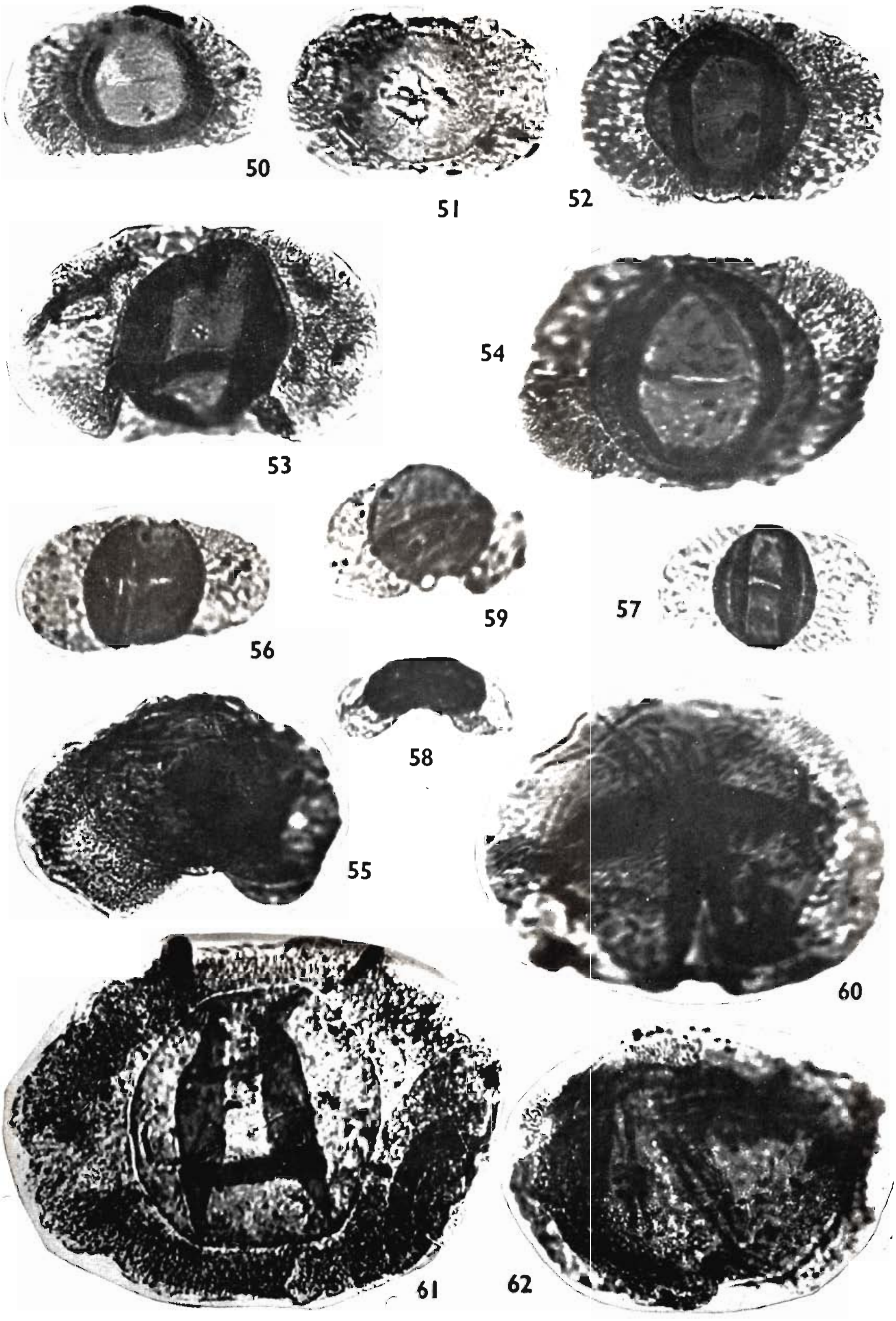
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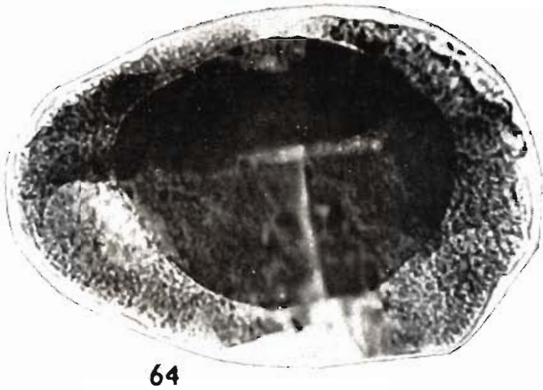
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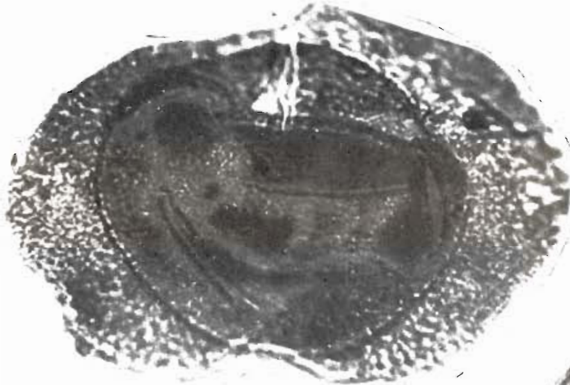
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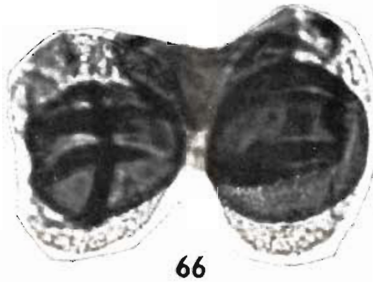
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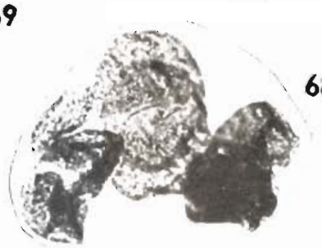
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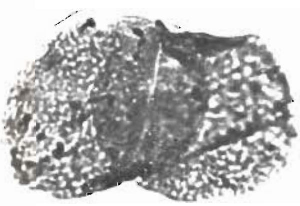
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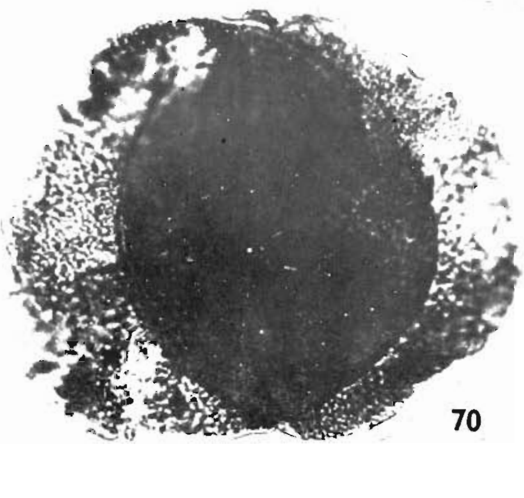
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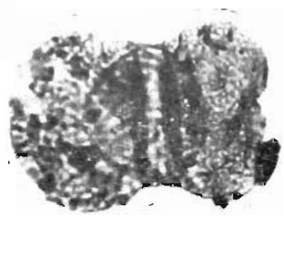
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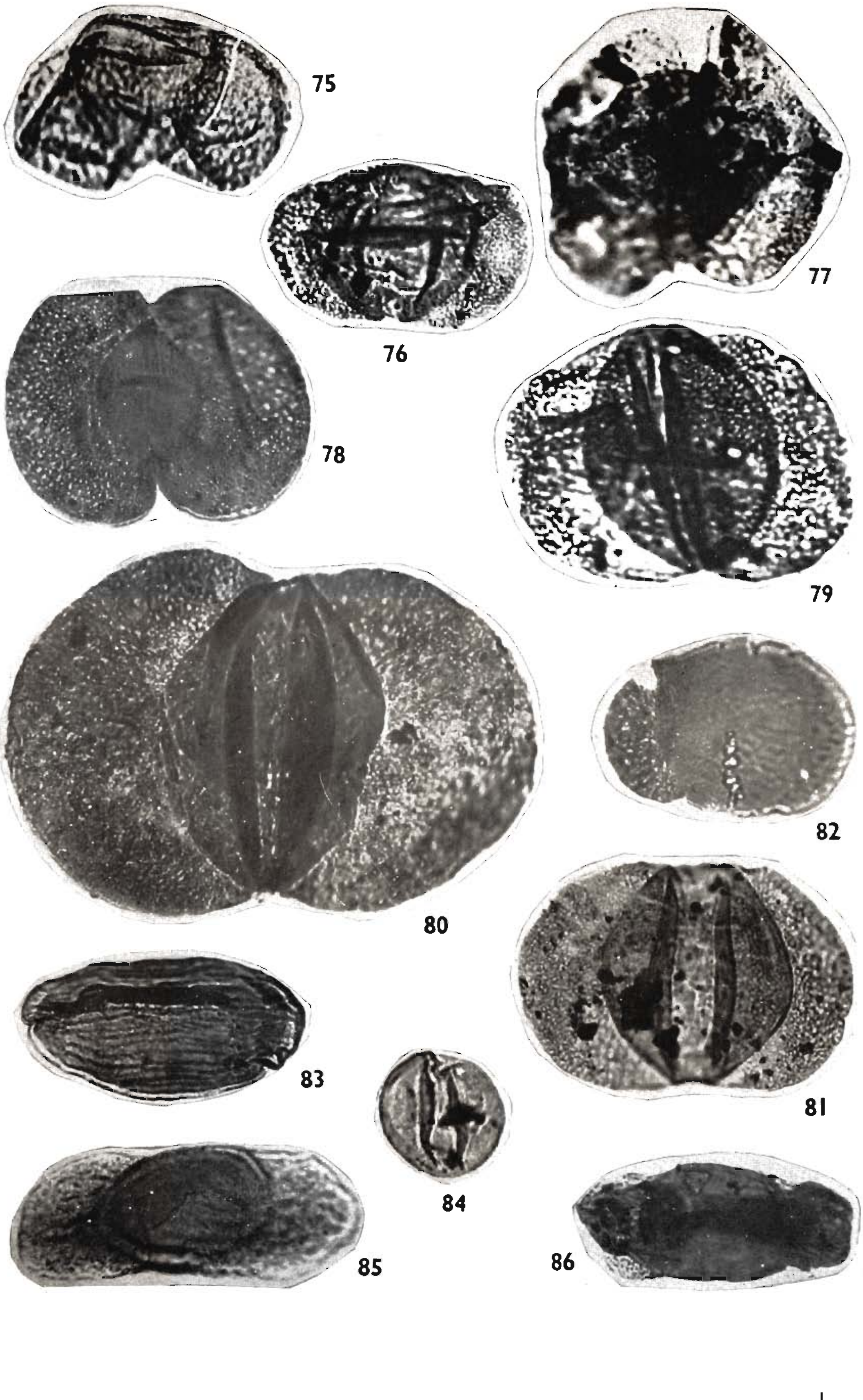
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17. *Acanthotriletes* sp. 41 M., slide 6(7).
18. *Microbaculispora ganjrensis* sp. nov. 64 M., slide 205(3).
19. *Microbaculispora ganjrensis* sp. nov. Spore shown in Fig. 20 at a different focus.
20. *Reticulatisporites* sp. 34-36 M., spore group. Slide 176.
21. *Reticulatisporites* sp. 29 M., slide 20.

PLATE 2

22. *Triquitrites valvaetus* sp. nov. 55 M., slide 205(2).
23. *Lycospora minuta* sp. nov. 24 M., slide 22(1).
24. *Densosporites splendens* sp. nov. 50 M., slide 45.
25. cf. *Virkkipollenites zonatus* sp. nov. 14 M., slide 139.
26. *Plicatipollenites indicus* .80 M., slide 344.
27. *Plicatipollenites indicus*. 83 M., slide 130(3).
28. *Plicatipollenites indicus*. 84 M., slide 92(3).
29. *Plicatipollenites gondwanensis*. 103 M., slide 55(3).
30. *Plicatipollenites gondwanensis*. 109 M., slide 291(3).
31. *Plicatipollenites ganjraensis* sp. nov. 122 M., slide 337.
32. *Plicatipollenites ganjraensis*. 74 M., slide 134(2).
33. *Parasaccites* sp. 114 M., slide 119(6).
34. *Parassacites diffusus*. 122 M., slide 79(3).

PLATE 3

35. *Plicatipollenites indicus*. 118 M., slide 145.
36. *Plicatipollenites gondwanensis*. 148 M., slide 128(7).
37. *Plicatipollenites gondwanensis*. 153 M., slide 221.
38. *Stellapollenites gondwanensis* sp. nov. 179 M., slide 143(1). × 400.
39. *Parassaccites diffusus*. 142 M., slide 222.
40. *Guthorilisporites* sp. 181 M., slide 133(6). 400.

PLATE 4

41. *Potonieisporites neglectus*. 185 M., slide 315. × 435.
42. cf. *Virkkipollenites zonatus* sp. nov. 88 M., slide 167.
43. *Vestigisporites densus* sp. nov. 52 M., slide 318.
44. *Vestigisporites densus* sp. nov. 70 M., slide 104(2).
45. *Florinites walikalensis*. 174 M., slide 178.
46. *Potonieisporites* sp. B. 144 M., slide 277. 550.
47. *Vestigisporites rudis*. 92 M., slide 195(2).
48. *Vestigisporites rudis*. 115 *M*., slide 68(7).
49. *Vestigisporites rudis*, 122 M., slide 224.

PLATE 5

50. *Potonieisporites* sp. A. 82 M., slide 79(4).
51. *Vestigisporites* sp. 86 M., slide 144(4).
52. *Vestigisporites* sp. 100 M., slide 114(3).
53. *Vestigisporites* sp. 116 M., slide 46(3b).
54. *Potonieisporites* sp. A. 111 M., slide 268.
55. *Striatites sewardii*. 110 M., slide 208.
56. *Illinites delasaucei*. 81 M., slide 256.
57. *Illinites delasaucei*. 70 M., slide 239.
58. *Illinites delasaucei* sp. B. 57 M., slide 400(2).
59. *Illinites delasaucei*. 66 M., slide 254.
60. *Potonieisporites* sp. A. 120 M., slide 6(2a). × 550.
61. *Potonieisporites* sp. B. 198 M., slide 178(11). × 400.
62. *Striatites ganjraensis* sp. nov. 134 M., slide 174(1).

PLATE 6

63. *Potonieisporites* sp. C. 136 M., slide 316.
64. *Potonieisporites* sp. C. 136 M., slide 105(7).
65. *Potonieisporites* sp. C. 151 M., slide 275.
66. *Illinites* sp. Spore group. 57-64 M., slide 401.
67. *Pityosporites* sp. 47 M., slide 157, Side view.
68. *Pityosporites* sp. 48 M., slide 157. Distal view.
69. *Alisporites grandis* sp. nov. 104 M., slide 122(3).
70. *Alisporites grandis* sp. nov. 139 M., slide 117(2).
71. *Sulcatisporites* sp. 53 M., slide 68(8).
72. *Cuneatisporites royalensis* sp. nov. 60 M., slide 133(2).
73. *Primuspollenites levis*. 64 M., slide 118(2).
74. *Cuneatisporites royalensis* sp. nov. 79 M., slide 196(4).

PLATE 7

75. cf. *Lunatisporites pityoformis* sp. nov. 89 M., slide 400(1).
76. cf. *Lunatisporites pityoformis* sp. nov. 86 M., slide 178(12).
77. *Cuneatisporites royalensis* sp. nov. 98 M., slide 107(4).
78. *Lunatisporites notabilus*. 102 M., slide 396.
79. *Lunatisporites indicus*. 115 M., slide 196(2).
80. *Cuneatisporites majus* sp. nov. 173 M., slide 311.
81. *Lunatisporites indicus*. 110 M., slide 177(1).
82. *Verticipollenites* sp. 85 M., slide 65(2).
83. *Welwitschiapitys* sp. 94 M., slide 66.
84. cf. *Marsupipollenites* sp. 40 M., slide 237(1).
85. *Pollenites insertae* 114 M., slide 10(3).
86. *Pollenites insertae* 92 M., slide 297.