The Palaeobotanist, 31(1): 1-12, 1983.

MORPHOLOGICAL AND STRUCTURAL STUDIES ON SOME BARAKAR MEGASPORES

K. M. LELE & A. K. SRIVASTAVA
Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

ABSTRACT

The paper describes megaspores belonging to the genera *Srivastavaesporites*, *Trilaevipellitis*, *Jhariatriletes*, *Talchirella* and *Barakarella* gen. nov. recovered from the Lower Barakar shales of Churulia area, East Raniganj Coalfield, West Bengal. Megaspores have been studied both under dry as well as under wet conditions through controlled maceration. The exosporium and inner body have been found in all the megaspores. Particular attention has been given to the morphological features of the inner body and their taxonomic value is stressed. *Barakarella* gen. nov. is characterized by a baculose outer exosporium and cushioned inner body.

Key-words — Megaspores, Morphology, *Barakarella*, East Raniganj Coalfield, Lower Permian (India).

सारांश

कुछ बाराकार गुरुबीजाणुओं का आकारिकीय एवं संरचनात्मक अध्ययन – केशव मुकुन्द लेले एवं अश्विनी कुमार श्रीवास्तव

पूर्व रानीगंज कोयला-क्षेत्र (पश्चिमी बंगाल) में चुरुलिया क्षेत्र के अधरि बाराकार शैलों से उपलब्ध श्रीवास्तविस्पोराइटिस, ट्राइलेविपेल्लिटिस, झरियाट्राइलिटीज़, तालचिरेल्ला एवं बाराकारेल्ला नव वंश के गुरुबीजाणु वर्णित किये गये हैं। नियंत्रित मसूणन द्वारा गुरुबीजाणुओं का शुष्क अवस्था तथा आर्द्र अवस्था में अध्ययन किया गया है। सभी गुरुबीजाणुओं में बीजाणु-बाह्यःचोल एवं आन्तर पिंड पाये गये हैं। आन्तर पिंड के आकारिकीय संलक्षणों को विशेष महत्व दिया गया है तथा इनके वर्गीकणिक महत्व पर बल दिया गया है। बाराकारेल्ला नव वंश दंडाकार बीजाणु-बाह्यःचोल एवं आन्तर पिंड से अभिलक्षणित है ।

INTRODUCTION

THE presence of different and distinct exine layers in fossil megaspores has been known to palynologists for several decades but the value of these structural features in the taxonomy of megaspores became evident only with the work of Hφeg, Bose and Manum (1955) who describes a two-layered megaspore, *Duosporites congoensis*, from the Permian of Zaire. The possibility of separating the layers from each other through a controlled progressive treatment, in mild alkali (1-2%), opened a new scope for studying the characters of the two layers, particularly the inner layer (mesosporium or intexine of authors).

The structural studies carried out by Pant and Srivastava (1962) revealed a number of features, especially the inner layer, which further helped in the identification of megaspores. According to them there could be as many as three layers. They suggested a proposal for classifying those megaspores under Megasporites in which knowledge of layers existed and left others to Triletes wherein only external features were known.

A more comprehensive study of Lower Gondwana megaspores by Bharadwaj and Tiwari (1970), however, revealed that these megaspores have only two layers. The inner layer (innerbody, intexine, etc.) is of two types: (i) with cushions and separated from exoexine in all sides except near the proximal region, and (ii) without cushions and separated or attached to the exoexine.

Lele and Chandra (1974) found that the trilete trace on Talchir megaspores shows

variation in its extent and the extension of cushions also correspondingly varies. This probably indicates that while in some megaspores the inner body was attached to the exoexine along the entire proximal region (as evidenced by the full length of mark and cushions on it), in other cases the attachment was partial (as evidenced by the short mark and correspondingly short radial extensions of cushions).

The present investigation of megaspores from the Lower Barakar shales of Churulia in the East Raniganj Coalfield (type locality for all new species) has provided further insight into megaspores wall structure and sculpture. The inner bodies have been separated in a large number of cases to enable a more detailed study of the trilete trace, inter-ray area of attachment and the nature of cushions. All the type slides and figured specimens are preserved in Birbal Sahni Institute of Palaeobotany Museum.

MATERIAL AND METHODS

Samples for the investigation have been collected from a section exposed in a quarry about 250 m east of Churulia Railway Station (23°47′15″/87°:5′16″) in the north-eastern part of the East Raniganj Coalfield. The samples have yielded a rich miofloral assemblage having a Lower Barakar affinity (Srivastava, 1982).

The samples have been treated with Schultz's solution and the megaspores have been picked up with the help of zero number brush under a low power binocular microscope. Dry megaspores have been studied under incident light. The trilete mark and arcuate ridges could be best studied in the dry state but the sculpture was not always very clearly brought out. Sometimes megaspores were moistened with a drop of water to better observe the details of surface ornamentation.

To study the structural details of the exine layers, individual megaspores were treated with 1-5% KOH solution for 2 to 10 minutes. Higher concentration of the alkali and longer treatment was required only for those megaspores which possessed dark-coloured inner body. Photographs have been taken at different stages of controlled maceration which gradually dissolved the exoexine and released the inner membrane. Reaction could be withheld at a particular phase by adding water and both membranes, with some details of each, could be photographed (optimum condition). In general, the inner body comes out easily when most of the exoexine had been dissolved. The inner body is generally thin and transparent but it is resistant enough to alkali treatment. In a few specific cases remains of exoexine would seem to be sticking hard to the intexine in the apical region. Preparations have been mounted in canada balsam with the help of polyvinyl alcohol. Some of the inner bodies have been stored in vials for special studies.

Photographs at different stages of maceration have been taken on 35 mm, 10 Din microfilm under Carl Zeiss Microscope. Some photographs have also been taken under Leitz dialux microscope 20 EB with phase contrast and ordinary light optics.

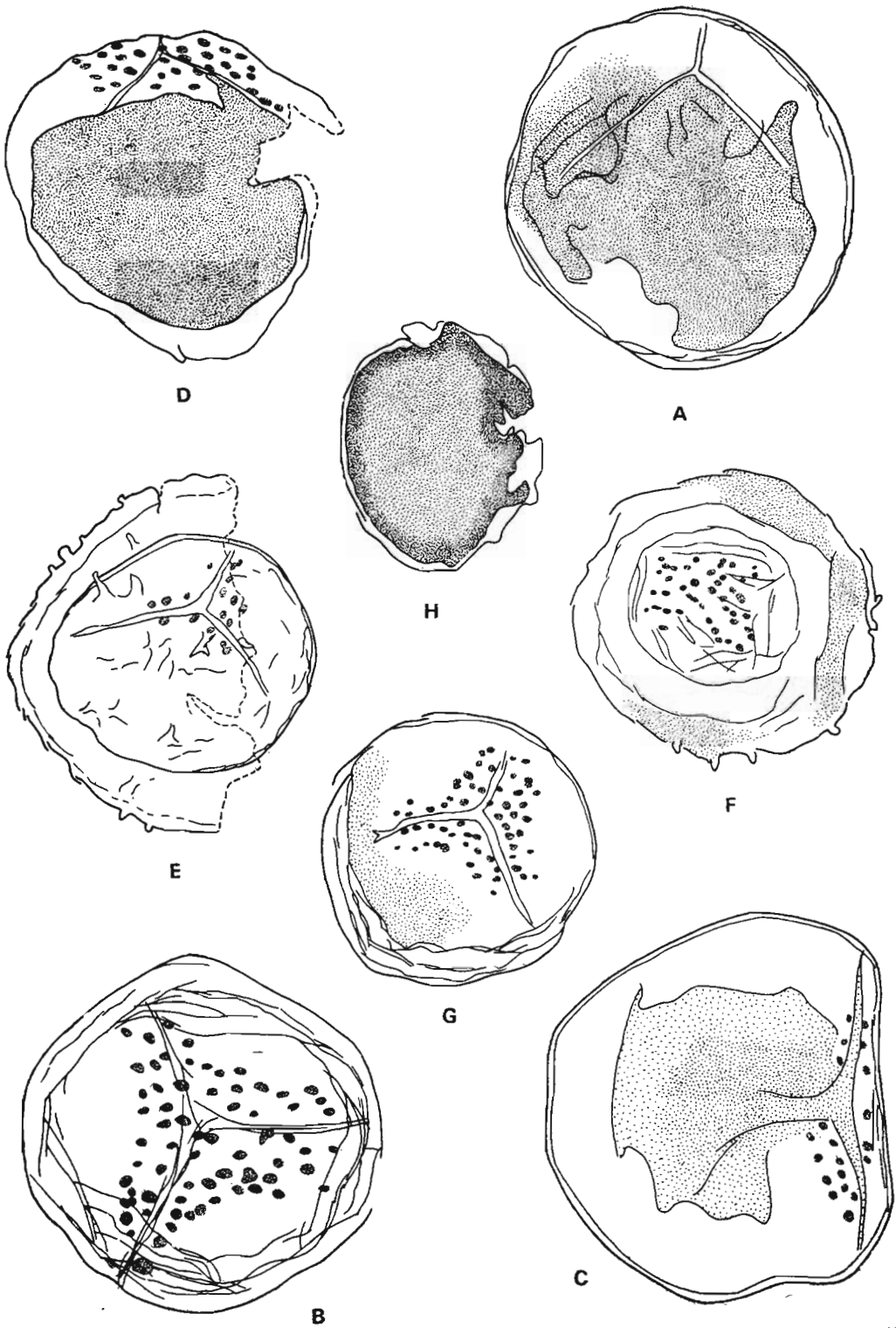
SYSTEMATIC DESCRIPTION

Genus — *Trilaevipellitis* Kar emend. Bharadwaj & Tiwari, 1970

Type Species — Trilaevipellitis psilatus Kar emend. Bharadwaj & Tiwari, 1970.

→

TEXT-FIG. 1 — **A**, *Srivastavaesporites indicus* showing the dark coloured inner body with distinct trilete trace,× 110. **B**, *Talchirella trivedii* showing the inner body where number of cushions are arranged trigonally along the trilete trace,× 110. **C**, *T. raniganjensis* showing the inner body with biseriate arrangement of cushions,× 150. **D**, *T. nigra* sp. nov.— holotype showing the dark coloured inner body with distinct trilete trace and cushions,× 110. **E**, *Barakarella churuliaensis* gen. et sp. nov.— holotype showing the baculate ornamentation and cushioned inner body with distinct trilete trace,× 110. **F**, *B. pantii* sp. nov. — holotype macerated stage of the megaspores where the outer coat and inner body with cusions are clearly visible,× 110. **G**, *B. pantii* sp. nov. showing fine punctate to granulose inner body where the cushions are arranged along the trilete trace,× 110. **H**, *Jhariatriletes densus* sp. nov.— holotpye showing thick dark coloured inner body,× 110.



TEXT-FIG. 1

Trilaevipellitis multipulvinatus sp. nov.

Pl. 1, figs 1, 2; Text-fig. 2

Diagnosis — Circular to subcircular; smooth surface, trilete mark distinct, rays 4/5 radius long, simple, straight delimited by low arcuate ridges; inner body thin, large, circular, well-defined, smooth to fine granulose, trilete trace on inner body distinct, 3/4 to 4/5 of radius; microfolds present; cushions 60-80, small, 5-10 μm in diameter, irregularly distributed in the inter-ray area forming a trigonal zone (Pl. 1, fig. 2; Text-fig. 2).

Holotype — Pl. 1, fig. 1; slide no. B.S.I.P. 6446.

Dimensions — Wet megaspore: 500-650 μm, dry 220-300 μm; inner body 475-600 μm; cushions 60-80, 5-10 μm.

Comparison — The present species differs from *T. psilatus* Kar emend. Bharadwaj & Tiwari in having large number of cushions scattered in the trigonal area. *T. talchirensis* Lele & Chandra (1974) is distinguishable by possessing uniseriate, distinct cushions and also by its indistinct trilete mark.

Remarks — Lele and Chandra (1974) have erroneously compared *Trilaevipellitis talchirensis* with the verrucose-granulose megaspore, *Talchirella nitens* Bharadwaj & Tiwari.

Genus — *Srivastavaesporites* Bharadwaj & Tiwari, 1970

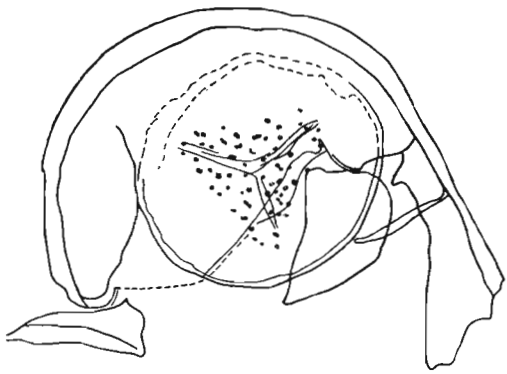
Type Species — *Srivastavaesporites karanpuraensis* Bharadwaj & Tiwari, 1970.

Srivastavaesporites indicus (Singh) Bharadwaj & Tiwari, 1970

Pl. 1, figs 3, 4; Text-fig. 1A

Dimensions — Wet megaspores 600-800 μm, dry 450-700 μm; inner body 550-750 μm.

Description — Megaspores subcircular to subtriangular in shape. Surface granulose to verrucose, verrucae sparsely distributed. Trilete mark distinct to indistinct, rays 3/4 of radius, simple, raised and straight. Arcuate ridges mediumly curved. Inner body thick, dark brown but not uniform in colour and density, some portions being darker than others, perhaps due to affects of alkali treatment, wall of the inner body infrapunctate and sometimes with the thick secondary folds. Trilete trace faintly discernible in some inner bodies, rays at least 3/4 radius or longer and may be raised by associated folds.



TEXT-FIG. 2 — *Trilaevipellitis multipulvinatus* sp. nov. — holotype showing smooth outer coat and large number cushioned inner body, × 185.

Srivastavaesporites sp.

Pl. 1, figs 5, 6

Dimensions — Wet megaspores 700-750 μm, dry 450-530 μm; inner body 700-725 μm.

Description — Megaspores circular to subcircular in shape with finely verrucose surface. Trilete mark prominent, rays straight, extending 4/5 of radius. Arcuate ridges show low curvaturae. Inner body separating only by drastic alkali treatment, nearly fits within spore cavity, trilete trace distinctly marked on inner body for about 4/5 of radius.

Comparison — In the presence of a finely verrucose exoexine and the absence of cushions on the inner body, the specimen is referable to *Srivastavaesporites*. The distinct trilete mark with low arcuate ridges and the large size of the inner body of the present specimens are comparable with *S. karanpuraensis* but there are some notable differences also. *S. karanpuraensis* has sinuous trilete rays and the inner body and its trilete trace are both indistinct. On the contrary, the present specimens have straight trilete rays, distinct inner body with a well-developed trilete mark. Species of *Banksisporites* Dettman emend. Banerji, Kumaran & Maheshwari described by Banerji *et al.* (1978) are difficult to compare as no details of inner body are given by them.

Genus — *Talchirella* Pant & Srivastava emend. Bharadwaj & Tiwari, 1970

Type Species — Talchirella trivedii Pant & Srivastava emend. Bharadwaj & Tiwari, 1970.

Talchirella trivedii Pant & Srivastava emend. Bharadwaj & Tiwari, 1970

Pl. 1, figs 7-10; Pl. 2, figs 11-13; Text-fig. 1B

Dimensions — Wet megaspores 600-800 μm; dry 400-450 μm; inner body 550-675 μm; cushions 40-65, 10-20 μm.

Description — Megaspores circular to roundly triangular in shape, with a finely granulose to verrucose surface. Trilete mark distinct and confined to arcuate ridges, rays 3/4 and 4/5 radius in length. Arcuate ridges low to mediumly curved and show medium relief. Inner body circular and mediumly thick, trilete trace on inner body clearly visible, rays extending up to 3/4 of body radius and raised by folds, folds sometimes involve cushions. Cushions distinct, numerous (40-65), irregularly scattered in inter ray area, sometimes very close even fusing with one another.

Remarks — It is observed that during controlled treatment with mild alkali, the exoexine dissolves out easily but in the proximal region, it still adheres fast to the intexine (inner body) and is left as a dark trigonal patch surrounding the trilete traces on the inner body (cushion-bearing) (Pl. 2, fig. 11). Prolonged drastic alkali treatment may dissolve this dark patch, but still its impression is left to the inner body to some extent (Pl. 2, figs 12, 13). Obviously, the inter-ray area of the intexine is the region which is in intimate contact with the exoexine. The portions peripheral to the inter ray area are perhaps not involved in attachment and therefore are susceptible to secondary compression folds (Pl. 2, fig. 13).

Further, it has been observed by us that the inner body of this species has a distinct trilete mark with long rays. It is also experienced that the maceration of the inner body may reduce the clarity of the trilete trace. However, in optimum conditions a clear trace is seen on the inner body. Specimens of Bharadwaj and Tiwari (1970, pl. 4, fig. 5) as well as of Pant and Srivastava (1961, pl. 30, figs 8, 9) show only a faint impression of the trace. The number of cushions are much greater in the specimens of Bharadwaj and Tiwari (1970, 50-80) and Pant and Srivastava (1961, about 80-125). Besides these differences, the present forms are very similar to *T. trivedii*.

Talchirella raniganjensis Bharadwaj & Tiwari, 1970

Pl. 2, figs 14, 15; Text-fig. 1C

Dimension — Wet megaspores 700-800 μm, dry 480-620 μm; inner body 700-800 μm; cushions 20-35, 8-20 μm.

Description — Megaspores circular to subcircular in shape with finely verrucose to granulose surface. Trilete mark distinct, rays being 3/4 radius long, straight and simple. Inner body thin, occupying nearly whole space of the megaspore, in some cases showing remains of exoexine as a dark patch which is very difficult to remove as in *Talchirella trivedii*, trilete trace distinct over inner body. Cushions biseriately arranged along the trilete trace.

Talchirella media sp. nov.

Pl. 2, figs 16-18; Text-fig. 3

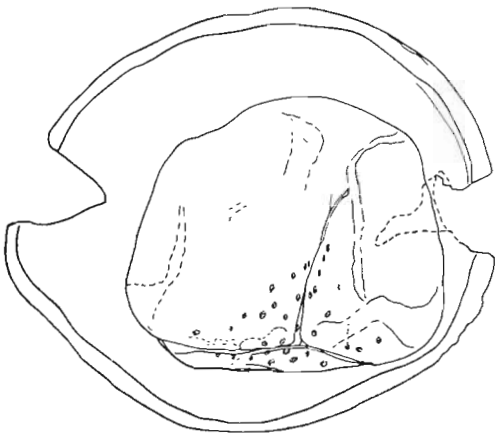
Diagnosis — Subcircular to roundly triangular megaspores, surface verrucose; arcuate ridges and mark in high relief; ridges mediumly curved, rays 3/4 to 4/5 radius long, straight. Inner body thin, subcircular to subtriangular; finely granulose or punctate; trilete trace distinct, rays 3/4-4/5 radius long, straight, associated with folds. Cushions 15-35, bold; irregularly distributed in inter-ray trigonal zone.

Holotype — Pl. 2, fig. 17; slide no. BSIP 6451.

Dimensions — Wet megaspores 560-700 μm; dry 500-650 μm; inner body 450-600 μm; cushions 15-35, 8-20 μm.

Remarks — The inner body in Pl. 2, fig. 18 is broken along the polar axis and both the halves show part of the cushion-bearing proximal area. It can also be noticed that the proximal surface of the inner body is darker than the distal one. It seems possible that the proximal half of the inner body was slightly thicker and differentiated from the distal half.

Comparison — *Talchirella media* sp. nov. compares with *T. vulgata* (Dijkstra) Bharadwaj & Tiwari (1970), *T. notabilis* Bharadwaj & Tiwari (1970) and *T. flavata* Bharadwaj &



TEXT-FIG. 3 — *Talchirella media* sp. nov.— macerated stage of megaspore showing the outer coat and cushioned inner body, × 185.

Tiwari (1970) in having fine verrucose-granulose surface and irregularly distributed cushions in the trigonal area but differs considerably in possessing mediumly curved arcuate ridges and also in the high relief of the ridges and trilete mark. The inner body of *T. media* sp. nov. shows bold cushions while the inner bodies of *T. vulgata, T. notabilis* and *T. flavata* have small and distinct cushions. *T. media* sp. nov. differs from *T. trivedii* in the smaller number of irregularly distributed cushions in the trigonal area and in the straight mark. *T. sparsa* Bharadwaj & Tiwari (1970) differs in having much smaller number of cushions (16-20), deeply curved arcuate ridges and sinuous trilete mark.

Talchirella nigra sp. nov.

Pl. 2, ig. 19; Text-fig. 1D

Diagnosis — Circular to subcircular megaspores, surface granulose to verrucose; trilete mark faint, rays 3/4 radius long, arcuate ridges clear, mediumly curved; inner body dense, dark brown, thick. Cushions 15-20, sparse, indistinct, scattered in a trigonal zone in inter-ray area, trilete trace clear elevated by folds.

Holotype — Pl. 1, fig. 19; slide no. B.S.I.P. 6453.

Dimensions — Wet megaspores 550-700 μm, dry 400-500 μm; inner body 500-700 μm; cushions 15-20, 20-35 μm.

Remarks — The margin of inner body becomes thin during drastic alkali treatment but a large central area remains dark brown (Pl. 2, fig. 19). We suspect that in this species too, the contact region of the inner body was differentiated in a manner comparable with that in *T. trivedii* and *T. raniganjensis*.

Comparison — The thick dark coloured inner body of *T. nigra* sp. nov. and its scattered cushions are comparable with *T. densicorpa* Bharadwaj & Tiwari, 1970 but the former differs in having only a few indistinct and small cushions localized in the inter-ray area whereas the latter is characterized by massive cushions (15-25) distributed all over the inner body. The trilete mark in *T. nigra*, both on the megaspores as well as on the inner body is much more prominent than in *T. densicorpa*.

Genus — *Barakarella* gen. nov.

Type Species — *Barakarella churuliaensis* sp. nov.

Diagnosis — Circular to roundly triangular trilete megaspores; surface baculose; bacula ± parallel sided, small and having slightly expanded tips, fine grana or verrucae rarely present in between bacula; trilete mark distinct, rays simple, 3/4 of radius; arcuate ridges clear, mediumly curved, circumscribing the mark. Inner body with cushions.

Comparison — The new genus is closely comparable with *Jhariatriletes* in having baculose exine but the inner body of the latter is devoid of cushions which easily distinguishes it from *Barakarella* gen. nov.

Bacutriletes v.d. Hammen ex Potonié has a baculose ornamentation. Since the internal features (inner body details) of this genus are not known, it is difficult to compare it with *Barakarella* gen. nov. *Talchirella* and *Duosporites* have cushioned inner bodies but differ in having verrucose-granulose exine sculpture.

Barakarella churuliaensis sp. nov.

Pl. 2, figs 20, 21; Pl. 3, figs 22-24; Text-fig. 1E

Diagnosis — Circular to subcircular megaspores, surface baculose, bacula 30-45 μm long and 10-18 μm broad, closely placed, tips occasionally flattened. Trilete mark prominent, rays 3/4 of spore radius, simple,

of almost uniform width throughout; arcuate ridges clear, low relief, mediumly curved, mark confined to arcuate ridges. Inner body thin, circular to subcircular, trilete mark distinct, cushions 10-15 indistinct, scattered in trigonal zone in the inter-ray area, cushions small, ± circular, 8-12 μm in diameter.

Holotype — Pl. 3, fig. 23; slide no. B.S.I.P. 6454.

Dimensions — Wet megaspores 550-700 μm, dry 350-420 μm; inner body 500-650 μm; cushions 10-15, 8-12 μm.

Barakarella pantii sp. nov.

Pl. 3, figs 25-27; Text-fig. 1F, G

Diagnosis — Circular megaspores, surface with sparsely placed small-sized bacula, 15-25 μm long and 8-12 μm broad; fine grana and verrucae intermixed. Trilete mark indistinct, rays 3/4 of spore radius; arcuate ridges indistinct, mediumly curved and delimiting mark. Inner body mediumly thin, finely granulose or punctate, secondarily folded; trilete mark clearly visible; cushions 35-50, distinct, scattered in a trigonal zone within the inter-ray area; cushions circular to subcircular, variable in size, 10-20 μm in diameter.

Holotype — Pl. 3, fig. 26; slide no B.S.I.P. 6455.

Dimensions — Wet megaspores 400-600 μm, dry 250-370 μm; inner body 400-500 μm; cushions 35-50, 10-20 μm.

Comparison — *B. pantii* sp. nov. can be distinguished from *B. churuliaensis* by its sparsely placed small-sized bacula and larger number of bolder cushions. The species has an inner body which is closely similar to that of *Talchirella trivedii* Pant & Srivastava emend. Bharadwaj & Tiwari (1970) but the two megaspores are different in their exoexine characters.

Genus — *Jhariatriletes* Bharadwaj & Tiwari, 1970

Type Species — *Jhariatriletes baculosus* Bharadwaj & Tiwari, 1970.

Jhariatriletes densus sp. nov.

Pl. 3, figs 28-30; Text-fig. 1H

Diagnosis — Circular to subcircular megaspores; surface covered with sparsely placed, short bacula 10 to 20 μm long and 8-15 μm broad. Trilete mark indistinct, rays 3/4 to 4/5 of spore radius, simple; arcuate ridge indistinct, lowly curved. Inner body finely granulose, thick, dark brown in colour and without cushions and trilete trace.

Holotype — Pl. 3, fig. 30; slide no. B.S.I.P. 6457.

Dimensions — Wet megaspores 700-850 μm, dry 400-600 μm; inner body 600-800 μm.

Comparison — *Jhariatriletes densus* sp. nov. is distinct from all the known species in possessing a thick, dark brown inner body.

DISCUSSION

Although the exosporium of megaspore has been studied in the recent past from taxonomic point of view, but enough attention has not been paid to the structure and sculpture of the inner membrane (intexine or inner body). Therefore, we thought to examine the inner bodies more critically. The results of our study are summarized below:

1. *Cushions* — Megaspores possess either a cushioned inner body or a plain inner body or are devoid of inner bodies. The cushions have been considered to be either pit-like depressions on the inner membrane (Pant & Srivastava, 1962) or elevated, lensoid structures (Høeg, Bose & Manum, 1955; Bharadwaj & Tiwari, 1970). From our observations the elevated nature of the cushions seems more plausible. They vary in their pattern of arrangement as well as in size and density and may be arranged in one or more rows along the trilete trace of the inner body or may be scattered in a trigonal zone over the trilete area. The radial extent of the cushions corresponds with the length of the trilete rays (Lele & Chandra, 1974). In the case of trigonal pattern it is observed that the zone is most well-marked where its sides are straight as in *Trilaevipellitis multipulvinatus* sp. nov. (Pl. 1, fig. 2). In such cases, the cushions are also more numerous. However, there are other examples in which the trigonal zone tends to have more or less concave sides, as in *Talchirella trivedii* (Pl. 2, fig. 13) and *Barakarella pantii* sp. nov. (Pl. 3, fig. 27). The number of cushions is reduced (20-30).

It can be well imagined that as the concavity of the sides deepens, the pattern may lose its trigonal shape and the cushions tend to simulate a serial arrangement. Whether a gradation exists between trigonal and serial patterns of cushions remains to be ascertained. At any rate, the two patterns are distinctly observable in the megaspores and their taxonomic value is established. Rarely the cushions may be irregular both in arrangement and size, e.g. in *Duosporites irregularis* Bharadwaj & Tiwari (1970, text-fig. 32).

The number of cushions varies both within and between species. Bharadwaj and Tiwari (1970) used this criterion for distinguishing *Talchirella trivedii* (50-80 cushions) from *T. sparsa* (16-20 cushions). Besides other characters, *T. media* sp. nov. is distinguished by a medium number of cushions (15-35 cushions).

Cushions vary from circular to subcircular to ovalish. Also their prominence seems to differ from species to species. They may be nearly flat and ill-defined as in *T. nigra* and *T. raniganjensis* but in other species, viz., *T. trivedii*, *T. media* and *Duosporites congoensis* they have high relief and become prominent.

The size of cushions may be ± uniform in some species while it may not be so in others. Both small and big cushions occur in *T. trivedii* and it seems that the smaller ones tend to be away from the trilete trace. In some forms cushions tend to fuse with each other or come very close to each other forming oblong fused units. This was particularly noticed in *T. trivedii* and is probably a useful supporting feature for specific differentiation.

2. *Trilete trace* — The trilete trace on the intexine is evidently an impression of the triradiate mark of the outer membrane of megaspore (Høeg, Bose & Manum, 1955; Bharadwaj & Tiwari, 1970). The trace is consistently developed and may even show greater or less degree of prominence and elevation as in the case of a triradiate mark. Some examples show a distinct trilete trace which is difficult to distinguish from a regular trilete mark (Pl. 1, fig. 6; Pl. 2, fig. 13). Folding of intexine may take place along the trace and enhance its prominence (Pl. 1, fig. 8). In such cases the folded region of the intexine may involve some cushions which are close to the trace (Pl. 1, fig. 10). The trilete mark of the intexine may extend up to the margin or close to it while in others it is distinctly shorter (2/3 to 3/4 of radius). Careful dissection of the intexine and exoexine layers has shown that the marks of the two layers are one below the other; however, during maceration the loose-fitting inner body can be readily displaced and the correspondence of the two marks (on inner and outer membrane) is lost.

3. *Intexine : shape, thickness, sculpture and structure* — The general shape of the inner body is either circular or triangular but may be often modified due to secondary foldings. Some inner bodies are thin, transparent to translucent while others are thick, dark-coloured and opaque. Both types are, however, very resistant to maceration treatments. Often in dark-coloured bodies, maceration treatment is not uniform with the result that darker and lighter irregular zones may develop. Transparent inner bodies may be externally smooth or may show fine granulations or puncta, e.g. *Talchirella media* and *Barakarella pantii*. Sometimes these features are so fine as to suggest internal structures. The inner body sculpture or structure should be studied in greater detail (especially with SEM) because it may have relevance to taxonomy.

An interesting feature which we observed for the first time is that the trilete area in certain cases is differentiated by thickness and colour. When stained the differentiated apical area takes a darker shade than the rest of the proximal exine (see *Talchirella trivedii*, Pl. 2, figs 11-13). The cushions are also confined to the differentiated area. It is therefore clear that optical differentiation in the inner bodies may serve as a useful taxonomic criterion.

The accumulated evidence demonstrates that the inner body possesses a number of qualitative and quantitative characters which can be utilized for classifying megaspore genera and species. Further detailed optical and ultramicroscopic studies in this direction would indeed prove very rewarding.

REFERENCES

BANERJI, J., KUMARAN, K. P. N. & MAHESHWARI, H. K. (1978). Upper Triassic *Sporae dispersae* from the Tiki Formation. Megaspores from the Janar Nala Section, South Rewa Gondwana Basin. *Palaeobotanist*, **25**: 1-26.

BHARADWAJ, D. C. & TIWARI, R. S. (1970). Lower Gondwana megaspores — A Monograph. *Palaeontographica*, **129B** (1-3): 1-70.

HØEG, O. A., BOSE, M. N. & MANUM, S. B. (1955). On double walls in fossil megaspores with description of *Duosporites congoensis* n. gen. n. sp. *Nytt. Mag. Bot.*, **4**: 101-107.

LELE, K. M. & CHANDRA, A. (1974). Studies in the Talchir flora of India-9. Megaspores from the Talchir Formation in the Johilla Coalfield, M.P., India. *Palaeobotanist*, **21** (2): 238-247.

PANT, D. D. & SRIVASTAVA, G. K. (1961). Structural studies on Lower Gondwana megaspores-Pt. I. Specimens from Talchir Coalfield, India. *Palaeontographica*, **109B**: 45-61.

PANT, D. D. & SRIVASTAVA, G. K. (1962). Structural studies on Lower Gondwana megaspores-Pt. II. Specimens from Brazil and Mhukuru, Tanganyika. *Palaeontographica*, **111B**: 97-110.

SRIVASTAVA, A. K. (1982). A Lower Barakar mioflora! assemblage from the Ranigani Coalfield. India. *Geophytology*., **12** (1): 131-132.

EXPLANATION OF PLATES

PLATE 1

1. *Trilaevipellitis multipulvinatus* sp. nov. Holotype specimen no. 3A and showing outer coat inner body. × 100. Slide no. 6446
2. *T. multipulvinatus* sp. nov. inner body showing cushion mark and trilete area. × 300. Holotype specimen no. 3A. Slide no. 6446.
3. *Srivastavaesporites indicus* (Singh) Bharadwaj & Tiwari. Megaspore in dry condition. Specimen no. 48. × 100.
4. *S. indicus* (Singh) Bharadwaj & Tiwari, showing dark colour. I.B. specimen no. 48. × 100. Slide no. 6447.
5. *Srivastavaesporites* sp. Specimen no. 2; wet megaspore before maceration. × 100.
6. *Srivastavaesporites* sp., inner body in wet condition. × 100.
7. *Talchirella trivedii* — Showing megaspore in wet condition before maceration. × 100. Specimen no. 14.
8. *T. trivedii* showing first stage of maceration. × 100.
9. Shows cushions in the phase contrast. Specimen no. 14. × 600. Slide no. 6448.
10. Shows trilete mark which is elevated and folded beneath the cushions. × 500. Specimen no. 8.

PLATE 2

11. *Talchirella trivedii* showing a patch intact over inner body. × 100.
12. Showing I.B. in ordinary light. × 100. Slide no. 6448.
13. Showing I.B. in phase contrast. × 150. Slide no. 6448.
14. *T. raniganjensis* Bharadwaj & Tiwari, specimen in wet condition. × 100. Specimen no. 3.
15. *T. raniganjensis* Bharadwaj & Tiwari — I.B. of the megaspore showing biseriate arrangement of cushions. × 150.
16. *T. media* sp. nov. showing wet specimen under reflected light. × 100. Holotype specimen no. 28.
17. *T. media* sp. nov. Holotype I.B. of the megaspore showing cushions and trilete mark. Exine shows fine grana-puncta. × 100. Specimen no. 28, slide no. 6451.
18. *T. media* sp. nov., another specimen showing broken I.B. × 100. Specimen no. 44, slide no. 6452.
19. *T. nigra* sp. nov., holotype showing dark colour inner body and cushions. × 150. Specimen no. 26, slide no. 6453.
20. *Barakarella churuliaensis* gen. et sp. nov.— megaspore in wet condition. × 100. Holotype specimen no. 18.
21. Showing baculate ornamentation of the outer coat along the margin. × 300. Specimen no. 18.

PLATE 3

22. *Barakarella churuliaensis* gen. et sp. nov., holotype after mild alkali treatment. × 100.
23. Showing inner body and outer coat details. × 100. Holotype slide no. 6454.
24. Showing baculate ornamentation over the surface of megaspores. × 300.
25. *Barakarella pantii* sp. nov., Holotype. Wet megaspore in incident light. × 100. Specimen no. 40.
26. Holotype, after alkali treatment and full megaspore shows the inner body with cushions and surrounding outer coat of the spore. × 100. Slide no. 6455.
27. *B. pantii* sp. nov., finely punctate-granulate inner body from another specimen. × 100. Slide no. 6455.
28. *Jhariatriletes densus* sp. nov., Holotype showing baculate ornamentation along the margin in wet condition. × 100. Specimen no. 55.
29. Showing only the outer coat of the holotype. × 100. Slide no. 6457.
30. Inner body of *J. densus* sp. nov. recovered from another specimen. × 100. Specimen no. 47, slide no. 6458.

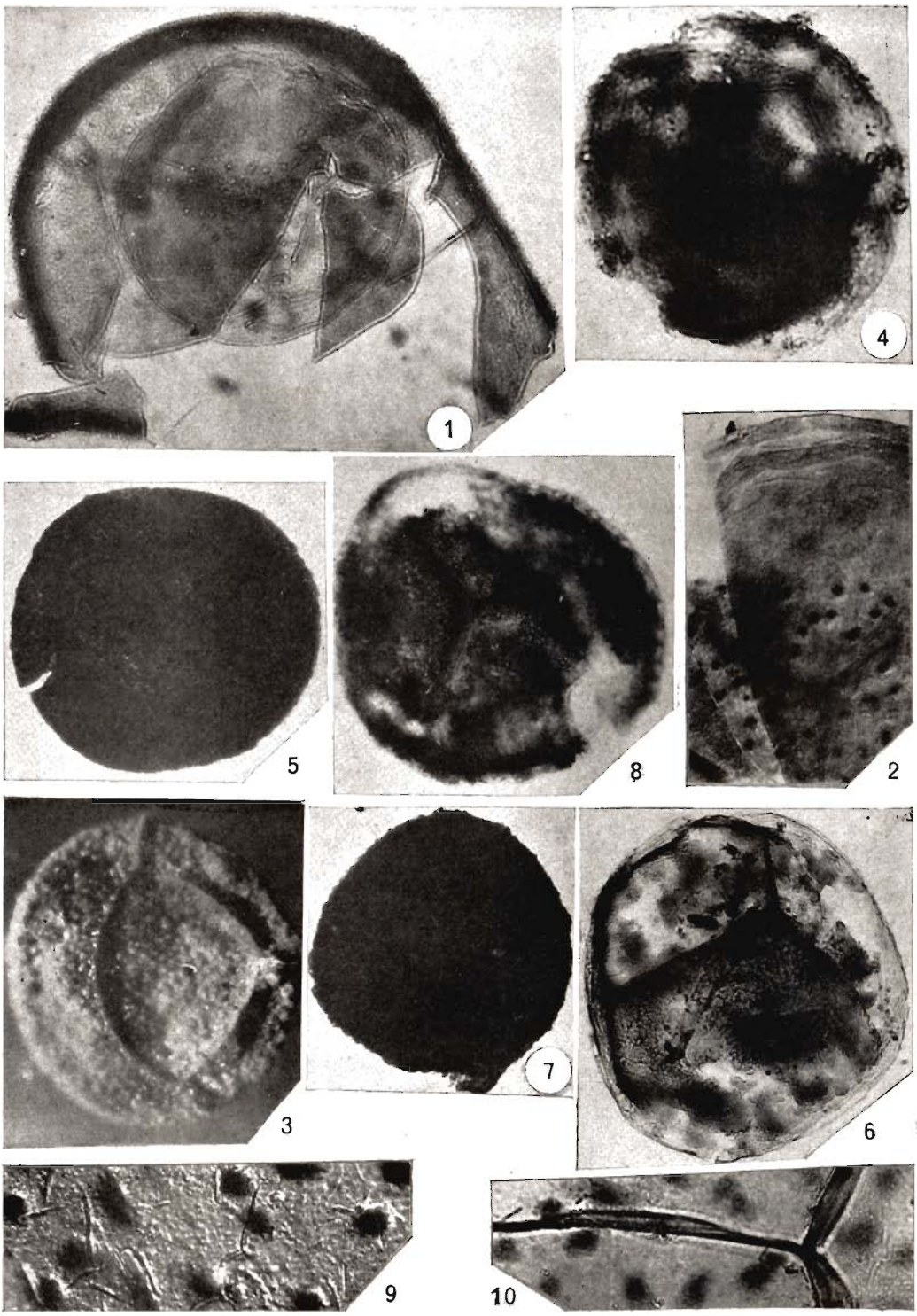


PLATE 1

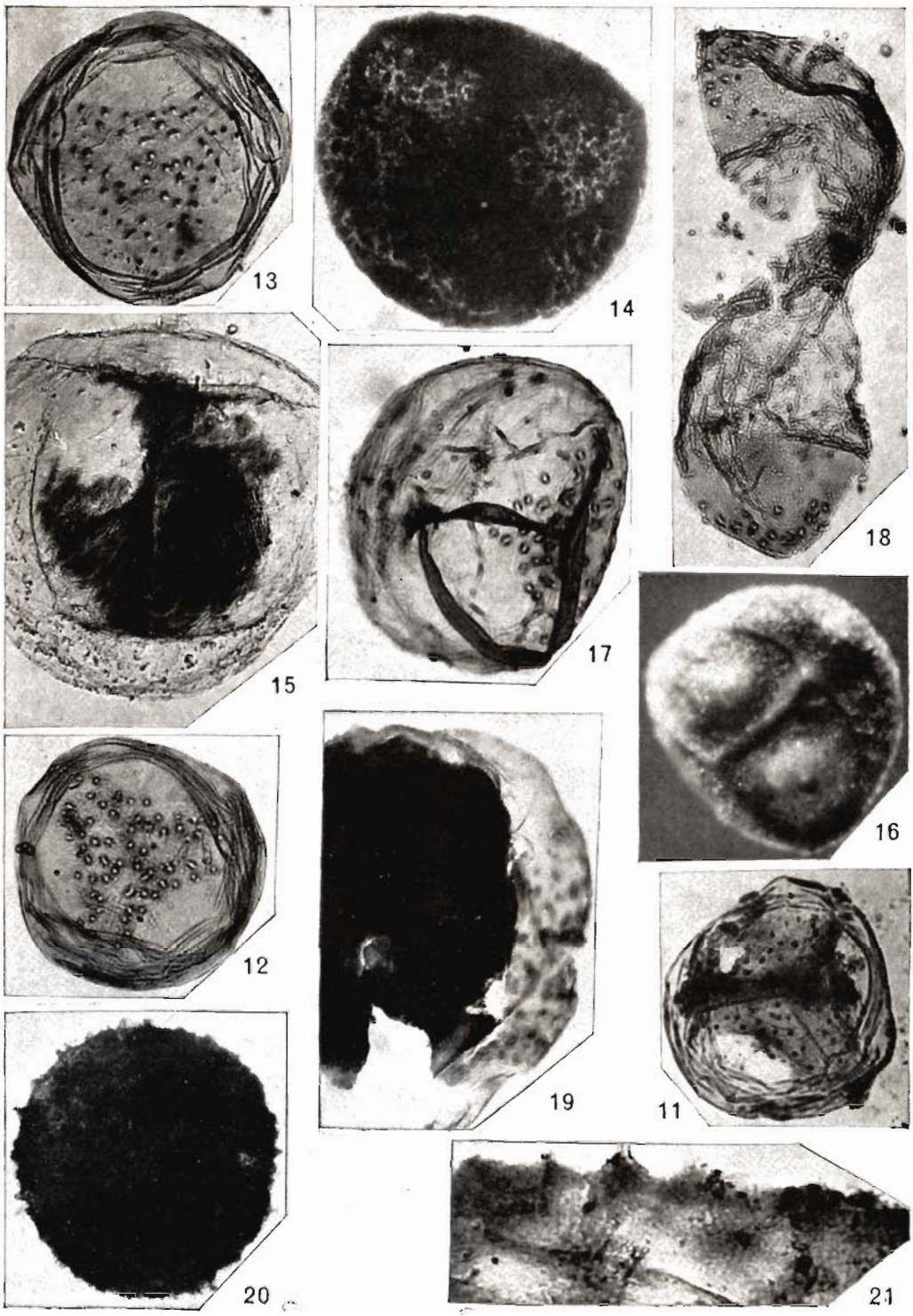


PLATE 2

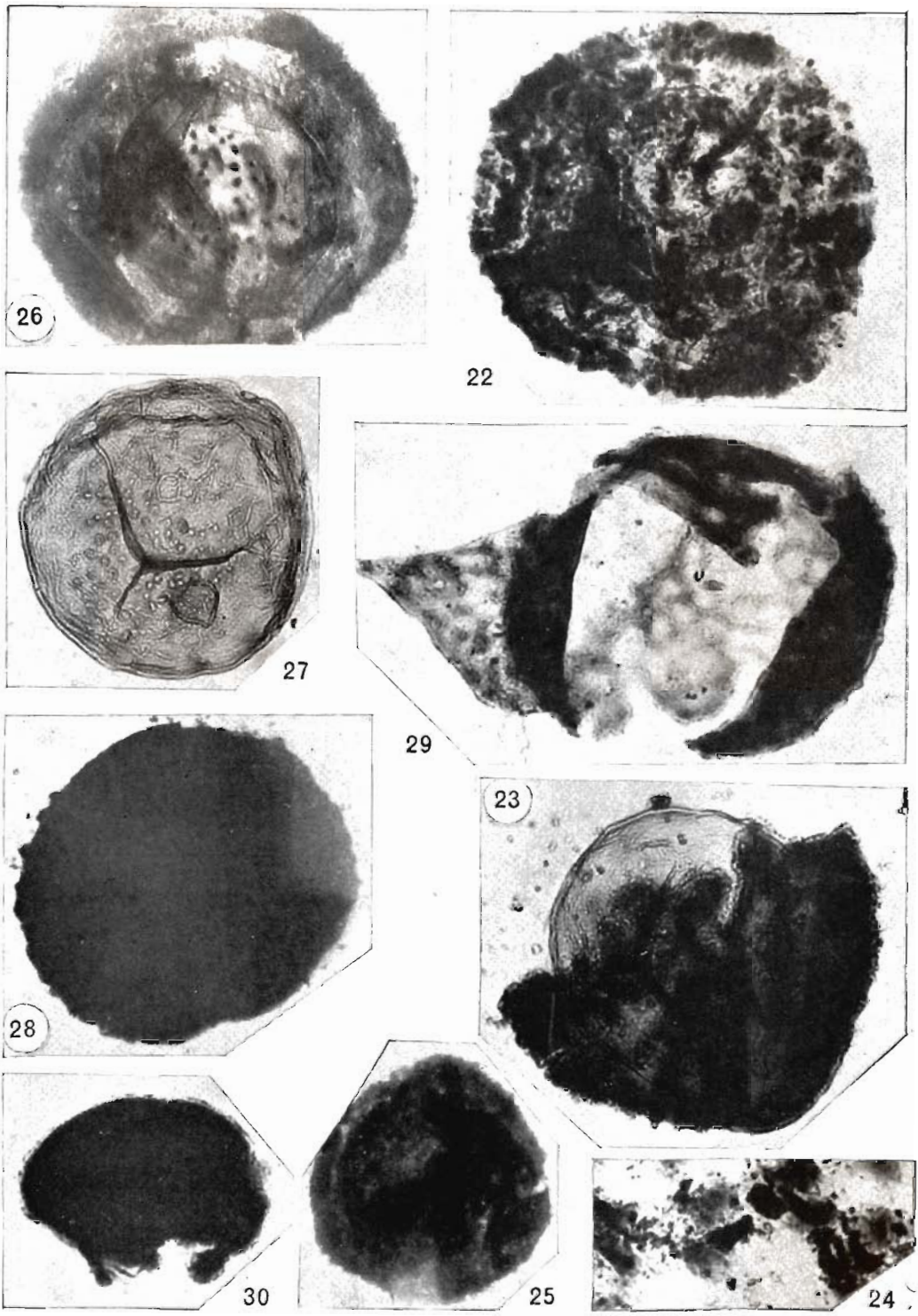


PLATE 3