STUDIES IN THE TALCHIR FLORA OF INDIA—7. PALYNOLOGY OF THE TALCHIR FORMATION IN THE JAYANTI COALFIELD, BIHAR

K. M. LELE AND REHANA MAKADA (MRS.)

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

Miospore assemblages are described from a succession of the Talchir Formation in the Patharjore Nala of the Jayanti Coalfield, Bihar. Of the total of 50 species belonging to 30 genera, four genera, viz., *Plicatisporites*, *Jayantisporites*, *Tuberisaccites* and *Circumstriatites* are newly erected. Assemblages earlier recorded from the two intercalated Boulder Beds of the same succession are also taken into account for a fuller discussion of palynological and biostratigraphical aspects of the Talchir Formation and its relation to the overlying Karharbari Formation.

INTRODUCTION

Investigation of the Lower Gondwana formations of the Jayanti (or Jainti) Coalfield near Madhupur, Bihar, was undertaken a few years ago for collecting fossil plants and palynological material of the Glossopteris flora. The small basin is very suitable for palaeobotanical studies as the starta concerned (NIYOGI & SANYAL, 1962) are limited to the Talchir and the Barakar (? Karharbari) Formation. Good sections of the Talchir Formation* were systematically studied along the Patharojore, Baghdaru and Gharghara-Ghusko nalas, all of which run roughly north-eastwards to feed the Jayanti river. Location of palynological samples from the Talchirs of these nalas, as well as other places north of Karaon, are given in the accompanying map.

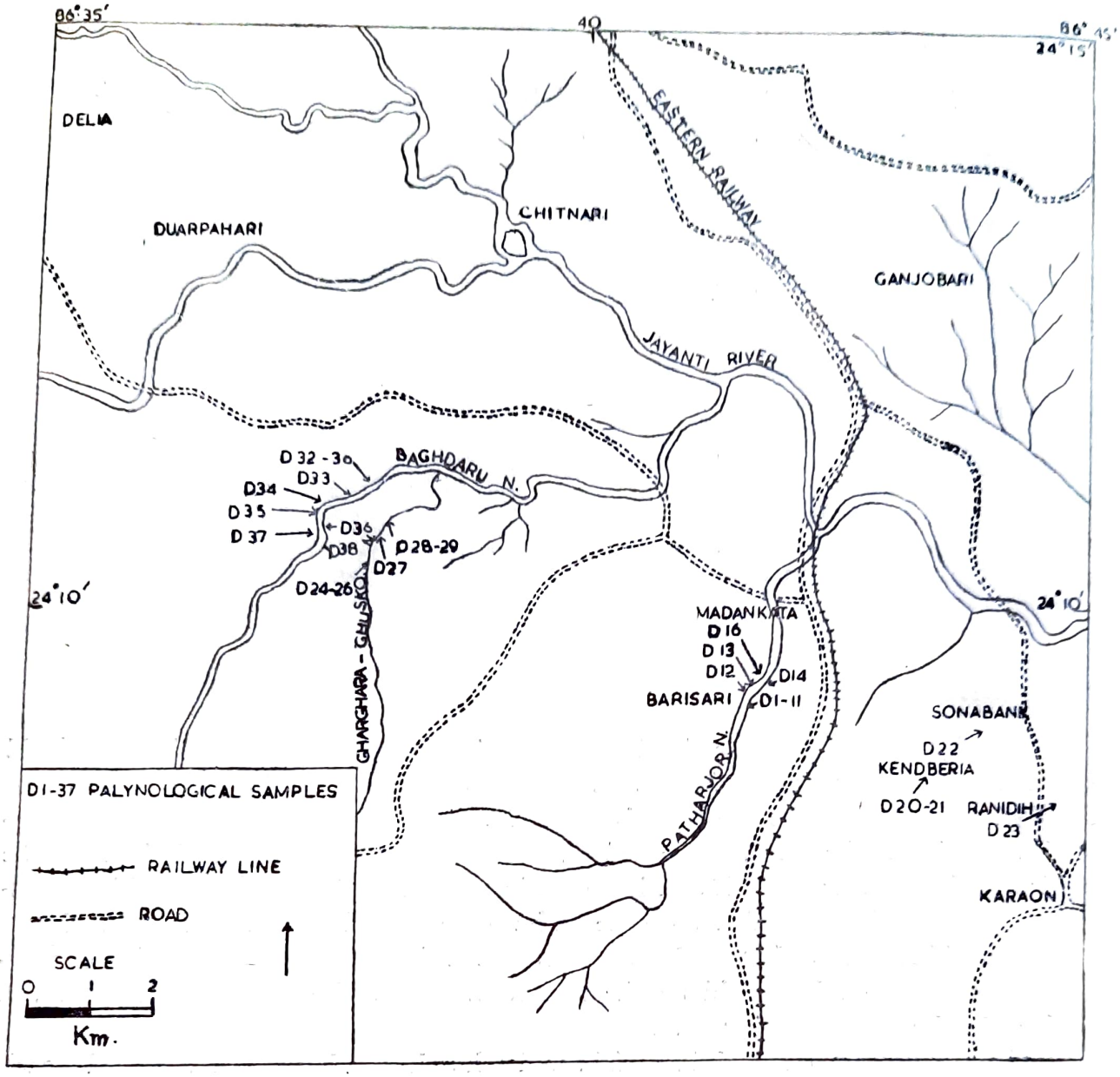
The sequences from Baghdaru Nala and Gharghara-Ghusko Nala proved nearly barren of miospores but a few plant fossils have been found in the uppermost part of the section. On the other hand, the Patharjore Nala sequence yielded very well-preserved miospore assemblages from almost all starta including the two intercalated Talchir Boulder Beds. The findings from the two Talchir Boulder Bed intercalations were published earlier in view of their palynostratigraphic significance (LELE & KARIM, 1971). These data are given due consideration in the present account which deals with the miospore assemblages recovered from several beds of the Talchir Formation exposed in the Patharjore Nala.

GEOLOGICAL BACKGROUND

In the Patharjore Nala, the Talchir-Metamorphic contact is seen about a mile east of Barisari village. Here the Talchirs, deposited along a boundary fault, are steeply inclined and show undulations.

---

*The terms 'Formation' and 'Group' are here used in the lithostratigraphical sense according to the current international nomenclature.



Map—Part of the Jayanti Coalfield showing location of samples.

The sequence (see Table 1) does not beign with the familiar Talchir Boulder Bed but with a sandstone which is free from any recognisable pebbles or cobbles, although some material of needle-shale appearance is apparently mixed up with the sandstone. This is followed upwards by several repetitions of fine-grained sandstone (or siltstone) and needle shale. The basal beds are relatively thinner and packed up but higher up the starta become thicker and more sharply recognisable, especially after the appearance of the first Boulder Bed. There is another distinct Boulder Bed, well separated from the first one by a considerable thickness of needle shales and siltstones. The miofloral assemblages of the two Talchir Boulder Bed intercalations have been separately described (Lele & Karim, 1971).

A nearly rhythmic sequence of siltstones and needle shales can be traced in continuation up to about half a mile north of the Talchir-Metamorphic contact. The total thickness of the beds encompassed in the present study is approximately 37 meters. (Table 1). At several places the siltstones or shales are varve-like in appearance. Organic debris of very probable plant origin can be seen as thin laminations within siltstones, shales and even the boulder beds. In the topmost siltstones of the section, some fossil plant-fragments

TABLE I

Ser. no.	Field Sample no.	Sequence (Talchir Formation)	Approximate Thickness (metres)	Organic contents
17		Alternating Siltstone & Needle shale (5 beds).	7 m.	Fragmentary plant fossils and seeds.
16	D16	Needle shale	9 m. 14 cm.	Miospores.
15	D15	Siltstone	1 m. 22 cm.	Indeterminate plants (fragments in thin zones). Miospores.
14	D14	Boulder Bed II	Variable (average(4m. 57 cm.	Miospores (Lele & Karim, 1971).
13	D13	Alternating Needle shales	9 m. 14 cm.	Miospores (from the topmost needle shale).
12	D11-D12	Needle shale	61 cm.	Miospores.
11	D10	Boulder Bed I	Variable average (4m. 57 cm.)	Thin zones of Indeterminate plant debris. Miospores. (Lele & Karim, 1971).
10	D9	Needle shale	10 cm.	Miospores.
9	D8	Shaly sandstone with occasional pebbles.	7 cm.	(Indeterminate organic remains.) Miospores.
8	D7	Sandstone	20 cm.	×
7	D6	Needle shale	9 cm.	Miospores.
6	D5	Fine sandstone	5 cm.	×
5	D4	Needle shale	7 cm.	Miospores.
4	D3	Fine sandstone	5 cm.	×
3	D2	Needle shale	5 cm.	Miospores.
2	No sample as it breaks.	Fine sandstone	5 cm.	×
1	D1	Muddy sandstone mixed with shaly matter.	13 cm.	Miospores.
		Metamorphics.		

were discovered. These are generally black (carbonaceous?) in colour and hardly show enough details for identification.

MATERIAL AND METHODS

Maceration of siltstone and shale samples was carried out by the methods outlined in in our previous paper (LELE & KARIM, 1971). Percentage frequency counts of the miospore population is based on 200 counts. In most cases a large number of slides had to be scanned to complete the counts. Rarely the population was below this mark.

Holotypes and figured specimens of moispores are preserved in the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC DESCRIPTION

Following 50 species belonging to 30 genera have been recovered from the material studied here. There are 4 new genera and 20 new species. Only those species which are marked with an asterisk (*) are described—

1. *Punctatisporites minutus* Kosanke, 1950
2. *Punctatisporites ganjrensis* Lele & Maithy, 1969
*3. *Plicatisporites distinctus* gen. et sp. nov.
*4. *Granulatisporites* sp.
5. *Cyclogranisporites plicatus* Allen, 1965
6. *Verrucosisporites varius* Maheshwari, 1967
7. *Horriditriletes novus* Tiwari, 1965
*8. *Jayantisporites pseudozonatus* gen. et sp. nov.
*9. *Jayantisporites indicus* sp. nov.
*10. *Jayantisporites conatus* sp. nov.
11. *Virkkipollenites densus* Lele, 1964
12. *Virkkipollenites obscurus* Lele, 1964
13. *Plicatipollenites indicus* Lele, 1964
14. *Plicatipollenites trigonalis* Lele, 1964
15. *Plicatipollenites diffusus* Lele, 1964
16. *Plicatipollenites densus* Srivastava, 1970
*17. *Rugasaccites ovatus* sp. nov.
18. *Parasaccites fimbriatus* Maheshwari, 1969
19. *Parasaccites obscurus* Tiwari, 1965
20. *Parasaccites talchirensis* sp. nov.
*21. *Parasaccites plicatus* sp. nov.
*22. *Parasaccites perfectus* Bose & Maheshwari, 1968
23. *Parasaccites diffusus* Tiwari, 1965
*24. *Parastriopollenites segmentus* sp. nov.
*25. *Parastriopollenites indicus* sp. nov.
*26. *Tuberisaccites varius* gen. et sp. nov.
*27. *Tuberisaccites lobatus* sp. nov.
*28. *Tuberiscaccites tuberculatus* (Maheshwari, 1969) comb. nov.
*29. *Caheniasaccites distinctus* sp. nov.
*30. *Caheniasaccites decorus* sp. nov.
*31. *Diavarisaccus scorteus* sp. nov.
32. *Crucisaccites latisulcatus* Lele & Maithy, 1964
33. *Vestigisporites diffusus* Maithy, 1965
34. *Potenieisporites neglectus* Potonié & Lele, 1961
35. *Platysaccus papilionis* Potonié & Klaus, 1954
36. *Alisporites opii* Daugherty, 1941
*37. *Labiisporites densus* sp. nov.
38. *Illinites purus* Leschik, 1956
39. *Vesicaspora breckmanii* Bose & Maheshwari, 1968
*40. *Vesicaspora crassa* sp. nov.

41. *Sulcatisporites maximus* Singh, 1964
42. *Rhizomaspora singula* Tiwari, 1965
*43. *Circumstriatites talchirensis* gen. et sp. nov.
*44. *Circumstriatites obscurus* sp. nov.
*45. *Circumstriatites ovatus* sp. nov.
*46. *Striatites* sp.
47. *Faunipollenites varius* Bharadwaj, 1962
48. *Faunipollenites goraiensis* (Potonié & Lele) Maithy, 1965
49. *Lahirites singularis* Bharadwaj & Salujha, 1964
*50. *Striasulcites* sp.

Anteturma—Sporites Potonié, 1893
Turma—Triletes (Reinsch) Potonié & Kremp, 1954
Subturma—Azonotriletes Luber, 1935
Infraturma—Murornati Potonié & Kremp, 1954

Genus—**Plicatisporites** gen. nov.

Type species—*Plicatisporites distinctus* gen. et sp. nov.

Diagnosis—Miospores circular-subcircular, size range 40-70 μ; trilete mark distinct; exine punctate to finely reticulate, variously folded.

Description—Miospores mostly circular, occasionally broadly oval; trilete mark distinct, often eccentric, suggesting lack of proximo-distal compression, rays equal, short, straight, uniformly broad, labra thin to thick, covered all over with closely spaced puncta (up to 2 μ wide) or fine reticulum; several prominent secondary folds present often obscuring tetrad mark, *extrema lineamenta* rough.

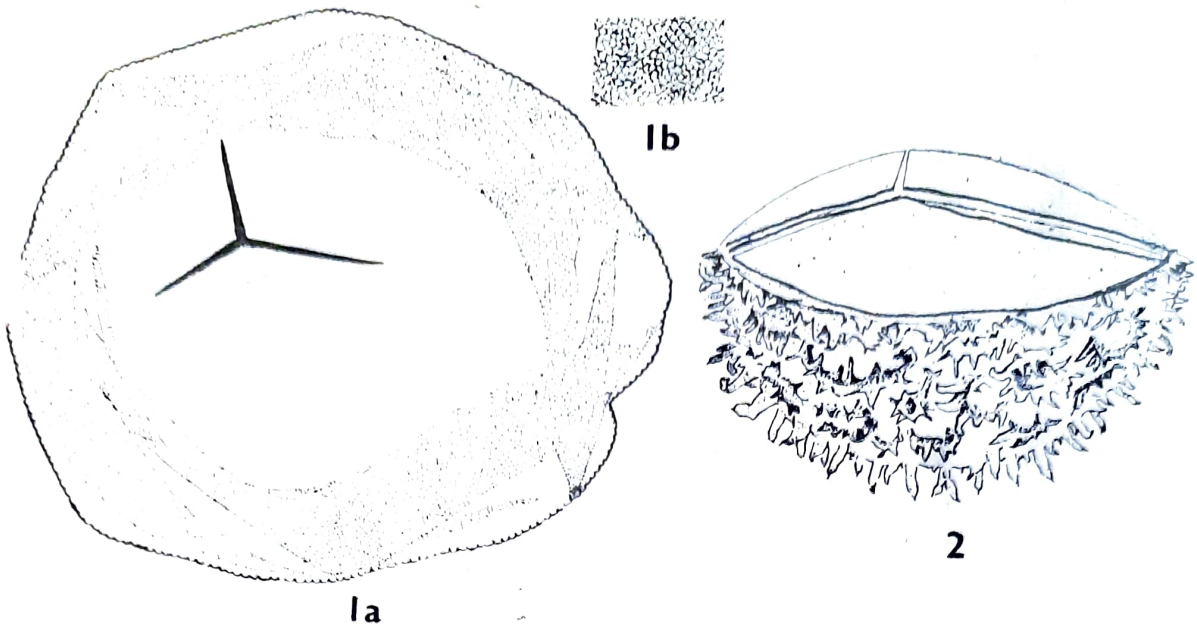
Comparison—The genus *Plicatisporites* is characterised by generally distinct, short trilete mark and a punctate-reticulate exine having several conspicuous secondary folds. *Calamospora* Schopf, Wilson & Bentall (1944) shows resemblance in having folded exine but differs in its fine infrapunctate to structureless exine, a ± distinct *area contagionis* and smooth *extrema lineamenta*. *Microreticulatisporites* (Knox) Potonié & Kremp (1955) is distinguishable by its triangular shape, distinct reticulum and lack of semilunar folds. *Cyclofoveolatispora* Venkatachala & Kar (1968) resembles in general appearance but is distinguishable by its obscure trilete mark and in having microfoveolate ornamentation only on the distal side of the exine. *Punctatisporites* differs in its smooth and probably structureless exine and usually longer trilete mark.

Some specimens (Pl. 1, fig. 4) show splitting of the exine, but no regular, weak zones of splitting are recognisable.

Plicatisporites distinctus sp. nov.

Pl. 1, Figs. 1-4, Text-Fig. 1

Diagnosis—Miospores ± circular; trilete mark distinct, often eccentric, rays all equal, 1/2 spore radius long, straight, uniformly broad, labra thin to thick, vertex raised, exine mediumly thick, densely punctate to reticulate; secondary folds prominent.



Text-Fig. 1a—*Plicatisporites distinctus* gen. et sp. nov. Camera lucida sketch of geno-holotype. × *Ca* 1400.
1b—Exine details.
Text-Fig. 2 —Organisation of *Jayantisporites* gen. nov.

Description—Miospores circular, 42-60 × 57-70 μ in size; many speimens indicate that the trilete rays maintain a more or less uniform width up to nearly their ends. Puncta often as closely spaced as to produce a microreticuloid affect, puncta 1-2 μ wide; irregularly arranged semilunar to lenticular folds mostly along the periphery; *extrema lineamenta* rough.

Holytype—Pl. 1, Fig. 1 (55 × 43 μ).

Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Genus—**Granulatisporites** (Ibrahim) Potonié & Kremp, 1954

Type species—*Granulatisporites granulatus* Ibrahim, 1933

Granulatisporites sp.

Pl. 1, Fig. 5

Description—Miospores triangular, 22-36 μ in size; interradial sides convex, apices bluntly rounded; trilete mark distinct, rays slightly wavy, almost reaching apices, accompanied by thin folds; exine thin, ornamentation granulose all over, grana uniformly and closely distributed.

Remarks—The few specimens, although smaller, are idential with *Granulatisporites* sp. described by Lele and Karim (1971) from the Talchir Boulder Bed. In the presence of thin folds associated with the mark this form appears to be distinct from the known species.

Infraturma —Varitrileti Venkatachala & Kar, 1965

Genus—**Jayantisporites** gen. nov.

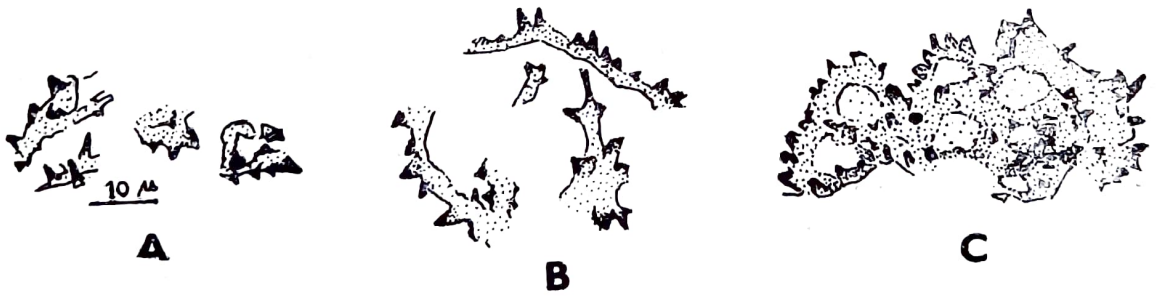
Type species—*Jayantisporites pesudozonatus* gen. et sp. nov.

Diagnosis—Size range 50-80 μ; radial triangular to subcircular miospores; trilete

mark prominent, rays ± raised, usually reaching spore margin; exine nearly smooth proximally, infrapunctate to infragranulose; distally ornamented with distinct, compound processess (bacula, spines, verrucae or coni in different combinations); reduced sculpture of grana, coni or spinules may be interspersed between larger elements; processes strongly tend to fuse in groups through confluence of basal parts forming separate or connected cristate ridges; fusion and overlapping of elements near spore equator may often produce a partial to complete pseudozonate structure; Inner body may develop.

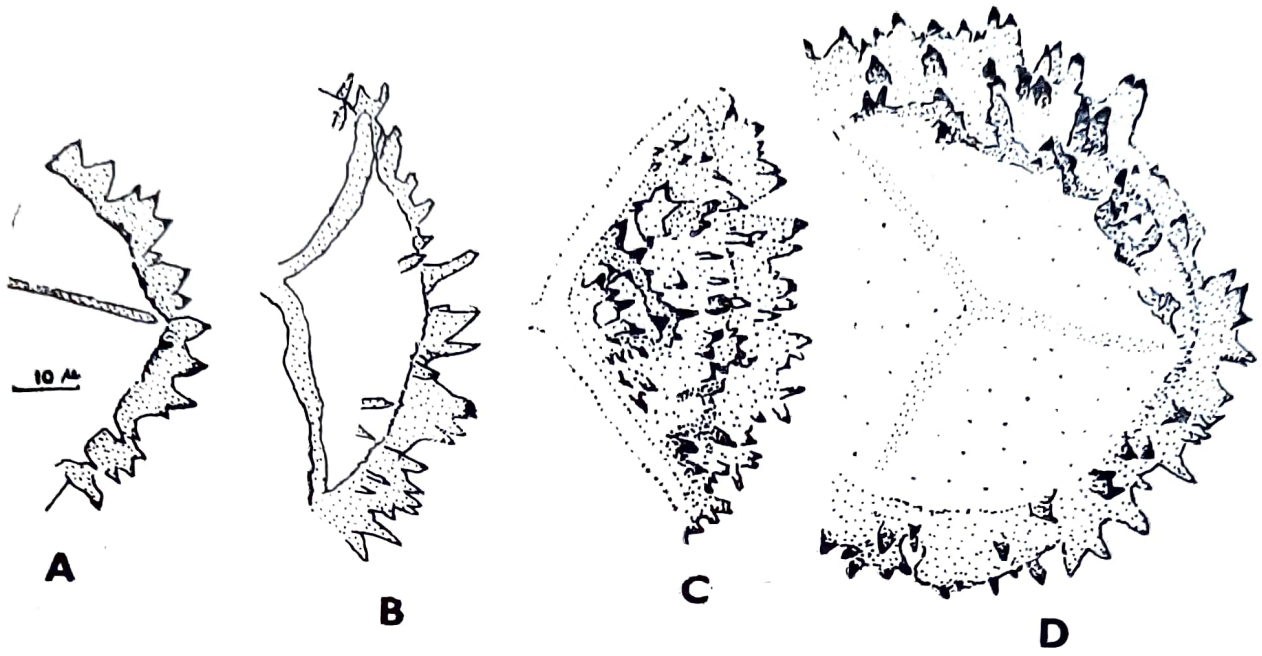
Discussion—Oblique views of specimens in tetrad or isolated conditions (Pl. 1, figs. 8, 18, 20) clearly indicate that the miospores are heteropolar, having a pyramidal proximal face and ± sub-hemispherical distal side as shown in the interpretation (Text-Fig. 2). Consequently a slight eccentricity is often noticed in flattened specimens. The rays apparently have thick lips and may be associated with somewhat flappy elevated folds. The trilete mark is well seen nearly up to the spore equator and rarely may project into the pseudozonate structure (Pl. 1, fig. 7).

Ornamentation—The sculpture is chiefly confined to the distal sub-hemispherical part (Pl. 1, fig. 8). The proximal pyramidal part is nearly smooth but sometimes appears finely granulose or punctate which may be due to exine structure. The distal ornament is mostly composed of compound elements, more often fingure-like in appearance having bacculate to somewhat verrucate lower parts surmounted by small cones to spines. A fine setose point may be noticed at the apex of several processes. The processes may also be ± granulose (Pl. 1, figs. 10,11). In some cases the terminal units of the processess appear somewhat different in thickness. The remainder of the distal exine as well as the pseudozonate structure may also bear very reduced sculpture of minute coni, spinules, or grana (Pl. 1, figs. 10, 11). The sculptural pattern of the three species of *Jayantisporites* is shown in Text-figs. 6-8.



Text-Fig. 3 (A-C)—Camera lucida sketches of *Jayantisporites* showing trends in the development of reticuloid pattern of cristate ridges through sculptural fusion.

Pseudozona—The larger elements, besides being peculiar in their structure, show another characteristic feature in their strong tendency of fusion. The elements fuse in groups along their ± confluent bases which results in the development of high cristate ridges. The ridges, in their turn, further link each other (Pl. 1, figs. 9, 18) and form in extreme cases a nearly complete reticuloid pattern (Pl. 1, figs. 7, 17, Text-Fig. 3A, B, C). Towards the spore equator, where the elements appear to be more crowded and overlapping, a partial to complete pseudozonate structure may develop from the different degree of sculptural fusion (Text-fig. 4A-D). Besides, on flattening the bulging distal side is somewhat projected around the equator (i.e., the contact line between the proximal and distal faces) which accentuates the pseudozonate appearance. These observations, based on a study of large number of specimens, clearly indicate that the pseudozona is only a derived feature of inconsistent



Text-Fig. 4—Camera lucida sketches of *Jayantisporites* showing development of pseudozona through sculptural fusion and overlapping.

development and the miospores are basically azonate. Examples of lateral or oblique views of spores in isolated condition or in tetrads also confirm this point.

Tetrads—There are in the same preparations, a number of well-preserved tetrahedral tetrads whose individual components are identical with *Jayantisporites* in all essential respects. However, the average size of the spores in the tetrads and their ornament is comparatively smaller than in liberated individual (Text-figs. 6A-8A). The tetrads evidently represent immature stages of development. In favourable state of preservation (Pl. 1, fig. 13), the trilete mark could be detected. No inner body is revealed in the tetrads. Liberated individuals show a thin inner body (Pl. 1, fig. 8) and it seems probable that the development of the inner body was related to maturity of the spores. In view of this it is believed that the incidence of inner body in *Jayantisporites* may vary in different materials.

Visscher (1966) created *Lapposisporites* for some Triassic miospores still attached in tetrahedral tetrads, which bear a rather close external resemblance to the tetrads of *Jayantisporites*. *Lapposisporites* is, however, distinct as that name is applicable to an obligate spore-tetrad. Unlike *Jayantisporites*, nothing is therefore known about the development trends of the pseudozonate structure or inner body in the case of *Lapposisporites*. Above all *Jayantisporites* has its large ornament restricted to the distal side which is not known in *Lapposisporites*.

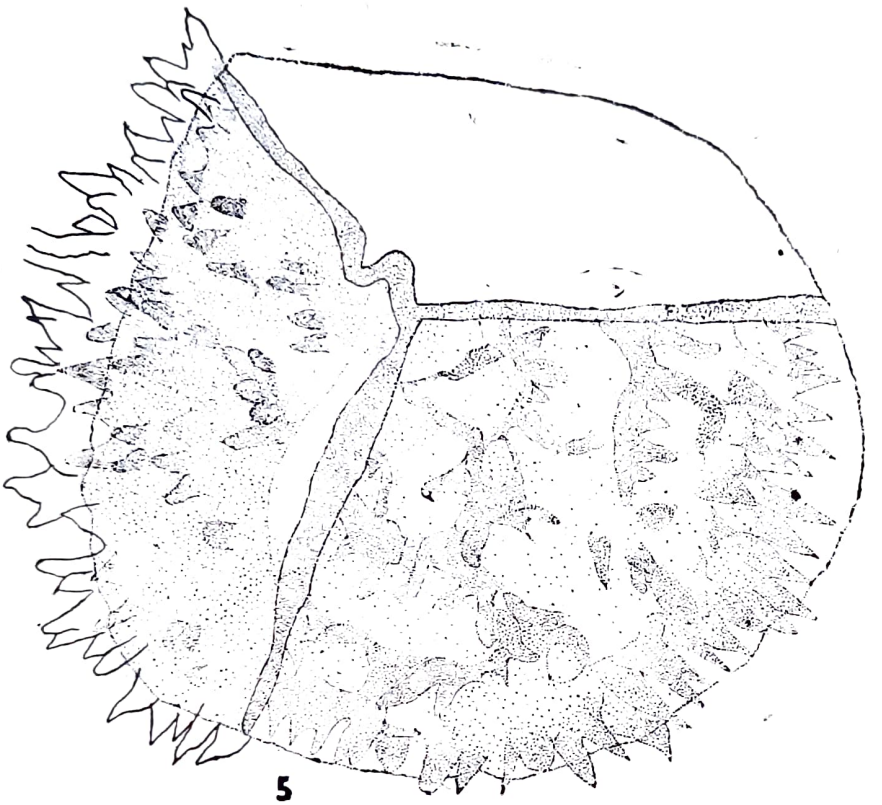
Comparisons—In its basically azonate organization this genus is distinct from the zonotrilete or camerate taxa like *Hymenozonotriletes* Naumova (1953), *Indotriradites* Tiwari (1964), *Gondisporites* Bharadwaj (1962), *Krauselisporites* (Leschik) Jansonius (1962), *Cristatisporites* (Potonié & Kremp) Butterworth *et al.* (1964), *Spinozonotriletes* Neves & Owens (1966), *Dentatispora* Tiwari (1964) and *Potonietriradites* Bharadwaj & Sinha (1969).

Among the azonate miospores *Brevitriletes* Bharadwaj & Srivastava (1969) is comparable to *Jayantisporites* gen. nov. in having compound spines, but the elements never fuse as in *Jayantisporites*. *Didecitriletes* Venkatachala & Kar (1965) and *Lukugasporites* Kar & Bose (1967) also lack the distal fusion of sculptural elements. In *Altitriletes* Venkatachala & Kar (1968) the exine is distally ornamented with simple coni, verrucae and warts. Also the development of inner body is unknown in these genera.

Jayantisporites pseudozonatus sp. nov.

Pl. 1, Figs. 6-13; Text-figs. 5-6, 6A

Diagnosis—Miospores subtriangular, 70-80 × 80-95 μ in size; trilete mark distinct; exine proximally laevigate to infrapunctate or infragranulose, distally bearing smooth to granulose finger-like long processess ranging from spines to bacula with obtuse to conate tips, elements 7-10 μ long and 2-4, μ broad, bases of elements showing a strong tendency of



Text-Fig. 5—*Jayantisporites pseudozonatus* sp. nov. Camera lucida sketch of geno-holotype. The left portion shows individual ornament elements and pseudozona; the right portion shows an incomplete reticulum of cristate ridges. Details are not shown in third portion. ×*Ca*1000.

confluence and fusion forming cristate ridges which interlink to produce a reticulum; a partial to complete pseudozona bearing similar ornament may develop along spore equator through sculptural fusion and mode of flattening; 80—100 elements along equator.

Description—Trilete mark raised, rays sometimes wavy and associated with folds, equal, reaching spore equator rarely entering pseudozona (Pl. 1, Fig. 7); transitions from baculate to spinose processess observed in the same specimen, elements much longer than broad, generally finger or pencil shaped, bacula may be blunt or surmounted by conate tops (Text-fig. 6). A fine setose process sometimes seen at apex of the elements (Pl. 1, Figs. 10-11). Spines may be blunt to acuminate, fine ornament of ± pointed grana may develop on processess, reduced coni to grana present between larger elements distally; distal reticulum of cristate ridges and equatorial pseudozona may be nearly complete in extreme cases (Pl. 1, Fig. 7). The tetrads (Pl. 1, Figs. 12-13; Text-fig. 6A) show reduced sculpture.

Holotype—Pl. 1, Fig. 6 (size 80 × 95 μ).

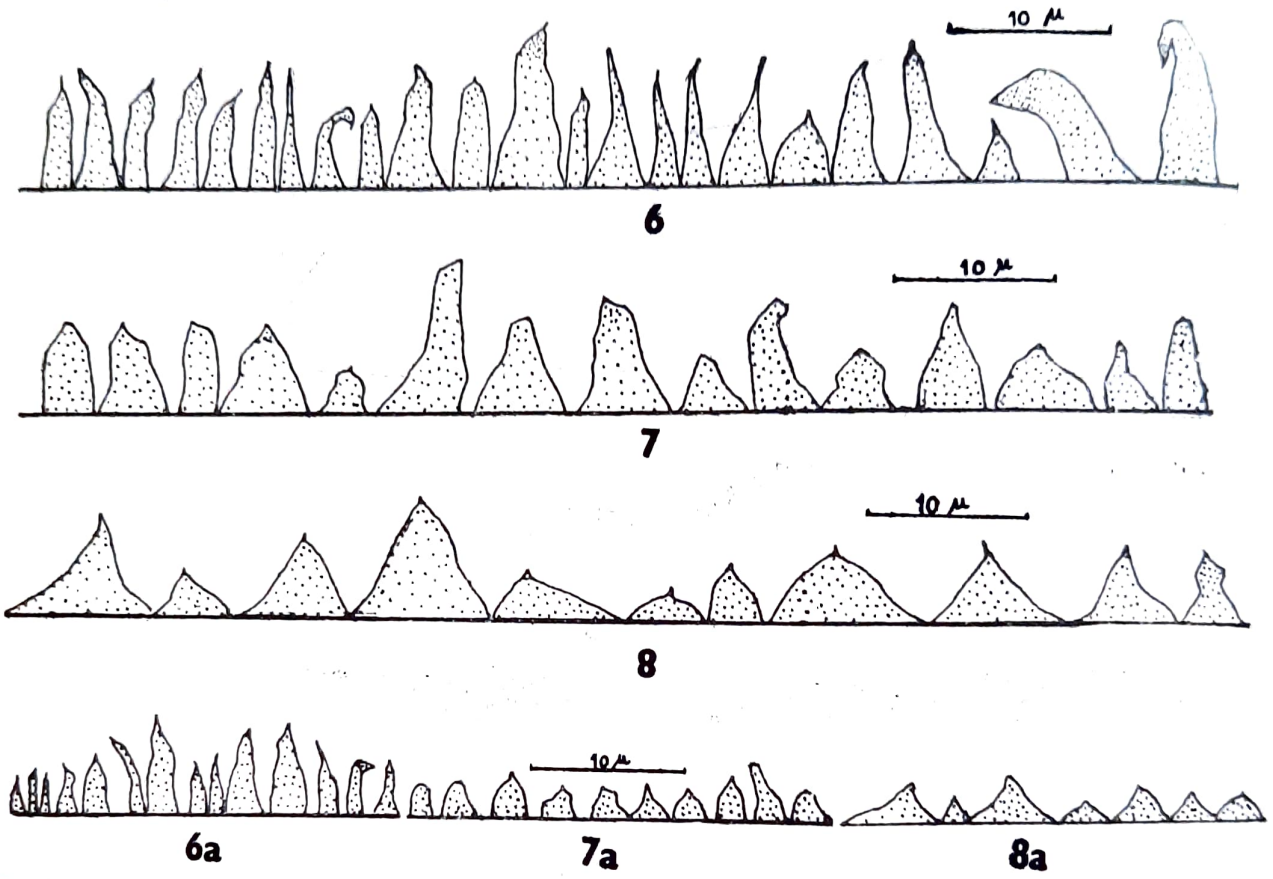
Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Jayantisporites indicus sp. nov.

Pl. 1, Figs. 14-16, Text-figs. 7, 7A.

Diagnosis—Miospores subtriangular, 50-60 × 57-70 μ in size; trilete mark distinct, rays reaching spore equator, exine proximally laevigate to infrapunctate; distal ornament ranging from small coni, spines to baculate processess often surmounted by conate tips, size of elements 4-6 μ long, 2-5 μ broad, basal confluence of processess not well marked, reticulum imperfect; 40-60 elements along spore equator (Text-fig. 7).



Text-Fig. 6-8—Camera lucida sketches showing sculpturalp attern in *Jayantisporites*
6—*Jayantisporites pseudozonatus* sp. nov., 6A—Tetrad of the same, 7—*Jayantisporites indicus* sp. nov., 7A—Tetrad of the same, 8—*Jayantisporites conatus* sp. nov., 8A—Tetrad of the same.

Description—Trilete mark distinct, rays sometimes flappy; occasionally a fine setose point observed at the apex of processess; elements equal or slightly longer than broad, pseudozona incomplete.

Comparison—The present species differs from *Jayantisporites pseudozonatus* in having shorter, irregular processess which are also lesser in number along the equator. Besides in this species the reticulum is incompletely developed because of scarce fusion of the bases. In the tetrads (Pl. 1, Fig. 16; Text-fig. 7A) the ornament is relatively smaller.

Holotype—Pl. 1, Fig. 6 (Size 65 × 55 μ).

Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Jayantisporites conatus sp. nov.

Pl. 1, Figs. 17-21, Text-figs. 8, 8A

Diagnosis—Miospores traingular to subtriangular, 55-70 × 50-70 μ in size; trilete mark distinct, rays reaching spore equator; exine proximally laevigate to infrapunctate,

distal ornament ranging from broad-based conate to verrucose processess, often bearing fine apical point (Pl. 1, Fig. 19; Text-fig. 8), size of elements 3-5 μ long and 5-8 μ broad, basal confluence of processess well marked forming thick ridges and ± complete reticulum (Pl. 1, Fig. 17); pseudozona imperfect (Pl. 1, Fig. 18), 30-50 elements along spore equator. The tetrads (Pl. 1, Fig. 21; Text-fig. 8A) have relatively smaller elements.

Description—Elements generally wider than long, cristate ridges on distal side may be up to 7 μ wide (Pl. 1, Fig. 18).

Comparison—This species is distinct from the previous two species mainly in the shape and size of distal ornament and thick ridges of distal reticulum. A specimen earlier described as *cf. Dentatispora* by LELE and KARIM (1971, Pl. 1, fig. 5) from the boulder bed intercalation of Patharjore Nala is found to be closely comparable with *Jayantisporites conatus*.

Holotype—Pl. 1, Fig. 17 (size 60 × 62 μ).

Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Turma—SACCITES Erdtman, 1947

Subturma—MONOSACCITES (Chitaley) Potonié & Kremp, 1954

Infraturma—APERTACORPITI Lele, 1964

Genus—**Rugasaccites** Lele & Maithy, 1969

Type species—*Rugasaccites polyplicatus* Lele & Maithy, 1969

Rugasaccites ovatus sp. nov.

Pl. 2, Fig. 22

Diagnosis—Miospores oval, bilateral, 105-120 × 130-160 μ in size; central body distinct, horizontally oval, 75-85 × 90-110 μ, vermiculate sculptured; trilete mark distinct, rays equal to unequal; saccus uniformly broad all round, frilled.

Description—Miospore outline wavy; central body exine sculptured with closely packed vermiculate ridges; angles and length of rays may be unequal; saccus frills close, narrow, superimposed, saccus offlap ± equal to central body radius, distal attachment associated with a central body infold near periphery conforming to overall shape of spore; saccus intrareticulation fine.

Comparison—*Rugasaccites polyplicatus* Lele & Maithy (1969) compares in oval shape but is distinct in its polygonal foldrim and widely spaced vermiculate pattern of body exine.

Holotype—Pl. 2, Fig. 22 (Size 160 × 112 μ).

Type locality—Patharojore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Infraturma—PARASACCITI Maheshwari, 1967

Genus—**Parasaccites** Bharadwaj & Tiwari, 1964

Type species—*Parasaccites korbaensis* Bharadwaj & Tiwari, 1964

Parasaccites talchirensis sp. nov.

Pl. 2, Figs. 23-24; Text-fig. 9

Diagnosis—Miospores monosaccate, circular to oval, 72-95 × 80-110 μ in size; central body distinct, dense; 50-65 × 50-75 μ in size, fine intramicroreticulate; trilete mark distinct rays ± ½ body radius long; saccus overlap clear, wide, saccus prominently frilled radially, saccus width 1/4-1/2 central body radius, intrareticulation fine.

Description—Spore outline undulating due to frills; central body darker than saccus, circular to subtriangular, margin rough; trilete rays ± equal, straight to slightly curved in some specimens, sometimes accompanied with folds; saccus overlap clear, 1/2-1/4 central body radius, zones of saccus attachment ± indistinct and irregular, saccus radially frilled, frills sinuous, compactly placed or overlapping, 4-9 μ broad, sometimes branched near saccus margin; saccus intrareticulation fine, often obscured by the saccus thickness.

Comparison—*P. densus* Maheshwari (1967) differs in having a shorter trilete mark, a much larger body as compared to the saccus and in the lack of a conspiuously frilled saccus. Other species of the genus differ in having an unfrilled saccus, light central body or weak trilete mark. *Parasaccites* sp. A recorded by Lele and Karim (1971) from Talchir Boulder Bed belongs to this new species.

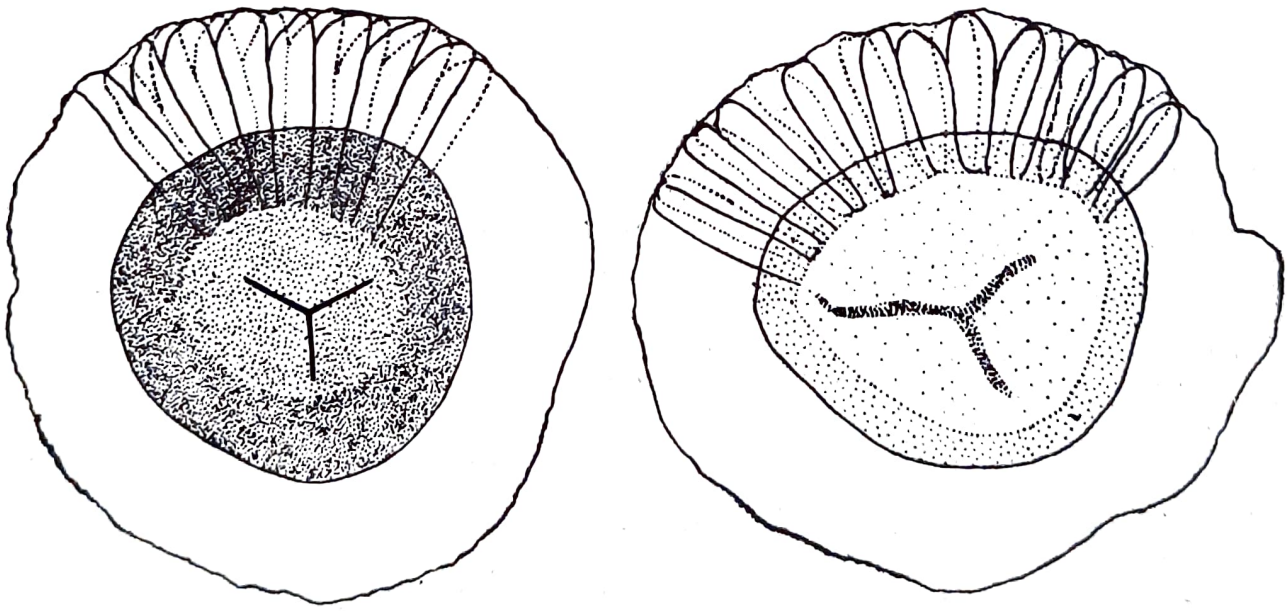
Holotype—Pl. 2, Fig. 23 (Size 100 × 95 μ).

Type Locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Parasaccites plicatus sp. nov.

Pl. 2, Figs. 25-26; Text-fig. 10



9 **10**

Text-Fig. 9—*Parasaccites talchirensis* sp. nov. Camera lucida sketch of the holotype. × *Ca* 625.
Text-Fig. 10—*Parasaccites plicatus* sp. nov. Camera lucida sketchof the holotype. × *Ca* 625.

Diagnosis—Miospores monosaccate, circular to subcircular, 85-105 × 87-120 μ in size; central body distinct, 50-80 × 50-75 μ in size; margin rough, exine intramicroreticulate; trilete mark distinct, rays ½-⅔ body radius long; saccus ± wide, overlap clear, ± narrow; saccus conspicuously frilled radially; intra-reticulation fine.

Description—Miospore outline undulating, central body distinct, circular to subtriangular, trilete rays equal or unequal, sometimes slightly curved, saccus width ± equal to or more than central body radius; saccus overlap clear, forming a ± dark rim along central body margin, overlap about 1/3 of off-lap or less; para-attachment zones ± fimbriate, saccus conspicuously frilled, frills narrow to broad, closely spaced or overlapping, saccus intrareticulation fine, often obscured by saccus thickness.

Comparison—This species is characterised by the conspicuous radial folds of the saccus and a ± distinct central body with a generally clear mark. These features are not found combined together in other species of the genus. *P. talchirensis* sp. nov. is closely comparable in the frilled nature of saccus but differs mainly in having a dense, thick body. *P. perfectus* Bose & Maheshwari (1968) differs in the smooth outline of the body as well as the saccus roots.

Holotype—Pl. 2, Fig. 25 (Size 105 × 92 μ).
Type Locality—Patharjore Nala, Jayanti Coalfield, Bihar.
Horizon—Talchir Formation.

Genus—**Parastriopollenites** Maheshwari, 1967

Type species—*Parastriopollenites rajmahalensis* Maheshwari, 1967

Parastriopollenites segmentus sp. nov.

Pl. 2, Figs. 27-28; Text-fig. 11

Diagnosis—Miospores monosaccate, circular to oval, 84-110 × 80-100 μ in size; central body ± distinct, 60-82 × 60-68 μ in size; exine intramicroreticulate, uneven narrow channels clear on proximal face and faint on distal side; trilete distinct to obscure, rays ± unequal, 1/2 - 2/3 central body radius long; saccus frilled, margin undualating to nearly fimbriate, roots lobate, intrareticulation fine.

Description—Central body light in colour, outline sometimes obscure; channels narrow, ± undulating, cross connected and delimiting irregular areas; saccus width 1/2 to same as central body radius, saccus overlap 1/3 of offlap or less, saccus frilled, frills closely placed or overlapping, saccus intrareticulation fine, often obscured by saccus thickness. Saccus undulations along margin may develop into ± distinct lobes (Pl. 2, Fig. 28).

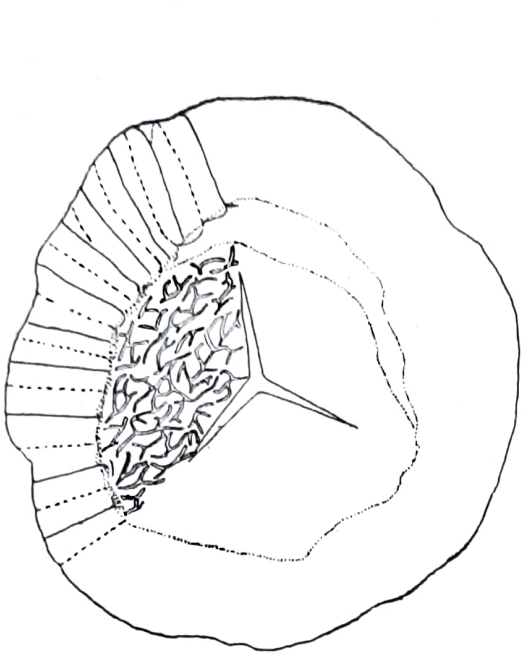
Comparison—This species differs from the genotype *Parastriopollenites rajmahalensis* Maheshwari (1967) in lacking the characteristic reticulately arranged channels delimiting large, ± polygonal areas. *P. sinuosus* Maheshwari (1967) while resembles *P. segmentus* in having undulating spore outline, differs in roundly triangular shape as well as in having some protuberances on the irregular areas of the central body. Other species of the genus do not have frilled saccus.

Holotype—Pl. 2 Fig. 27 (Size 108 × 100 μ).
Type Locality—Patharjore Nala, Jayanti Coalfield, Bihar.
Horizon—Talchir Formation.

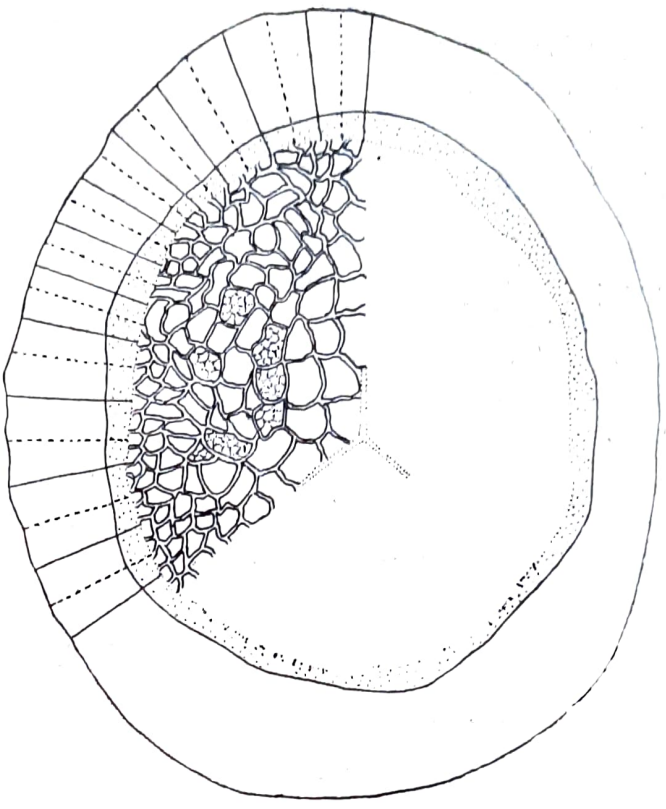
Parastriopollenites indicus sp. nov.

Pl. 2, Fig. 29; Text-fig. 12

Diagnosis—Miospores circular, 125-155 × 117-132 μ in size; central body distinct, 100-120 × 90-118 μ in size, exine intramicroreticulate, proximally with narrow undulating



11



12

Text-Fig. 11—*Parastriopollenites segmentus* sp. nov. Camera lucida sketch of the holotype. × *Ca* 625.
Text-Fig. 12—*Parastriopollenites indicus* sp. nov. Camera lucida sketch of the holotype. × *Ca* 625.
Solid and dotted lines indicate proximal and distal extent of saccus on the body.

channels cross-connected to form irregular areas, trilete mark obscure; saccus narrow in relation to body radius, folds often developed along zone of saccus attachment forming a ± continuous rim near central body periphery, saccus surface ± flat, intrareticulation fine.

Description—Central body outline conforming to over all shape of spore; areas enclosed by channels 3-5 μ in width, fade out towards periphery; trilete rays ± equal, about 1/3 central body radius long; surface usually unfrilled.

Comparison—This species differs from the genotype *Parastriopollenites rajmahalensis* Maheshwari (1967) in having more narrow ± elongated and undulating areas and also in having a rim of saccus folds near the central body periphery. The latter feature is also unknown in other species of this genus. *P. segmentus* sp. nov. is smaller in size and has a conspicuously frilled saccus.

Holotype—Pl. 2, Fig. 29 (Size 155 × 132 μ).

Type *locality*—Patharojore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Tuberisaccites gen. nov.

Type species—*Tuberisaccites varius* gen. et sp. nov.

The name *Tuberisaccites*, which was provisionally suggested in an earlier short note (Lele & Karim, 1969), is herewith formally recognised as a new generic taxon. The same applies to the new genus *Circumstriatites* (p. 61).

Diagnosis—Miospores monosaccate, mostly radially symmetrical; central body intramicroreticulate; trilete mark not observed; surface of body bears conspicuous, separate

or coalescent protuberances variable in number and shape; saccus ± fleshy, attachment in para-condition; structure obscure, margin smooth, undulate or lobate, surface flat or frilled.

Description—The grains are mostly circular to subcircular. The thin body exine is typically intramicroreticulate but occasionally it may appear coarsely intramicropunctate or even irregularly microverrucose on the surface. Some of these affects may result from the rough and irregular construction of the muri in the body structure. The para-attachment of the saccus can be ascertained by differential focus or by particular states of preservation. The saccus is often relatively denser than the body and appears somewhat fleshy. The structure is consequently difficult to ascertain. It may generally appear to be intramicropunctate but in well-preserved grains (Pl. 3, Fig. 30) the saccus structure is intra micro-reticulate. Inspite of a large number of specimens available for study no tetrad mark has been observed, although the probability is not excluded.

The most distinguishing feature of the pollen grains is the presence of a variable number of fairly large and conspicuous protuberances on the body. In the material studied so far these protuberances are seen only on one surface of the body. The protuberances are separate or coalescent and vary in shape from circular to oval or spathulate, measuring 18-34 × 24-34 μ. They also vary in number even in the same species from one to as many as nine. Some or all protuberances may appear to be concentrated in the polar region of the body, often in a concentric manner. Specimens having a single protuberance are not uncommon but the position of such a protuberance is not invariably polar. The distribution pattern of the protuberances therefore affords one of the means to delimit species. In general the exine of the protuberances suggests a striking resemblance to that of the saccus. This is further strengthened by observation under phase contrast optics. The exine thickness of the protuberances is variable. Another interesting feature is the development of secondary compression folds on the protuberances which are sometimes orientated in the same direction (Pl. 3, Fig. 30). This suggests that the protuberances were fairly high and probably not entirely solid. The height of the protuberances is variable and cannot be measured with accuracy.

Comparison—The saccus attachment of *Tuberisaccites* is similar to that of *Parasaccites* Bharadwaj & Tiwari (1964) and *Parastriopollenites* Maheshwari (1967), but both of these genera do not possess the conspicuous protuberances so characteristic of *Tuberisaccites*. Besides, *Parastriopollenites* is characterised by the presence of reticuloid grooves on the body and a trilete mark. In particular examples of *Tuberisaccites* where a single knob is seen more or less centrally placed over the body, it may at first sight be mistaken for the so called inner body of *Barakarites* Bharadwaj & Tiwari (1964), or the denser area around the trilete mark of *Plicatipollenites stigmatus* Lele & Karim (1971). However, *Barakarites* is easily distinguishable by the reticuloid grooves on the body and *Plicatipollenites* by the presence of body infold system and absence of para-attachment of saccus. Moreover, both genera bear a recognisable tetrad mark.

Tuberisaccites varius sp. nov.

Pl. 3, Figs. 30-32; Text-fig. 13

Diagnosis—Miospores ± circular, size range 130-140 × 120-135 μ; central body indistinct, intra-microreticulate, protuberances one to several in number; saccus narrow, margin smooth to slightly undulated.

Description—Miospores circular to subcircular; central body intramicroreticulate

sometimes surface appears irregularly microverrucose; protuberances separate or coalescent variable in size, ranging from 27-34 × 30-34 μ, fairly high, 1-9 in number without any definite orientation, some are concentrically arranged near pole; saccus narrow ± 1/3—1/4 of central body radius, width uniform, margin smooth to slightly undulated, surface flat, appearance ± fleshy, saccus structure obscure, intra-micropunctate to intramicrorcticulate.

Holotype—Pl. 3, Fig. 30 (Size 140 × 130 μ).

Type Locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Tuberisaccites lobatus sp. nov.

Pl. 3, Fig. 32.

Diagnosis—Miospores ± circular, 112-140 × 97-135 μ in size; central body outline obscure; protuberances fewer in number (up to 4 noticed in the present material), succus ± uniformly wide, appearance fleshy frilled and lobate.

Description—Miospores circular to subcircular, central body structure imperfectly intramicroreticulate to irregularly microverrucose; some protuberances concentrated pole wards, size 17-21 × 22-25 μ, mostly knob like, unevenly thick, rarely showing any distinct structure; occasionally some small verrucate elements present in the vicinity of the knobs; saccus width 17-22 μ, ± ½ to ⅔ of body radius, distinctly frilled and often lobate in appearance; structure obscure due to fleshy nature of saccus, saccus margin clearly undulated.

Comparison—This species is distinguishable from the type-species by its comparatively broader saccus which is very characteristically frilled and lobate and by the fewer number of protuberances.

Holotype—Pl. 3, Fig. 32 (97 × 90 μ).

Type Locality—Pathorjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Tuberisaccites (Parasaccites) tuberculatus (Maheshwari, 1969) comb. nov.

Pl. 3, Fig. 33

Tuberisaccites (Parasaccites) tuberculatus (Maheshwari, 1969) comb. nov. is rather closely comparable with *T. lobatus* sp. nov. However, it is desirable to restrict *Tuberisaccites tuberculatus* to those specimens in which one or all the protuberances are invariably concentrated in the polar region of the body as in the holotype (Maheshwari, 1969, pl. 3, fig. 12). In *T. lobatus* only some protuberances may be more polar in position while others are scattered or peripheral on the body. An example referable to *T. tuberculatus* (Maheshwari) comb. nov. showing one polar protuberance is figured in Pl. 3. Fig. 33.

Subinfraturma— Caheniasacciti Bose & Kar, 1966

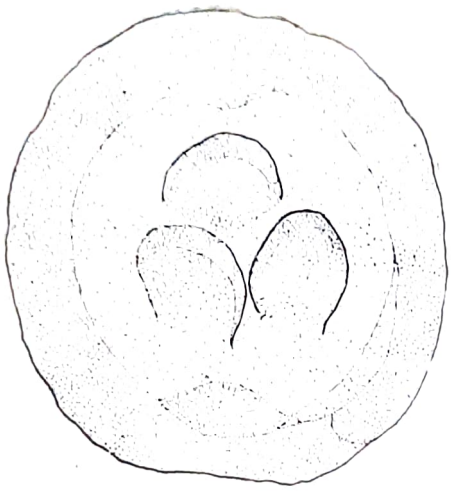
Genus—**Caheniasaccites** Bose & Kar, 1966

Type species—*Caheniasaccites flavatus* Bose & Kar, 1966

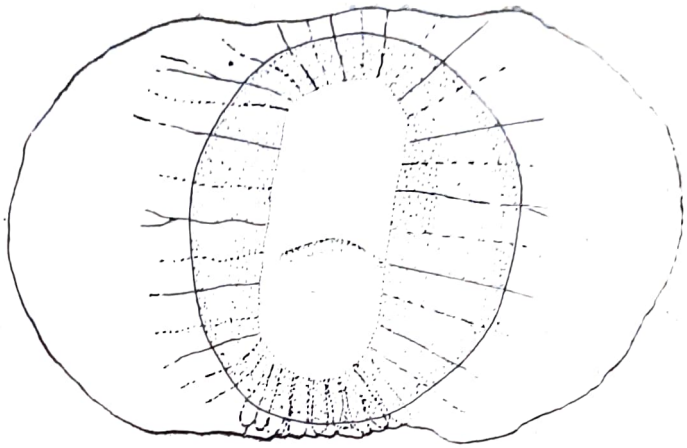
Caheniasaccites distinctus sp. nov.

Pl. 3, Figs. 34-35; Text-fig. 14

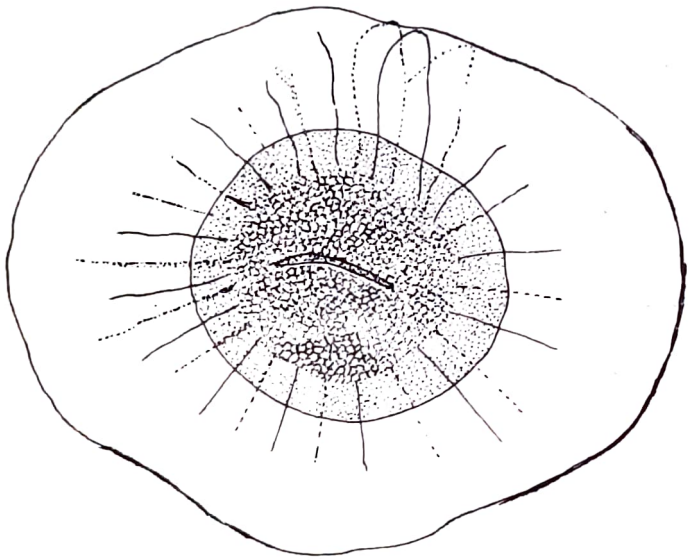
Diagnosis—Miospores bilateral, oval, 112-172 × 72-100 μ in size; central body 55-70



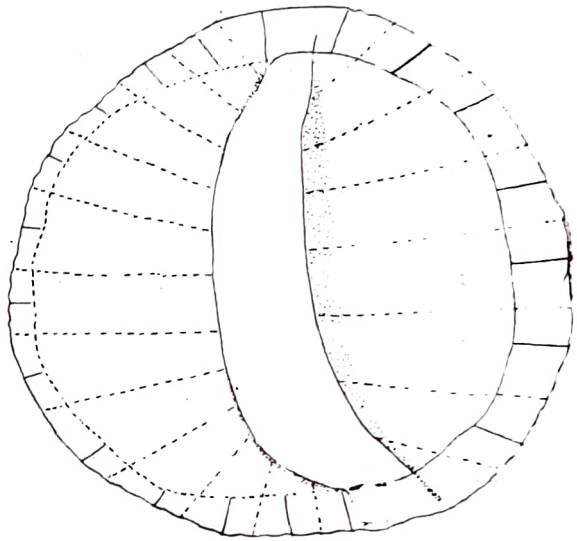
13



15



14



16

Text-Fig. 13—*Tuberisaccites varius* gen. et sp. nov. Camera lucida sketch of the geno-holotype. × *Ca* 385.
Text-Fig. 14—*Caheniasaccites distinctus* sp. nov. Camera lucida sketch of the holotype. × *Ca* 580.
Text-Fig. 15—*Caheniasaccites decorus* sp. nov. Camera lucida sketch of the holotype. × *Ca* 580.
Text-Fig. 16—*Divarisaccus scorteus* sp. nov. Camera lucida sketch of the holotype. × *Ca* 560.
Solid and dotted lines indicate proximal and distal extent of saccus on the body.

× 50-60 μ in size, circular to subcircular, margin rough, distinct, dense, exine intramicroreticulate; monolete usually clear; saccus comparatively narrow along the shorter axis of grains, usually constricted, radially frilled, saccus roots ± fimbriate, saccus-overlap narrow, intrareticulation fine.

Description—Miospores subcircular to oval; monolete ± equal to central body radius, straight or slightly bent; distal zone of saccus attachment may be deeper than proximal one, saccus overlap 1/3—1/4 central body radius.

Comparison—The new species is characterized by the presence of a dense central body and the conspicuous radial frills in the saccus. All the hitherto known species lack a dense body. *Caheniasaccites ellipticus* Bose & Maheshwari (1968) differs from the present species in the shape and thickness of the central body.

Holotype—Pl. 3, Fig. 34 (Size 125 × 100 μ)

Type locality—Patharojore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Caheniasaccites decorus sp. nov.

Pl. 3, Figs. 36-37; Text-fig. 15

Diagnosis—Miospores oval, 110-132 × 70-85 μ in size; central body 60-70 × 65-75 μ in size, ± distinct, circular, margin rough, subcircular, intramicroreticulum irregular; monolete mark faint; saccus attachment proximally subequatorial, distally ± bilateral, lateral extent narrow, roots often thickened, saccus thick, radially frilled, frills thick, ± overlapping; intrareticulation ± coarse.

Description—Miospores haploxylonoid; surface of body shows microfolds; monolete straight to bent; saccus proximally equatorial, distally ± bilateral, distal saccus free area ± oval; saccus intrareticulation coarse.

Comparison—None of the species of *Caheniasaccites* described so far have a distal bilateral attachment as in the present species. Besides the thickened saccus roots and the conspicuous radial frills are very characteristic in this species.

Holotype—Pl. 3, Fig. 36 (Size 125 × 80 μ).
Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.
Horizon—Talchir Formation.

Infraturma—DIVARISACCITI Bose & Kar, 1966

Genus—**Divarisaccus** Venkatachala & Kar, 1966

Type species—*Divarisaccus lelei* Venkatachala & Kar, 1966

Divarisaccus scorteus sp. nov.

Pl. 4, Figs. 38-39; Text-fig. 16

Diagnosis—Miospores circular-subcricular, 100-127 × 90-102 μ in size; central body obscure, exine intramicroreticulate, proximal saccus attachment equatorial, distal attachment bilateral, leaving a ± uniformly narrow sulcus, distal saccus roots sharp and sometimes thickened, saccus narrow in relation to body, faintly frilled, intrareticulation fine, meshes radially orientated.

Description—Spore outline undulating; no tetrad mark seen; proximal saccus attachment equatorial, distal sulcus distinct, ± uniformly broad, usualy parallel to shorter axis of grain, sometimes parallel to longer axis (Pl. 4, Fig. 40), ± rectangular in shape or slightly wider in middle, 16-30 μ in breadth.

Comparison—The genotype *Divarisaccus lelei* Venkatachala & Kar (1966) differs from the present species in being elongate oval in shape. *D. ovatus* Kar & Bose (1967) differs by its oval shape and larger size, distinct central body and unequally broad distal sulcus. *D. strengeri* Bose & Kar (1966) is also larger in size and has very close and often overlapping zones of distal saccus attachment.

Holotype —Pl. 4, Fig. 38 (size 110 × 97 μ).
Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.
Horizon—Talchir Formation.

Genus—**Vesicaspora** (Schemel) Wilson & Venkatachala, 1963

Type species—*Vesicaspora wilsonii* Schemel, 1951

Vesicaspora crassa sp. nov.

Pl. 4, Fig. 42

Diagnosis—Miospores haploxylonoid; oval, 115-140 × 80-95 μ in size; central body outline ill-defined, exine thin, indistinctly intra-microreticulate; saccus laterally continuous, appearance leathery, distal attachment zones obscure, sulcus broadly oval; saccus structure obscure.

Description—Miospores bilateral; central body probably vertically oval; sacci± hemispherical, thick, having narrow lateral continuations giving disaccoid overall appearance, distal attachment zones weak, widely separated; intra-reticulation of saccus obscured by its leathery texture.

Comparison—*Vesicaspora berckamanii* Bose & Maheshwari (1968) is more comparable than any other species but it differs in having a ± circular central body. *Vesicaspora distincta* Tiwari (1965) and *Vesicaspora indica* Tiwari (1965) are distinguishable in their distinct central body and narrow, well defined sulcus. *Vesicaspora* sp. described by Lele and Karim (1971) from the Talchir Boulder Bed belongs to the new species.

Holotype—Pl. 4, Fig. 42 (Size 118 × 95 μ).

Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Subturma—Disaccites Cookson, 1947

Infraturma—Disaccimonoleti Klaus, 1963

Genus—**Labiisporites** (Leschik) Klaus, 1963

Type Species—*Labiisporites granulatus* Leschik, 1956

Labiisporites densus sp. nov.

Pl. 4, Figs. 40-41; Text-Fig. 17

Diagnosis—Miospores dissaccate, haploxylonoid, 75-90 × 50-58 μ in size; central body intramicroreticulate; subcircular, 40-56×38-50 μ in size, denseer than sacci; monolete mark clear, long; sacci±hemispherical; distal zone of saccus attachment diffuse, sulcus broadly biconvex; saccus intrareticulation fine.

Description—Miospores oval; body structure sometimes coarse and irregular; monolete distinct, straight or bent, usually covering whole width of sulcus; distal inclination of sacci not considerable, very narrow, lateral continuations of sacci occasionally present, sulcus 20-36 μ broad.

Comparison—The present species differs from the genotype *Labiisporites granulatus* Leschik (1956) in having a distinct and usually dense central body and the comparatively long monolete mark. The saccus intrareticulation in *L. granulatus* is coarse.

Holotype—Pl. 4, Fig. 40 (Size 75 × 52 μ).

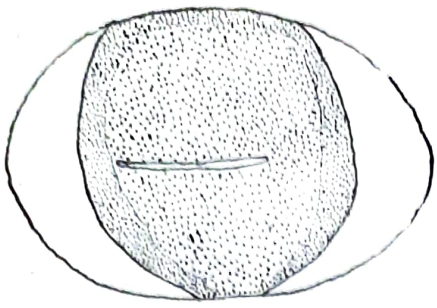
Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

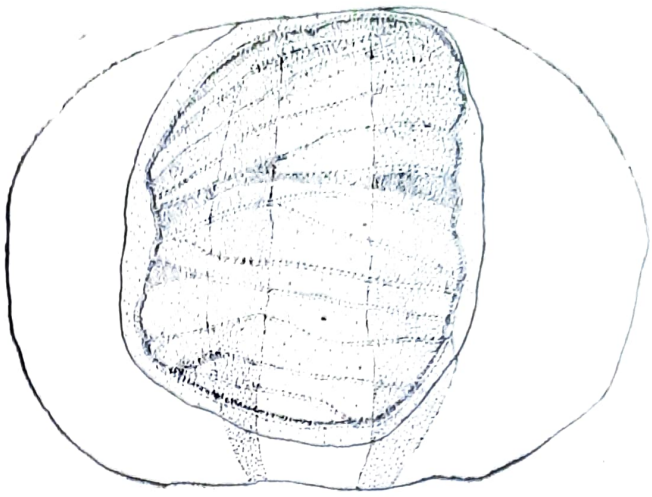
Infraturma—Striatiti Pant, 1954

Genus—**Striatites** (Pant) Bharadwaj, 1962

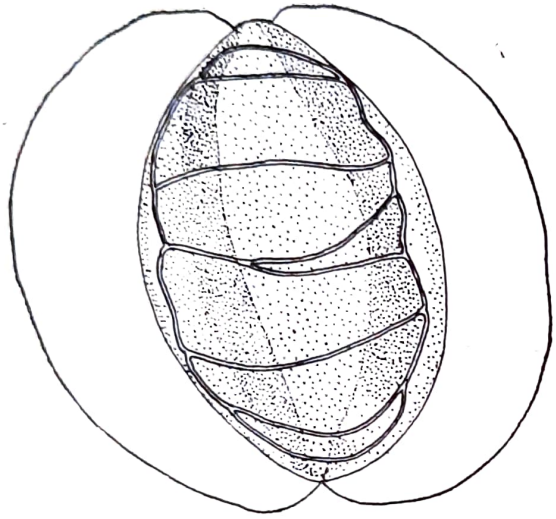
Type Species—*Striatites sewardii* (Virkki) Pant, 1955



17



19



18

Text-Fig. 17—*Labiisporites densus* sp. nov. Camera lucida sketch of the holotype. × *Ca* 610.

Text-Fig. 18—*Circumstriatites talchirensis* gen. et sp. nov. Camera lucida sketch of the geno-holotype. × *Ca* 660.

Text-Fig. 19—*Circumstriatites ovatus* sp. nov. Camera lucida sketch of the holotype. × *Ca* 620.

Striatites sp.

Pl. 4, Fig. 43

Description—Miospore disaccate, bilateral, diploxylonoid, 102-112 μ in size; central body hexagonal, 32 × 42 μ in size; proximally 8 horizontal striations seen, exine between striations microverrucose; sacci subcircular, bigger than central body, distal saccus attachment straight, distal saccus free area ± 15 μ wide; saccus intrareticulation fine.

Remarks—These specimens, though somewhat comparable with *Striatites rhombicus* Bharadwaj & Salujha (1964) differ from it in the shape of the central body and in the absence of the marginal ridge.

Infraturma—Circumstriatiti ser. nov.

Diagnosis of Series—Saccate pollen grains possessing circumstriate pattern of grooves, i.e., horizontal grooves on proximal face of body are terminally inter-connected by a system of vertical grooves which form a more or less circumstriate groove-ring at or near body periphery.

GENUS—**Circumstriatites** gen. nov.

Type species—*Circumstriatites talchirensis* sp. nov.

Vide remarks under *Tuberisaccites* gen. nov.

Diagnosis—Disaccate pollen grains usually ± haploxylonoid; central body distinct or indistinct, variable in shape from rhomboid-hexagonal to circular-oval; proximal horizontal grooves, simple or branched, branches often anastomosing, circumstriate groove-ring distinct to indistinct, smooth to zig-zag, ± subequatorial in position; central body intramicroreticulate, exine between striations may be unevenly thick; sacci ± hemispherical, distal attachment nearly straight, not invariably associated with body infolds; saccus intrareticulation fine.

Discussion—Pollen grains are essentially haploxylnoid, but a diploxylonoid tendency is observed. The shape of the central body is very variable, ranging from rhomboid to hexagonal or trapezoid on one extreme and vertically oval to subcircular on the other.

The proximal surface of the body bears distinct horizontal striations which show the following characteristics (1) the horizontal grooves are simple or branched showing anastomosis; they are straight or slightly sinuous and the groove margins may appear smooth or somewhat serrated; (2) the horizontal grooves generally do not extend up to the body periphery. Their ends are connected by vertical grooves which result in the formation of a nearly complete 'groove-ring' circumscribing the horizontal grooves (Text-figs. 18-19). The circumstriate 'groove-ring' is typically developed ± sub-equatorially but due to preservation factors, it may shift close to or may overlap with the body periphery. Such affects can, however, be detected by critical observation. Phase contrast studies have proved helpful in deciphering the groove-ring pattern, especially when it is ill-defined.

The two sacci are generally hemispherical but sometimes they may be smaller or bigger than a hemisphere. Distal attachment is more or less straight but may become convex or concave or derive other intermediate shapes due to preservation. The distal channel, in typical examples,is nearly as wide as the overlap of the saccus. The saccus offlap tends to be slightly greater than the overlap. In the type species the saccus roots are accompanied by vertical body infolds but the consistency of this feature is doubtful. The characteristic circumstriate pattern of grooves in *Circumstriatites* not only serves to clearly distinguish it but it also represents an altogether new morphological feature, the like of which has not been known in any of the grooved (striate) disaccate pollen grains of the Lower Gondwana. In the known striate pollen (Striatiti, Rectistriatiti or Striasacciti Bharadwaj, 1962) the grooves run freely up to the body periphery and are not sorrounded by any "groove ring'. *Circumstriatites*, therefore, indicates the presence of a different complex of saccates in the Lower Gondwana for which the series Circumstriatiti is here proposed.

Comparison—At first glance the grains of *Circumstriatites* may be mistaken for some of the striatiti genera like *Lunatisporites* and *Faunipollenites* (BHARADWAJ, 1962). However *Circumstriatites* is distinguishable by the characteristic circumstriate pattern of grooves. *Circumstriatites* compares with *Complexisporites* Jizba (1962) in the possession of a circular groove surrounding the horizontal striations. *Complexisporites* seems to be essentially distinct in that it has a prominently developed proximal cap which is multifissured. The fissures are also rather variable, dividing the cap into a few conspicuous ribs. There is also the development of a median longitudinal fissure (branched or unbranched) recalling a mark. Besides the forms of *Complexisporites* are relatively smaller (see also VISSCHER, 1966: *Illinites*).

Specimens with closely comparable groove-ring as in *Circumstriatites* have been figured from the Stephanian and Permian sediments of Canada by Barss (1967, pl. 33, figs. 3, 13; pl. 35, figs. 23-24).

Circumstriatites talchirensis sp. nov.

Pl. 4, Figs. 44-45; Text-fig. 19

Diagnosis—Miospores bilateral, 108-130 × 75-95 μ in size; central body distinct, 60-80 × 70-85 μ in size; proximally 8-17 horizontal grooves, distal channels straight, or concave to convex by modification, saccus roots associated with folds.

Description—Miospores bilateral, haploxylonoid; central body distinct, ± rhomboid, proximally bearing 8-17 horizontal grooves, straight to wavy, some of them forked one to 3 times and anastomosing; vertical partitions absent; groove ring clear, zig zag in outline but occasionally may approach or overlap body margin and become obscured; exine between horizontal grooves somewhat irregularly thickened and fold-like; sacci generally ± hemispherical, offlap somewhat greater than overlap; distal channel straight, concave to convex, saccus roots associated with distinct to indistinct body infolds.

Holotype—Pl. 4, Fig. 44 (Size 106 × 77 μ).

Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Circumstriatites obscurus sp. nov.

Pl. 4, Figs. 46-47

Diagnosis—Miospores bilateral, haploxylonoid to slightly diploxylonoid, size range 112-117 × 70-95 μ; central body indistinct, proximally bearing 8-12 horizontal striations; distal saccus attachment straight.

Description—Miospores bilateral, central body indistinct, apparently circular to horizontally oval; horizontal grooves 8-12, ± straight, some branched or anastomosed, exine between or adjacent to grooves irregularly thickened and fold-like; groove ring clear in well preserved examples, slightly zig zag; sacci hemispherical, offlap slightly greater than overlap; distal attachment straight, saccus roots not associated with body infolds, sulcus about 25-30μ wide.

Comparison—This species differs from the type species mainly by its indistinct body and absence of body infolds near the saccus roots.

Holotype—Pl. 4, Fig. 46 (Size 110 × 70 μ).

Type locality—Patharjore Nala, Jayanti, Coalfield, Bihar.

Horizon—Talchir Formation.

Circumstriatites ovatus sp. nov.

Pl. 4, Figs. 48-49; Text-fig. 18

Diagnosis—Miospores disaccate, 95-105 × 82-87 μ in size; central body vertically oval, 47-72 × 80-85 μ in size, proximally bearing 6-10 horizontal striations; distal saccus attachment zones distinct, convex.

Description—Miospores disaccate, haploxytonoid to diploxylonoid; Central body distinct, proximally bearing 6-10 horizontal striations, sometimes branched and anastomosed, exine between the striations intramicroreticulate; groove ring distinct, subequatorial prox-

imally, zig zag; sacci generally hemispherical, reniform, overlap and offlap ± equal, distal saccus attachment zones convex leaving a fusiform, 8-24 μ broad sulcus, saccus roots often associated with body infolds.

Comparison—The present species differs from the type species in overall shape, in the shape of central body and in the convex distal saccus-attachment. From *C. obscurus* sp. nov it differs in having a distinct and vertically oval central body.

Holotype—Pl. 4, Fig. 48 (Size 800 × 87 μ)

Type locality—Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon—Talchir Formation.

Turma—Monocolpates Ivers. & Troels-Smith, 1950

Subturma—Monoptyches (Naum.) Potonié, 1958

Genus—**Striasulcites** Kar, 1964

Type Species—*Striasulcites tectus* Venkatachala & Kar, 1968

Striasulcites sp.

Pl. 4, Fig. 50.

Description—Pollen grain spindle-oval, 60 × 52 μ in size; distal sulcus well developed, about 8 μ wide, running full length, exine thick, ornamentation indistinct, about 10 simple or forked, ± parallel horizontal striations seen.

Comparison—The genotype *Striasulcites tectus* Kar (1964) differs in being larger in size (80-101 μ). *S. ovatus* Kar (1964) is horizontally oval in shape.

INCERTAE SEDIS

Groups of Cells

Pl. 4, Figs. 51

Description—A number of organic-walled bodies of varying shape have been found in the Talchir sediments, more especially in the Boulder Bed intercalations. Some of these have earlier been recognized as *Leiosphaeridia* (Lele & Karim, 1971). Besides these there are several cell-groups apparently in the form of colonies. One of the type has polygonal cells, upto 30 μ in size. Their surface shows an abscure reticuloid pattern.

DISCUSSION

Total Miofloral Assemblage

The assemblages described in this paper, together with those described earlier from the two intercalated Talchir Boulder Beds in the Patharjore Nala sequence, make up the total mioflora of the Talchir Formation in the Jayanti Coalfield. There are 102 species, belonging to 45 genera which are listed below:

1. *Leiotriletes* sp.
2. *Punctatisporites minutus* Kosanke, 1950
3. *P. ganjrensis* Lele & Maithy, 1969

*4. *Callumispora gretensis* (Balme & Hennelly) Bharadwaj & Srivastava, 1969.
5. *Henellysporites* sp.
*6. *Plicatisporites distinctus* gen. et sp. nov.
7. *Granulatisporites granulatus* Ibrahim, 1933
8. *Granulatisporites* sp.
9. *Cyclogranisporites gondwanensis* Bharadwaj & Salujha, 1964
10. *C. plicatus* Allen, 1965
*11. *Lacinitrilets bundamensis* Venkatachala & Kar, 1965
12. *L. minutus* Venkatachala & Kar, 1968
13. *Verrucosisporites varius* Maheshwari, 1967
14. *Verrucosisporites* sp.
*15. *Acanthotriletes filiformis* (Balme & Hennelly) Tiwari, 1965
16. *Horriditriletes novus* Tiwari, 1965
17. *H. bulbosus* Tiwari, 1965
18. *Horriditriletes* sp.
*19. *Microfovcolatispora directa* (Balme & Hennelly) Bharadwaj, 1962
*20. *Brevitriletes unicus* (Tiwari) Bharadwaj & Srivastava, 1969
*21. *Jayantisporites pseudozonatus* gen. et sp. nov.
22. *J. indicus* sp. nov.
23. *J. conatus* sp. nov.
24. *Virkkipollenites densus* Lele, 1964
25. *V. obscurus* Lele, 1964
26. *Plicatipollenites indicus* Lele, 1964
27. *P. trigonalis* Lele, 1964
28. *P. diffusus* Lele, 1964
29. *P. gondwanensis* (Balme & Hennelly) Lele, 1964
30. *P. densus* Srivastava, 1970
31. *P. stigmatus* sp. nov.
32. *P. maculatus* sp. nov.
*33. *Rugasaccites obscurus* Lele & Maithy, 1969
34. *R. orbiculatus* Lele & Maithy, 1969
35. *R. ovatus* sp. nov.
36. *Parasaccites obscurus* Tiwari, 1965
37. *P. diffusus* Tiwari, 1965
38. *P. densus* Maheshwari, 1967
39. *P. perfectus* Bose & Maheshwari, 1968
40. *P. fimbriatus* Maheshwari, 1969
41. *P. talchirensis* sp. nov.
42. *P. plicatus* sp. nov.
*43. *Parastriopollenites segmentus* sp. nov.
44. *P. indicus* sp. nov.
45. *Parastriopollenites* sp.
*46. *Tuberisaccites varius* gen. et sp. nov.
47. *T. lobatus* sp. nov.
48. *T. tuberculatus* (Maheshwari, 1969) comb. nov.
*49. *Caheniasaccites ovatus* Bose & Kar, 1966
50. *C. densus* Lele & Karim, 1971
51. *C. distinctus* sp. nov.

52. *C. decorus* sp. nov.
*53. *Divarisaccus lelei* Venkatachala & Kar, 1966
54. *D. scorteus* sp. nov.
55. *Divarisaccus* sp.
56. *Crucisaccites latisulcatus* Lele & Maithy, 1964
57. *Vestigisporites diffusus* Maithy, 1965
58. *V. novus* Tiwari, 1965
59. *V. nigratus* sp. nov.
60. *Potonieisporites neglectus* Potonié & Lele, 1961
61. *P. densus* Maheshwari, 1967
62. *P.* cf. *lelei* Maheshwari, 1967
63. *P. magnus* sp. nov.
64. *P. jayantiensis* sp. nov.
*65. cf. *Rimospora*
*66. *Valiasaccites densus* Lele & Karim, 1971
67. *V. indicus* Lele & Karim, 1971
68. *Limitisporites diversus* Lele & Karim, 1971
69. *L. elongatus* Lele & Karim, 1971
70. *L.* cf. *monosaccoides* Bose & Maheshwari, 1968
71. *L.* Cf. *congoensis* Bose & Maheshwari, 1968
72. *L.* cf. *hexagonalis* Bose & Maheshwari, 1968
73. *L.* cf. *leschiki* Klaus, 1963
74. *Labiisporites dencus* sp. nov.
75. *L.* cf. *granulatus* Lesch., 1956
*76. *Gigantosporites indicus* Lele & Karim 1971
77. *Platysaccus papilionis* Potonié & Klaus, 1954
*78. *Alisporites opii* Daugherty, 1941.
*79. *Illinites purus* Leschik, 1956
80. *I. notus* Lele & Karim, 1971
81. *Illinites* sp.
82. *Vesicaspora obliqua* Singh, 1964
83. *V. ovata* (Balme & Hennelly) Hart, 1960
84. *V. breckmanii* Bose & Maheshwari, 1968
85. *V. crassa* sp. nov.
86. *Sulcatisporites maximus* (Hart.) Singh, 1964
87. *S. tentulus* Tiwari, 1968
*88. *Rhizomaspora singula* Tiwari, 1965
89. *Strotersporites rhombicus* Lele & Karim, 1971
90. *Strotersporites* sp.
91. *Faunipollenites varius* Bharad., 1962.
92. *F. goraiensis* (Potonié Lele) Maithy, 1965
*93. *Faunipollenites* sp.
94. *Circumstriatites talchirensis* gen. et sp. nov.
95. *C. obscurus* sp. nov.
*96. *C. ovatus* sp. nov.
*97. *Lahirites singularis* Bharadwaj & Salujha, 1964
98. *Crustaesporites* sp.
*99. *Striasulcites* sp.

*100. *Ginkgocycadophytus novus* Srivastava, 1970
*101. *Pilasporites calculus* Balme & Hennelly, 1956
102. *Leiosphaeridia talchirensis* Lele & Karim, 1971

Quantitative Analysis

The mioflora is composed of Triletes, Monosaccates, Disaccates, Monocolpates and Acritarchs. The whole sequence is vertually dominated by the monosaccate group (76% to 97% in various samples). The pioneering genera are *Parasaccites, Plicatipollenites* and *Virkkipollenites*. The proportion of these genera is somewhat fluctuating in different samples, although *Parassaccites* seemes to be generally more dominant. Associated with the dominant taxa are *Vestigisporites, Potonieisporites* and *Tuberisaccites*. Among the disaccates a low proportion of *Faunipollenites* occurs in most samples. Triletes and leiospheres are generally poor, but may be significantly present in certain beds. Monocolpates are practically missing. The percentage distribution of the larger miospore groups is represented in Histogram 1.

Certain taxa are apparently less regular in their general distribution but they are at the same time proportionately significant in particular samples. These are—*Plicatisporites, Punctatisporites, Jayantisporites* (trilete), *Tuberisaccites, Parastriopollenites, Caheniasaccites, Vesicaspora* (monosaccates) and *Valiasaccites, Limitisporites, Circumstriatites* (disaccates).

Following genera are insignificant *Leiotriletes, Callumispora, Granulatisporites, Cyclogranisporites, Hennellysporites, Lacinitriletes, Verrucosisporites, Acanthotriletes, Apiculatisporis, Horriditriletes, Microfoveolatispora, Thymospora, Rugasaccites, Divarisaccus, Crucisaccites, Illinites, Gigantosporites, Labiisporites, Sulcatisporites, Playtysaccus, Cuneatisporites, Striatites, Striatopodocarpites, Lunatisporites, Rhizomaspora, Lahirites, Striasulcites, Crustaesporites, Ginkgocycadophytus, Pilasporites* and *Leiosphaeridia*. Some of these do not appear in counting.

A quantitative percentage count of 37 genera in the various samples is represented in Table 2 and Histogram 2. Although the spore population in most samples is rather on the poor side, the frequency counts have yielded some useful and interesting points on the microfloristics of the whole section.

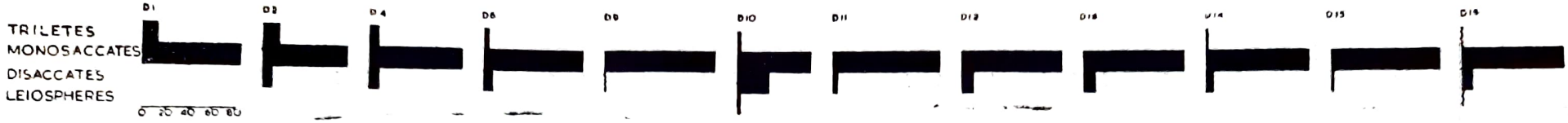
A striking feature of the Patharjore Nala sequence is the occurrence of two boulder beds (D_{10} and D_{14}) which undoubtedly indicate a change in the depositional environment. A corresponding microfloristic change is also evident at the two boulder bed levels. From this viewpoint, the histogram patterns of the whole succession (Histogram 2) whould appear to fall into two or possibly three recognisable sets of miofloral associations: (1) lower set (beds D_1-D_9), (2) Middle set (beds D_{19}-D_{13}) and (3) Upper set (beds D_{14}-D_{16}).

Qualitative Analysis

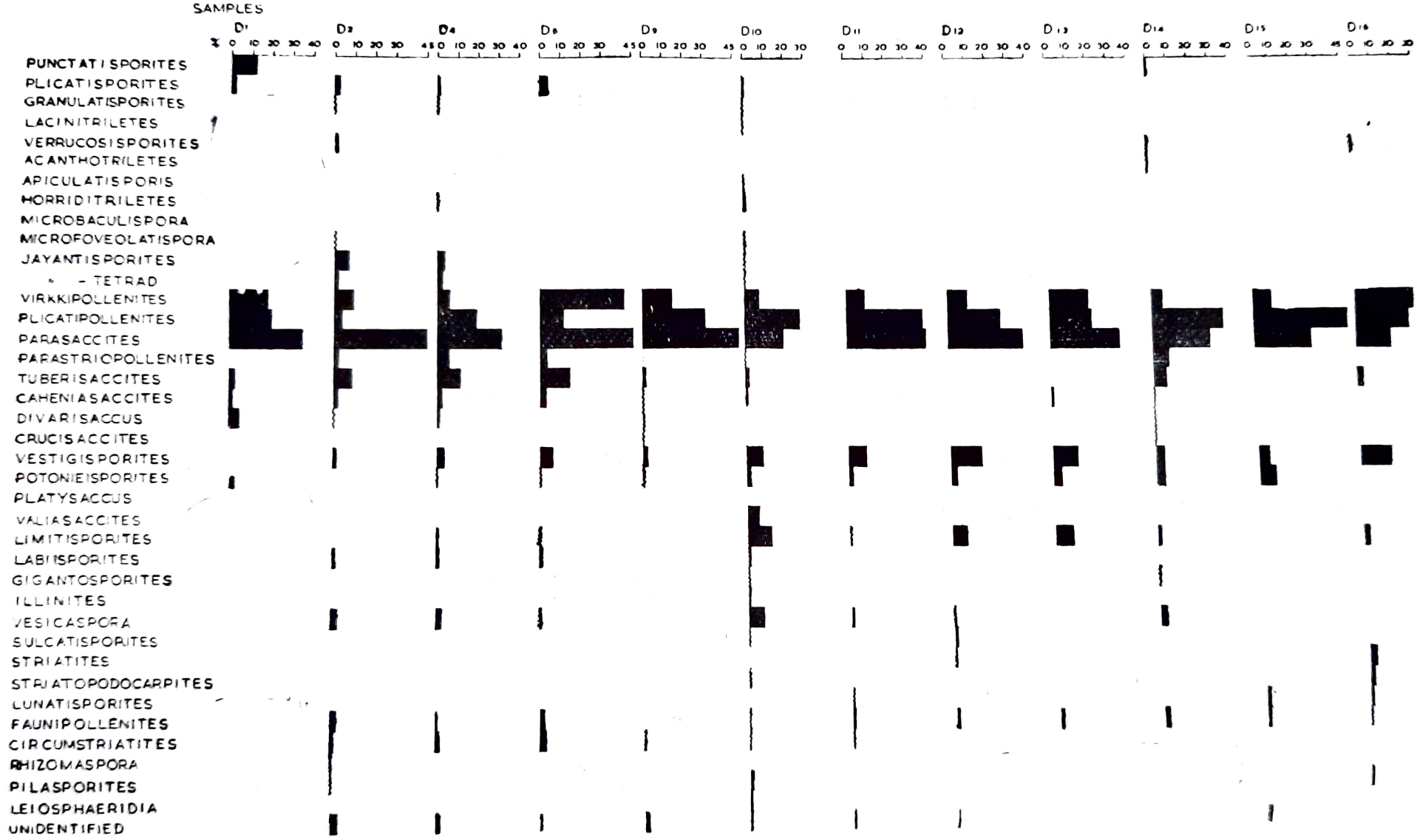
The new genus *Jayantisporites* demonstrates very well the wide variation in the distal ornament and the trends leading to the formation of a pseudozonate structure. It may be observed in this connection that *Jayantisporites* and perhaps some other genera of the series *Varitrileti* constitute a distinct group of trilete spores which bear a distal ornament of spines or other sculpture. Like *Jayantisporites*, their processess may often tend to be compound, being built up of more than one unit. Spores with compound (or biform) sculptural elements are wellknown from the Devonian and Lower Carboniferous strata of the Northern Hemisphere. Like these forms, some of the southern varitrilete genera may prove to be morphologically as well as stratigraphically significant to the Lower Gondwana. Such forms

TABLE II—Percentage Distribution of Palynological taxa in Different Samples of Talchir Formation, Jayanti Coalfield, Bihar

Sl. no.	Genera	D1	D2	D4	D6	D9	D10	D11	D12	D13	D14	D15	D16
1	*Punctatisporites*	11.6	..	..	..	..	..	..	..	..	1	..	..
2	*Plicatisporites*	1.7	2.5	1	4	..	0.7	..	..	..	..	..	..
3	*Granulatisporites*	..	0.5	0.5	..	..	0.4	..	..	..	..	..	..
4	*Lacinitriletes*	..	..	..	..	..	0.2	..	..	..	..	..	..
5	*Verrucosisporites*	..	1	..	..	..	..	..	..	..	0.5	..	0.5
6	*Acanthotriletes*	..	..	..	..	..	..	..	..	..	0.5	..	..
7	*Apiculatisporis*	..	..	..	..	..	0.4	..	..	..	..	..	..
8	*Horriditriletes*	..	..	0.5	..	..	0.9	..	..	..	..	..	..
9	*Microfoveolatispora*	..	0.5	..	..	..	0.4	..	..	..	..	..	..
10	*Jayantisporites Tetrad*	..	2	2.5	..	..	0.3	..	..	..	..	..	..
11	*Jayantisporites*	..	7	3.5	..	..	0.2	..	..	..	..	..	..
12	*Virkkipollenites*	18.3	9.5	6	4	14.5	7.4	9	9.5	19	5.5	9	28.5
13	*Plicatipollenites*	20	4	19	11.5	30.5	26.7	37.5	25.5	20.5	34.7	46	26
14	*Parasaccites*	35	45	31.5	45.5	47	18.6	39	36.5	34	28.5	28	17
15	*Parastriopollenites*		2.5	6	3.5	..	0.4	..	..	..	7.3	..	..
16	*Tuberisaccites*	3.3	9	11.5	14.5	1.5	2	..	..	..	6.5	..	3
17	*Caheniasaccites*	1.7	2	2.5	3	0.5	1	..	..	1	0.5	..	..
18	*Divarisaccus*	5	0.5	1.5	..	0.5	..	..	..	..	0.5	..	0.5
19	*Crucisaccites*	..	..	..	..	0.5	..	..	..	..	0.3	..	..
20	*Vestigisporites*	..	1.5	3.5	6	2	8	8.5	15	12	4	5	15
21	*Potonieisporites*	3.4	..	0.5	0.5	0.5	1.8	1.5	3	4	4	8	..
22	*Platysaccus* ..	..	..	..	..	..	..	..	..	..	0.3	..	..
23	*Valiasaccites*	..	..	..	..	..	5.6	..	..	..	..	..	..
24	*Limitisporites*	..	..	1	0.5	..	11.6	0.5	7	8.5	1	..	2
25	*Labiisporites*	..	1.5	1.5	1	..	0.8	..	..	..	..	..	..
26	*Gigantosporites*	..	..	..	..	..	0.2	..	..	..	0.2	..	..
27	*Illinites*	..	..	..	..	..	0.8	..	..	..	..	..	..
28	*Vesicaspora*	..	2.5	2.5	0.5	..	7.5	1	0.5	..	2.5	..	..
29	*Sulcatisporites*	..	..	..	..	..	0.3	..	1	..	..	..	..
30	*Striatites*	..	..	..	..	..	..	..	0.5	..	..	..	3
31	*Striatopodocarpites*	..	..	..	..	..	0.2	..	..	..	..	..	2
32	*Lunatisporites*	..	..	..	..	..	..	0.5	..	..	..	1	1
33	*Faunipollenites*	..	2.5	..	2	..	0.2	1	1	1	2.2	1	0.5
34	*Circumstriatites*	..	1.5	2	3	0.5	0.2	0.5	..	..	..	..	..
35	*Rhizomaspora*	..	0.5	..	..	..	..	..	..	..	..	..	..
36	*Pilasporites*	..	0.5	..	..	..	1.5	..	..	..	..	..	1
37	*Leiospheridia*	..	..	..	..	..	0.6	..	..	..	..	..	..
38	Unidentified	..	3.5	2	0.5	2	1.1	1	0.5	..	..	2	..



HISTOGRAM 1



HISTOGRAM 2

therefore warrant more attention than given so far with regard to the details of their organisation and sculptural pattern.

Among the monosaccates a number of genera show an amphilateral mode of saccus attachment. More noteworthy are *Parasaccites*, *Parastriopollenites* and the new genus *Tuberisaccites* which not only share a para-condition of saccus attachment, but there are some transitional trends between the three genera. Typical cases of each genus are, however, distinguishable as the basic pattern of their proximal body sculpture is very distinct. Conspicuous body-sculptural patterns are hence considered of generic significance in the morphography of monosaccate taxa.

The new genus *Circumstriatites* adds a new point in the morphology of striate saccate pollen. Unlike *striatiti*, the pollen of the new series *Circumstriatiti* have their striations nearly enclosed by a ± subsequatorial groove-ring on the proximal side of the body.

Comparisons

Among the Talchir miospore assemblages (Lele, 1966), some comparison can be attempted with the Goraia mioflora to the South Rewa basin (Potonié & Lele, 1961; Lele, 1966). About 17 genera are common in the South Rewa and Jayanti assemblages. Both miofloras have a comparable predominance of the common monosaccates, such as *Parasaccites*, *Plicatipollenites*, *Virkkipollenites* and *Potonieisporites*. However, the comparisons can hardly be stretched any further, for the Jayanti mioflora is much more diversified and richer than any known Talchir miofloras. In fact the whole composition of the Jayanti mioflora is rendered very distinct by the occurrence of as many as 25 new taxa (indicated by asterisk in the list, pp. 55-58) hitherto unknown from the Talchir Formation of South Rewa or other basins. Some of these taxa occur in significant numbers in certain beds viz. *Plicatisporites*, *Jayantisporites*, *Parastriopollenites*, *Tuberisaccites*, *Caheniasaccites*, *Divarisaccus*, *Valiasaccites*, *Limitisporites*, *Circumstriatites*, *Striatites* and *Leiosphaeridia*.

Some of the above new elements may be recognized in future in the miofloras of South Rewa basin or other areas. Nevertheless the distinction of the Jayanti mioflora would broadly remain sharp enough from the South Rewa mioflora since the latter stands out in its characteristic content of *Horriditriletes*, *Ginkgocycadophytus* and *Quadrisporites*, all of which are practically missing from the Jayanti mioflora. The Giridih Talchir mioflora is still poorly known and does not permit detailed comparisons.

Comparable Miofloras from Gondwanaland

The rich mioflora from the Assise glaciares et periglaciares at Fundi Sadi in Congo described by Bose and Kar (1966) shows a general similarity with the Jayanti mioflora and other Talchir assemblages in the common prevalence of monosaccates (*Plicatipollenites*, *Virkkipollenites*, *Vestigisporites*, *Parasaccites*, *Potonieisporites*, *Divarisaccus*, *Caheniassacites*) and the presence of some disasaccates (*Valiasaccites*, *Limitisporites*, *Faunipollenites*, *Stotersporites*, *Rhizomaspora* and *Lunatisporites*). In both cases, triletes are poorly represented. It is likely that the Indian and Congo assemblages are nearly homotaxial.

The assemblages from the two intercalated Boulder Beds of the Jayanti basin have already been compared with those of the Bacchus Marsh Tillite in our earlier paper (Lele

Histogram I—Distribution of different Palynological groups in the Talchir Formation of the Jayanti Coalfield Bihar.

Histogram II—Showing Frequency of Palynological Taxa in samples of Talchir Formation, Tayanti Jayanti Coalfield, Bihar.

& KARIM, 1971). Although comparable in a wider sense, the Jayanti boulder bed mioflora is peculiar in its content of Leiospheres.

RELATION OF TALCHIR-KARHARBARI MIOFLORAS

With the amount of knowledge now available, it becomes all the more evident that the miofloras of the Talchir Formation are intimately related with those of the succeeding Karharbari Formation. The dominant genera of the Talchir Formation, viz. *Parasaccites*, *Plicatipollenites* and *Virkkipollenites* and their associates such as *Potonieisporites*, *Caheniasaccites* and *Vestigisporites* continue to occupy the same position in the Karharbari Formation. Besides, both the formations are generally deficient in trilete and disaccate spores. This microfloristic relationship is thus in full agreement with the palaeobotanical evidence for grouping together the Talchir and Karharbari Formations under the Talchir Group (Talchir Series).

There are, however, differences also in some other details of the miofloristic and megafloristic composition of the two formations which only help in their delimitation. For instance, one of the broad distinctions is that the striate and non-striate saccates become more substantially representated and diversified in the Karharbari Formation as against the Talchir Formation where they are rather insignificant. Besides, some taxa such as *Quadrisporites*, *Ginkgocycadophytus* and *Stellapollenites* may lend some peculiar significance to the Talchir Formation in the same way as *Crucisaccites* and *Vittatina-Welwitschiapites—Tiwariasporis* complex to the Karharbari Formation. The new taxa, known from both these formations, will have to be examined also from stratigrahpical standpoint. For instance, it is striking to note that forms of *Punctatisporites* (now mostly assigned to *Callumispora* Bharadwaj & Srivastava, 1969) are insignificant in the Talchir Formation but they seem to gain a sudden, although probably short-lived, prominence in the earlier phases of the Karharbari Formation. This feature is particularly observable in the miofloras of the Talchir-Karharbari Formation in the Jayanti Coalfield. Critical studies in other areas are, therefore, likely to yield comparable data on the guide fossils for delimiting the Talchir-Karharbari boundary.

REFERENCES

*References marked with an asterisk have not been accessible in original.

ALLEN, K. C. (1965). Lower and Middle Devonian Spores of North and Central Vestspitsbergen. *Palaeontology*. **8**(4): 687-748.

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

BALME, B. E. & HENNELLY, J. P. F. (1956a). Monolete, Monocolpate and Alete sporomorphs from Australian Permian sediments. *Aust. J. Bot.* **4**(1): 54-67.

BALME, B. E. & HENNELLY, J. P. F. (1956b). Trilete sporomorphs from Australian Permian sediments. *Aust. J. Bot.* **5**: 240-260.

BARSS, M. S. (1967). Illustrations of Canadian Fossils: Carboniferous and Permian Spores of Canada. *Geol. Surv. Canada*. Paper 67-11.

BHARADWAJ, D. C. (1962). The miospore genera in the coals of Raniganj Stage (Upper Permian), India. *Palaeobotanist*: **9**(1 & 2): 68-106.

BHARADWAJ, D. C. & SALUJHA, S. K. (1964). Sporological study of Seam VIII in Raniganj Coalfield, Bihar, India. Pt. I Description of the Sporae dispersae. *Palaeobotanist*. **12**: 181-215.

BHARADWAJ, D. C. & SRIVASTAVA, S. C. (1969). Some new miospores from Barakar Stage, Lower Gondwanas India. *Palaeobotanist*. **17**(2): 220-229.

BHARADWAJ, D. C. & TIWARI, R. S. (1964). On two monosaccate genera from Barakar Stage of India. *Palaeobotanist*. **12**(2): 139-146.

Bharadwaj, D. C. & Sinha, V. (1969). Some new miospores from the Lower Gondwana Coals. *J. Sen Mem. Vol., Calcutta:* 7-16.

Bose, M. N. & Kar, R. K. (1966). Palaeozoic *Sporae dispersae* from Congo. I: Kindu Kalima and Walikale regions. *Annls Mus. r. Afr. cent. Ser. in* 8*vo*. **53:** 1-238.

Bose, M. N. & Maheshwari, H. K. (1968). Palaeozoic *Sporae dispersae* from Congo. VII. Coal Measures near Lake Tanganyika South of Albertville. *Annls Mus. r. Afr. cent. Ser. in* 8*vo*. **60:** 1-116.

Butterworth, M. A. *et al.* (1964). *Densosporites* (Berry) Potonié & Kremp and related genera. *C. r. 5th Cong. Int. Strat. geol. Carbon.* **3:** 1049-1057.

Cookson, I. C. (1947). Plant microfossils from the Lignites of Kerguelen Archipelago. in *B.A.N.Z. Ant. Res. Exped.* 1929-1931. *Rept.*—Ser. A. 2:127-142.

Daugherty, L. H. (1941). The Upper Triassic Flora of Arizona. *Carnegie Inst. Wash. Publ.* **526:** 1-108.

Erdtman, G. (1947). Suggestions for the classification of fossil and recent pollen grains and spores. *Sv. Bot. Tidskr.* **41**(1): 104-114.

Hart, G. F. (1960). Microfloral investigation of the Lower Coal Measure (k**2**); Ketewaka—Mchuchuma Coalfield, Tanganyika. *Bull. geol. Surv. Tanganyika.* **30:** 1-18.

Ibrahim, A. C. (1933). *Sporenformen des Aegirhorizonts des Ruhr Riviers.* Dissertatoin, Berlin; Privately published 1933 by Konard Triltsch, Wurzburg; 1-47.

Jansonius, J. (1962). Palynology of Permian and Triassic sediments, Peace river area, Western Canada. *Palaeontographica.* **110**(B): 35-98.

Jizba, K. M. M. (1962). Late Palaeozoic bisaccate pollen from the United States, Mid Continent area. *J. Palaeocont.* **36**(5): 871-887.

Kar, R. K. & Bose, M. N. (1967). Palaeozoic *Sporae dispersae* from Congo. III. Assise des Schistes Noirs de la Lukuga. *Annls Mus. r. Afr. cent. Ser. in 8 vo.* **54:** 2-84.

Klaus, W. (1963). Sporen aus dem Sudalpinen Perm. *Jb. Geol.* **106:** 229-363.

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

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

Lele, K. M. (1966). Studies in the Talchir Flora of India. 4. Quest for the early traces and subsequent development of the Glossopteris Flora in the Talchir Stage. *Symp. Floristics Strat. Gondwld. Lucknow.* 1964: 85-97.

Lele, K. M. & Karim, R. (1969). Discovery of Talchir Miospore Floras in the Jayanti Coalfield, Bihar. *Curr. Sci.* **38**(18): 436-437.

Lele, K. M. & Karim, R. (1971). Studies in the Talchir Flora of India-6. Miospores from Talchir Boulder Beds in Jayanti Coalfield, Bihar. *Palaeobotanist* **19**(1): 52—69.

Lele, K. M. & Maithy, P. K. (1964). An unusual monosaccate spore from the Karharbari Stage, Giridih Coalfield, India. *Palaeobotanist.* **12**(3): 307-312.

Lele, K. M. & Maithy, P. K. (1969). Miospore assemblage of Ganjra Nala Beds, South Rewa Gondwana Basin, with some remarks on the Age of the Beds. *Palaeobotanist.* **17**(3): 298-309.

Leschik, G. (1956). Sporen aus dem Salston des Zechsteins von Neuhof (bei Fulda). *Palaeontographica.* **100**(B): 125-141.

*Luber, A. A. (1935). Petrographic characterization of Karagand Coal (in Russian). *Khim. tverd. Topl.*, na 5.

Maheshwari, H. K. (1967). Studies in the Glossopteris flora of India—29. Miospore assemblage from the Lower Gondwana Exposures along Bansloi river in Rajmahal Hills, Bihar. *Palaeobotanist.* **15**(3): 258-280

Maheshwari, H. K. (1969). Palaeozoic Sporae Dispersae from Congo—X. Microfossils from **a** Cliff section at the confluence of Lufupa and Mushyashya rivers, South Katanga. *Annls Mus. r. Afr. cent. Ser* in *8vo* **63:** 115-168.

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

Naumova, S. N. (1953). Sporo-pollen complexes of the Upper Devonian of the Russian platform and their Stratigraphic vaule. *Trans. Inst. Geol. Sci., Acad. Sci. USSR.* **143:** Geol. Series (60): 1—203. (English Translation; Catalogue of Fossil Spores and Pollen, Vol. 1).

Neves, R. & Owens, B. (1966). Some Namurian camerate miospores from the English Pennines. *Pollen Spores.* **8**(2): 337—360.

Niyogi, D. & Sanyal, S. P. (1962). Gondwana rocks of Jayanti Coalfield. *Q. J. geol. Min. metall. Soc. India.* **84**(4): 183—193.

PANT, D. D. (1954). Suggestions for the classification and nomenclature of fossil spores and pollen grains. *Bot. Rev.* **20**: 33-66.

POTONIÉ, R. (1956). Synopsis der Gattungen der *Sporae dispersae* Pt. 1. *Beih. Geol. Jb.* **23**: 1-103.

POTONIÉ, R. (1958). Synopsis der Gattungen der *Sporae dispersae*. Pt. 2. *Beih. Geol. Jb.* **31**: 1-114.

POTONIE, R. (1960). Synopsis der Gattungen der *Sporae dispersae* Pt. 3. *Beih. Geol. Jb.* **39**: 1-189.

POTONIÉ, R. & KLAUS, W. (1954). Einige sporen gattungen des alpinen Salzbirges. *Geol. Jb.* **68**: 517—544.

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

POTONIÉ, R. & KREMP, G. (1955). Die *Sporae dispersae* des Ruhrakarbons, ihre Morphographie und Stratigraphie mit ausblicken auf arten anderer gebiete und Zeitabschnitte. Pt. I. *Palaeontographica.* **98** (B): 1-136.

POTONIÉ, R. & KREMP, G. (1956). Die *Sporae dispersae* des Ruhrkarbons, ihre Morphographie und Stratigraphie mit ausblicken auf arten anderer gebiete und Zeitabschnitte. Pt. 2. *Palaeontographica* **100 B**: 85-121.

POTONIÉ, 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**: 22-37.

SCHOPF, J. M., WILSON, L. R. & BENTALL, R. (1944). An annonated Synopsis of Palaeozoic fossil spores and the definition of generic groups. *Ill. St. geol. Surv. Rep.* **91**: 1-66.

SINGH, H. P. (1964). A miospore assemblage from the Permian of Iraq. *Palaeontology.* **7**(2): 240-255.

SINHA, V. (1968). Some 'acritarchs' and other microfossils from Barakar Stage of Lower Gondwanas, India. *Palaeobotanist.* **17**(3): 326-331.

SRIVASTAVA, S. C. (1970). Miofloral Investigations in some coals of Talcher Coalfield (Orissa), India. *Palaeobotanist.* **18**(2): 154-166.

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

TIWARI, R. S. (1965). Miospore assemblage in some coals of Barakar Stage (Lower Gondwana) of India. *Palaeobotanist.* **13**(2): 168-214.

VENKATACHALA, B. S. & KAR, R. K. (1965). Two new trilete spore genera from the Permian of India. *Palaeobotanist.* **13**(3): 337-340.

VENKATACHALA, B. S. & KAR, R. K. (1966). *Divarisaccus* gen. nov. a new saccate pollen genus from the Permian sediments of India. *Palaeobotanist.* **15**(1): 102-106.

VENKATACHALA, B. S. & KAR, R. K. (1968). Palynology of the Kathwai shales, Salt Range, West Pakistan 1. Shales 25 ft. above the Talchir Boulder Bed. *Palaeobotanist.* **16**(2): 141-148.

VISSCHER, H. (1966). Palaeobotany of the Mesophytic—III. Plant Microfossils from the Upper Bunter of Hengelo, The Netherlands. *Acta. bot. neerl.* **15**: 316-375.

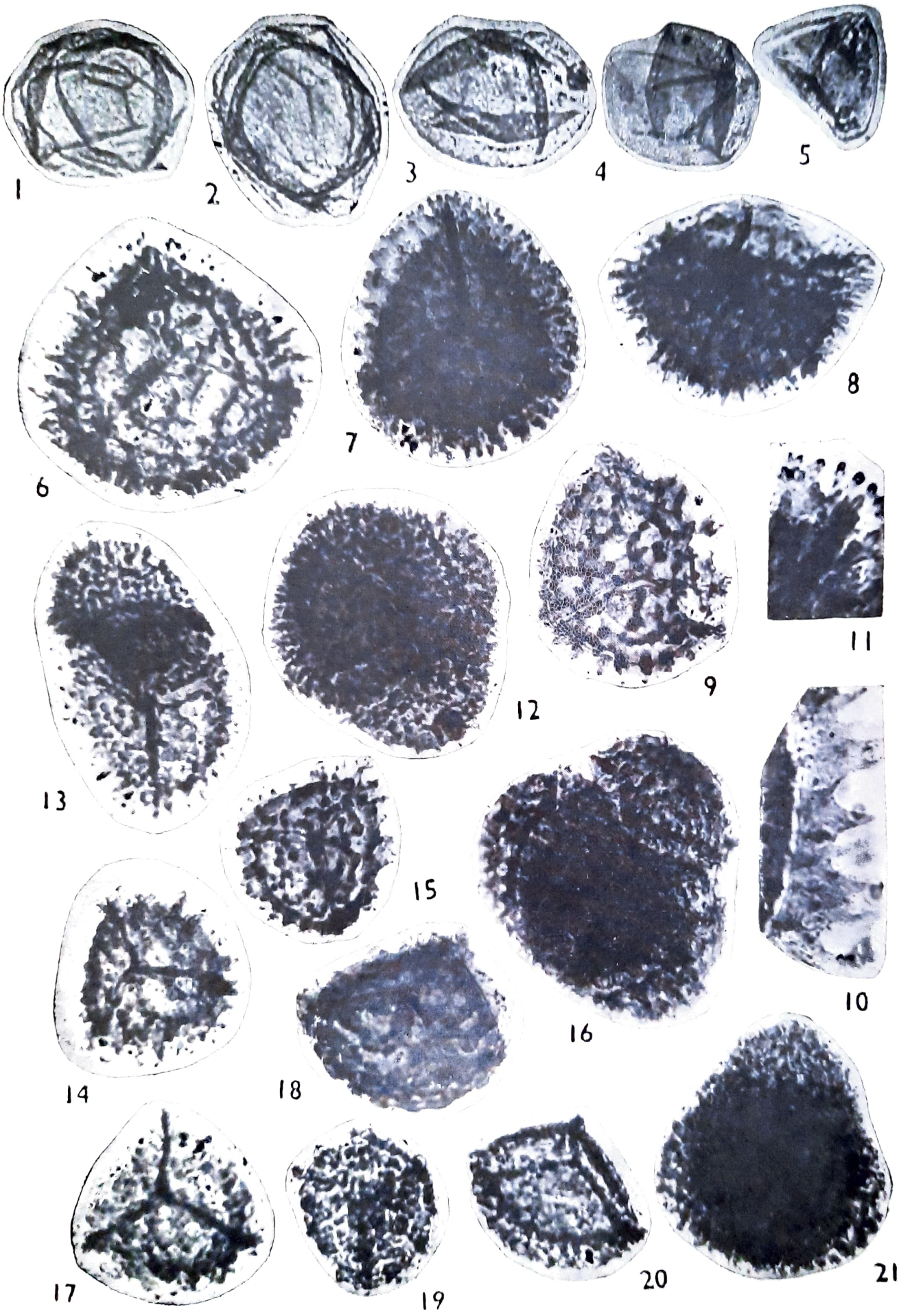
WILSON, L. R. & VENKATACHALA, B. S. (1963). A morphologic study and amendation of *Vesicaspora* Schemel, 1951. *Okla Geol. Notes.* **23**(6): 142-149.

EXPLANATION OF PLATES

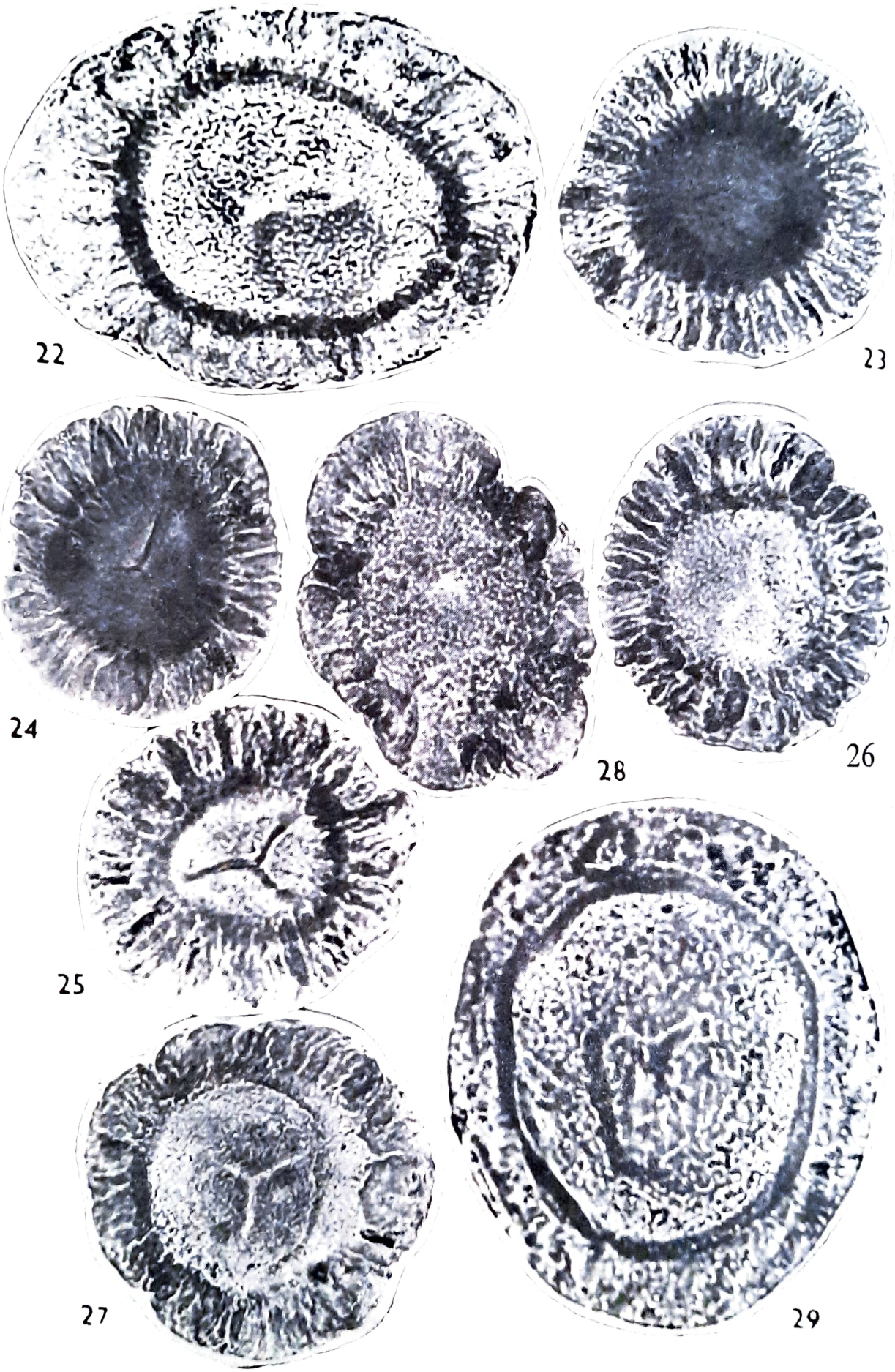
(All magnifications × 500)

PLATE 1

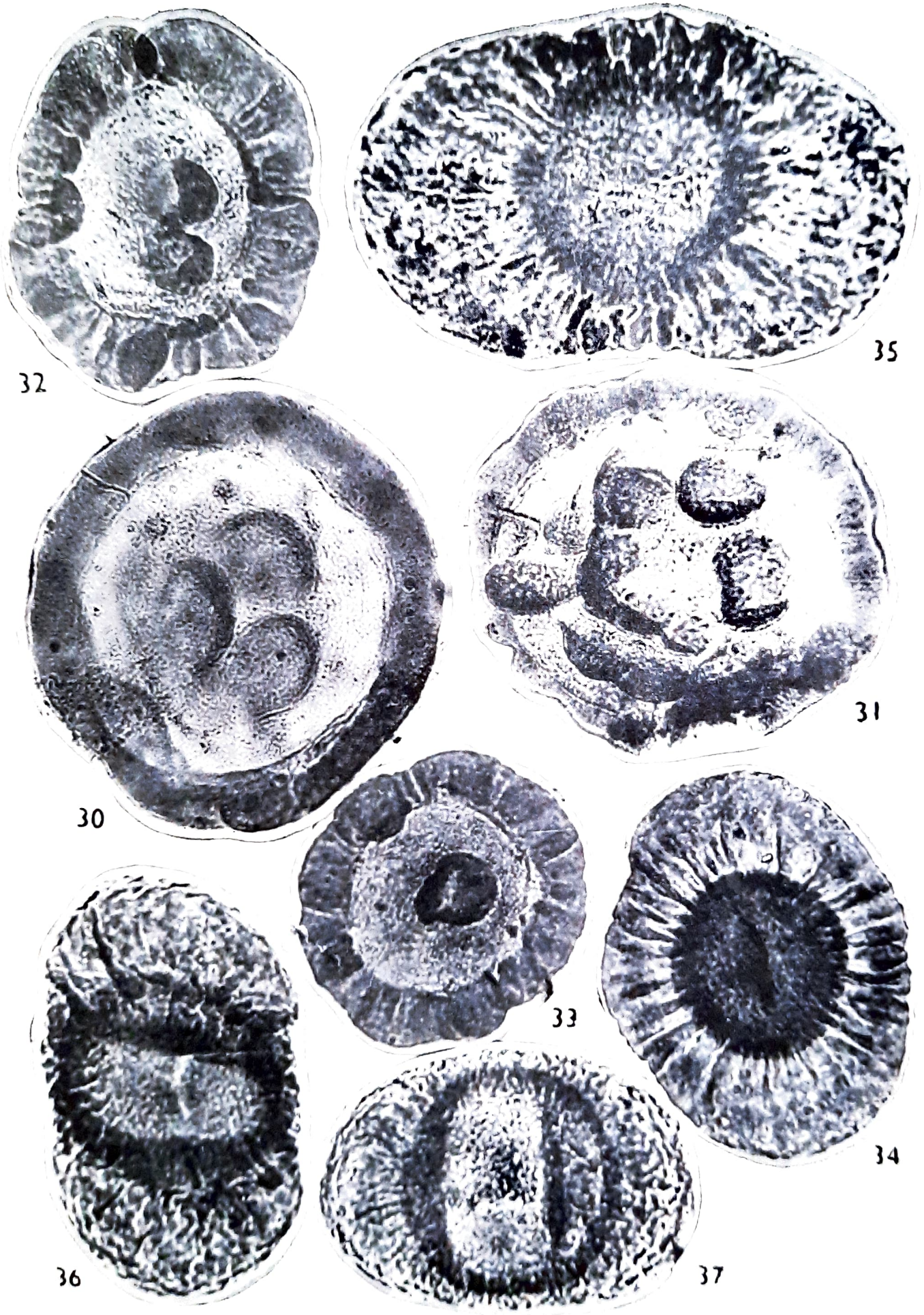
1. *Plicatisporites distinctus* gen. et sp. nov. Holotype. Reg. No. 4251.
2-4. *Plicatisporites distinctus* Reg. Nos. 4252, 4253, 4254.
5. *Granulatisporites* sp. Reg. No. 4255.
6. *Jayantisporites pseudozonatus* gen. et sp. nov. Holotype. Reg. No. 4256.
7. *Jayantisporites pseudozonatus* Reg. No. 4257.
8. *Jayantisporites pseudozonatus* Lateral view. Reg. No. 4258.
9. *Jayantisporites pseudozonatus* Reg. No. 4259.
10-11. *Jayantisporites pseudozonatus* A portion enlarged to show sculptural elements. × 1500. Reg. Nos. 4260, 4257.
12. Tetrad of *Jayantisporites pseudozonatus* Reg. No. 4261.
13. Two spores separated in the Tetrad of *Jayantisporites pseudozonatus* Reg. No. 4262.
14. *Jayantisporites indicus* sp. nov. Holotype. Reg. No. 4263.
15. *Jayantisporites indicus* Reg. No. 4264.

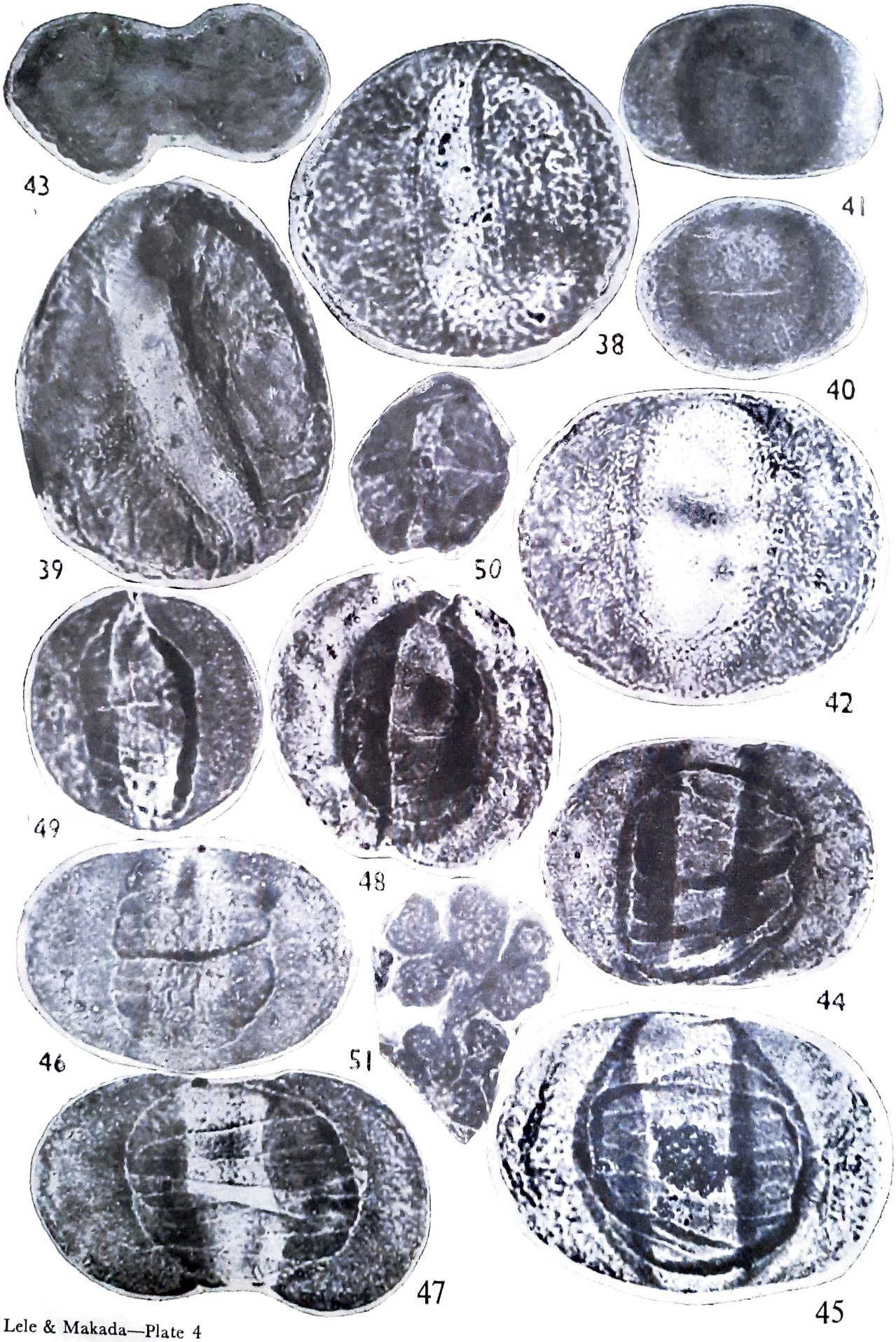


Lele & Makada—Plate 1



Lele & Makada—Plate 2


32
35
30
31
33
34
36
37



Lele & Makada—Plate 4

16. Tetrad of *Jayantisporites indicus* Reg. No. 4265.
17. *Jayantisporites conatus* sp. nov. Holotype. Reg. No. 4266
18-19. *Jayantisporites conatus* Reg. Nos. 4267, 4296.
20. *Jayantisporites conatus* Lateral view Reg. No. 4268.
21. Tetrad of *Jayantisporites conatus* Reg. No. 4269.

PLATE 2

22. *Rugasaccites ovatus* sp. nov. Holotype Reg. No. 4270.
23. *Parasaccites talchirensis* sp. nov. Holotype. Reg. No. 4271.
24. *Parasaccites talchirensis* Reg. No. 4272.
25. *Parasaccites plicatus* sp. nov. Holotype. R3g. No. 4264.
26. *Parasaccites plicatus* Reg. No. 4273.
27. *Parasitriopollenites segmentus* sp. nov. Holotype. Reg. No. 4274.
28. *Parastriopollenites segmentus* Reg. No. 4276.
29. *Parasitriopollenites indicus* sp. nov. Holotype. Reg. No. 4275.

PLATE 3

30. *Tuberisaccites varius* Gen. et sp. nov. Holotype Reg. No. 4276.
31. *Tuberisaccites varius* Reg. No. 4277.
32. *Tuberisaccites lobatus* sp. nov. Holotype. Reg. No. 4278.
33. *Tuberisaccites tuberculatus*, comb. nov. Reg. No. 4279.
34. *Caheniasaccites distinctus* sp. nov. Holotype. Reg. No. 4261.
35. *Caheniasaccites distinctus* Reg. No. 4280.
36. *Caheniasaccites decorus* sp. nov. Holotype. Reg. No. 4281.
37. *Caheniasaccites decorus* Reg. No. 4282.

PLATE 4

38. *Divarisaccus scorteus* sp. nov. Holotype. Reg. No. 4283.
39. *Divarisaccus scorteus* Reg. No. 4264.
40. *Labiisporites densus* sp. nov. Holotype. Reg. No. 4284.
41. *Labiisporites densus* Rge. No. 4285.
42. *Vesicaspora crassa* sp. nov. Holotype. Reg. No. 4286.
43. *Striatites* sp. Reg. No. 4287.
44. *Circumstriatites talchirensis* gen. et sp. nov. Holotype. Reg. No. 4288.
45. *Circumstriatites talchirensis* Reg. No. 4289.
46. *Circumstriatites obscurus* sp. nov. Holotype Reg. No. 4290.
47. *Circumstriatites obscurus* Reg. No. 4291.
48. *Circumstriatites ovatus* sp. nov. Holotype Reg. No. 4292.
49. *Circumstriatites ovatus* Reg. No. 4293.
50. *Striasulcites* sp. Reg. No. 4294.
51. Group of cells. Reg. No. 4295.