STUDIES IN THE TALCHIR FLORA OF INDIA — 6. PALYNOLOGY OF THE TALCHIR BOULDER BEDS IN JAYANTI COALFIELD, BIHAR

K. M. LELE & REHANA KARIM*
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

Miospore assemblages and acritarchs are for the first time recorded from the matrix of two intercalated Talchir Boulder Beds in the Jayanti Coalfield. *Virkkipollenites, Plicatipollenites, Parasaccites, Caheniasaccites, Vestigisporites, Potonieisporites* and *Limitisporites* are predominant. The distribution pattern of the miospores in the two boulder beds is studied and comparisons are made with known equivalent assemblages. The bio-stratigraphical and palaeobotanical significance of the present findings is briefly discussed.

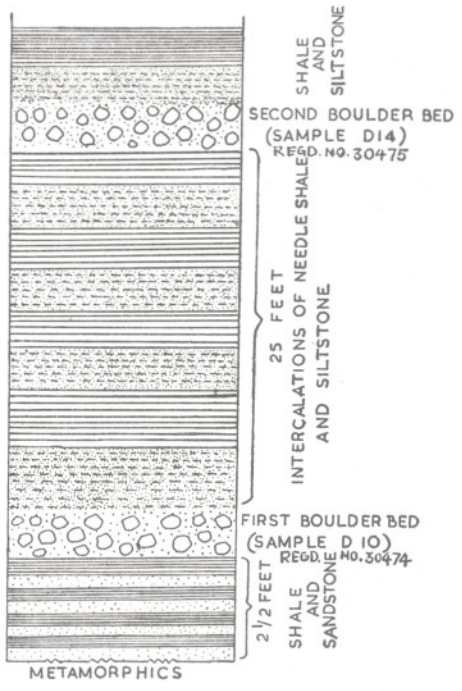
INTRODUCTION

RECENT studies on the Talchir sediments have indicated the presence of spores and plant remains at fairly deep levels in the Talchir Stage. In few instances the evidence is almost close to the Talchir Boulder Bed which forms the base of the formation (Lele, 1965). However, we had hitherto no evidence of plant life directly coming from the Boulder Bed matrix, although a search in this direction was begun by Professor Sahni more than thirty years ago. This quest was pursued in some of the Penninsular basins with the result that at least in one case, i.e. the Jayanti Coalfield, a tolerably good recovery of spores and pollen has now been made from two intercalated Talchir Boulder Beds.

GEOLOGICAL BACKGROUND

The Jayanti Coalfield is a small basin close to the Giridih Coalfield. The exposed formations belong to the Talchir and Karharbari (or ? Barakar) stage (Niyogi & Sanyal, 1962). The Talchir strata are well exposed in the Patharjore Nala and Bhagdaru Nala which feed the Jayanti river. The Talchir sequences in both the nalas show more than one intercalations of boulder beds towards the Archaean boundary. These Boulder Beds evidently represent what is designated as the Talchir Boulder Bed.

In the Patharjore Nala, which has yielded the present material, the Talchir — Metamorphic contact appears to be along a fault where the few basal Talchir beds are highly tilted and crushed. It may be pointed out that the stratum immediately in contact with the Archaeans is not a Talchir Boulder Bed but a kind of sandstone somewhat mixed with needle shale stuff Text-fig. 1. The bed is followed upward by several thin intercalations of fine-grained sandstone and needle shale (making up a thickn ss of about 2½ ft.). This small sequence ends with a needle shale which is



TEXT-FIG. 1 — Position of the two intercalated Talchir Boulder Beds in Patharjore Nala sequence of Jayanti Coalfield, Bihar (Diagrammatic).

*Now Mrs. Rehana Makada

overlain by the first recognisable Talchir Boulder Bed (Regd. No. 34073, Field Sample No. D10). The location is roughly one kilometer S.S.W. of Madankanta Railway station.

The Boulder Bed is a distinct unit, composed of rounded to subrounded metamorphic pebbles, cobbles or boulders as large as 3 ft. in diameter set in a sandy to silty matrix. The boulders are scattered irregularly along the vertical as well as horizontal extent of the bed. In the whole unit it is possible to recognize zones almost free from pebbles (resembling a siltstone). Lateral gradation of these zones into finer or coarser sediments is also noticeable. The relatively finer matrices may often show lamination or current-bedding. Some of the layers have a dark colour in sectional view, and on splitting one can notice numerous coaly imprints of indeterminate organic fragments — possibly vegetable debris. Stem-like objects with parallel ribbing are sporadically present in the coarser or pebbly matrices as well.

The first Talchir Boulder Bed (D10) is overlain by an alternation of siltstones and Talchir Needle shales (making up about 25 ft.). This sequence terminates with a needle shale stratum which is overlain by another distinct Boulder Bed (second in the whole sequence). The nature of the second Boulder Bed (Registered No. 34075 Field sample No. D14) is generally comparable with the first one in respect of matrix, boulder material and occasional stratification along zones containing fragmentary organic remains. The Boulder Bed is overlain by several alternating beds of siltstones and needle shale (making up about 50 feet). Some of the siltstones may reveal poorly preserved remains of seed-like bodies and fragmentary leaves (? *Gangamopteris*).

From the above description, it is clear that there are at least two distinct Talchir Boulder Beds separated by about 25 feet thick siltstones and shales. It is also apparent that the lower or first boulder bed does not form the basalmost unit of the Talchir sequence exposed in the Patharjore Nala. The shape of the boulder material, the nature of the matrix, the presence of finer stratification, current-bedding and layers of organic debris are features which indicate that both the Boulder Beds have been deposited predominantly under fluviatile conditions.

MATERIAL AND METHOD

The present study is confined to the samples of the two boulder beds (Sample Nos. D10 and D14), intercalated in the Talchir sequence described above. In view of the irregularity in the assortment of boulder material and its matrix, it was considered essential to select different types of samples from each Boulder Bed in order to get a representative idea of the spore population and the variations from sample to sample. Five samples were selected for palynological studies from the Lower Boulder Bed intercalation (numbered as D10A, D10B, D10C, etc.) and two samples from the Upper Boulder Bed intercalation (numbered as D14A, D14B). Table 1 shows the megascopic features of these samples and gives an idea of the incidence of spores and their preservation.

For the extraction of the miospores about 50 gm. of the material was crushed in pieces of approximately 5 mm. size. The material was treated with 40 per cent Hydrofluoric acid in polythene jars for about 48 hours, periodically stirring the solution. After the complete dissolution of the silicates the material was washed free of acid in a glass trough. Usually 6-8 washings were required. In between two washings, a time interval of 60-90 minutes was allowed for settling down of microfossils. The water was removed by siphoning. The miospores were separated by sieving through 300 mesh. The material was concentrated by centrifuging. A drop of concentrated material was evenly spread on a glass slide in Polyvenyl alcohol and allowed to dry. The coverslips (No. Zero) were sealed in Canada balsam.

The slides were thoroughly scanned and well preserved specimens were photomicrographed on 35 mm. negative film on an Olympus Microscope Cum Camera attachment. For frequency counts, 400 grains were counted. The preparations are preserved in the Museum of the Birbal Sahni Institute of Palaeobotany.

DESCRIPTION

Following 74 forms belonging to 40 genera have been recorded from the present assemblage. There are 59 definite species of which 15 are new. Only those species which

TABLE 1

Field Sample Nos.		Megascopic Features	Incidence of spores	Preservation
Registered No. 34075	D14A	Fine-Medium grained sandstone. Resembles D14B except for grain size	Good	Good
	D14B	Medium-Coarse grained sandstone with ± nodular inclusions of Talchir needle shale	Fair	Good
Registered No. 34074	D10A	Medium grained sandy matrix with subrounded pebbles	Poor	Good
	D10B	Sandy + silty matrix (medium grained), with occasional fragmentary organic remains (?Plant debris)	Fair	Fair
	D10C	Fine-grained light greyish sandy matrix, almost free from pebbles and containing coaly plant debris	Poor	Poor
	D10D	Fine-grained, grey siltstone, pebble-free	Good	Good
	D10E	Fine-grained light greyish to grey siltstone with fine indistinct stratification Combines features of D10C and D10D	Good	Good

are marked with an asterisk (*) are described —

1. *Leiotriletes* sp.
2. *Punctatisporites minutus* Kosanke, 1950.
3. *P. ganjrensis* Lele & Maithy, 1969.
4. *Callumispora gretensis* (Balme & Henn.) Bharadwaj & Srivastava, 1969.

*5. *Hennellyisporites* sp.

6. *Granulatisporites granulatus* Ibrahim, 1933.

*7. *G.* sp.

8. *Verrucosisporites* sp.
9. *Lacinitriletes budamensis* Venkatachala & Kar, 1965.
10. *L. minutus* Venkatachala & Kar, 1968.
11. *Cyclogranisporites gondwanensis* Bharadwaj & Salujha, 1964.
12. *Acanthotriletes filiformis* (Balme & Henn.) Tiwari, 1965.
13. *Horriditriletes bulbosus* Tiwari, 1965.

*14. *H.* sp.

*15. *Microfoveolatispora directa* (Balme & Henn.) Bharadwaj, 1962.

16. *Brevitriletes unicus* (Tiwari) Bharadwaj & Srivastava, 1969.

*17. cf. *Dentatispora* sp.

18. *Virkkipollenites densus* Lele, 1964.
19. *V. obscurus* Lele, 1964.
20. *Plicatipollenites indicus* Lele, 1964.
21. *P. triagonalis* Lele, 1964.
22. *P. diffusus* Lele, 1964.
23. *P. gondwanensis* (Balme & Henn.) Lele, 1964.

*24. *P. densus* Srivastava 1970

*25. *P. stigmatus* sp. nov.

*26. *P. maculatus* sp. nov.

27. *Rugasaccites obscurus* Lele & Maithy, 1969.
28. *R. orbiculatus* Lele & Maithy, 1969.
29. *Parasaccites obscurus* Tiwari, 1965.
30. *P. diffusus* Tiwari, 1965.
31. *P. densus* Maheshwari, 1967.
32. *P. perfectus* Bose & Maheshwari, 1968.

*33. *Parasaccites* sp. A.

34. *Parastriopollenites* sp.

*35. *Tuberisaccites varius* Lele & Karim (in press, also see Lele & Karim, 1969).

36. *Caheniasaccites ovatus* Bose & Kar, 1966.

*37. *C. densus* sp. nov.

38. *Divarisaccus lelei* Venkatachala & Kar (1966).

39. *D.* sp.

40. *Crucisaccites latisulcatus* Lele & Maithy, 1964.

*41. *Vestigisporites nigratus* sp. nov.

42. *V. novus* Tiwari, 1965.

*43. *Potonieisporites magnus* sp. nov.

*44. *Potonieisporites jayantiensis* sp. nov.

45. *P. densus* Maheshwari, 1967.

46. *P.* cf. *lelei* Maheshwari, 1967'
*47. cf. *Rimospora.*
*48. *Valiasaccites densus* sp. nov.
*49. *V. indicus* sp. nov.
*50. *Limitisporites diversus* sp. nov.
*51. *L. elongatus* sp. nov.
52. *L.* cf. *monosaccoides* Bose & Maheshwari, 1968.
53. *L.* cf. *congoensis* Bose & Maheshwari, 1968.
54. *L.* cf. *hexagonalis* Bose & Maheshwari, 1968.
55. *L.* cf. *leschiki* Klaus, 1963.
56. *Labiisporites* cf. *granulatus* Leschik, 1956.
*57. *Gigantosporites indicus* sp. nov.
*58. *Illinites notus* sp. nov.
59. *I.* sp.
60. *Vesicaspora obliqua* Singh, 1964.
61. *V. ovata* (Bal. & Henn.) Hart, 1960.
*62. *V.* sp. A.
63. *Sulcatisporites maximus* (Hart) Singh, 1964.
64. *S. tentulus* Tiwari, 1968.
*65. *Strotersporites rhombicus* sp. nov.
*66. *S.* sp.
67. *Faunipollenites varius* Bharadwaj, 1962
68. *F. goraiensis* (Pot. & Lele) Maithy, 1965.
*69. *F.* sp.
70. *Circumstriatites obscurus* Lele & Karim (in press, also Lele & Karim, 1969).
*71. *Crustaesporites* sp.
72. *Ginkgocycadophytus novus* Srivastava, 1970.
73. *Pilasporites calculus* Balme & Hennelly, 1956.
*74. *Punctatasporites brevis* sp. nov.

SYSTEMATIC DESCRIPTION

Anteturma — *Sporites* H. Potonié, 1893
Turma — *Triletes* (Reinsch) Pot. & Kr., 1954
Subturma — *Azonotriletes* Luber, 1935
Infraturma — *Laevigati* (Benn. & Kidst.) Pot. 1956

Genus — *Hennellysporites* Tiwari, 1968

Type species — Hennellysporites diversiformis (Balme & Henn.) Tiwari, 1968.

Hennellysporites sp.

Pl. 1, Fig. 1

Description — Miospores circular, 30 μ in size; exine ±1·5 μ thick; trilete mark distinct, rays unequal, one ray almost reaching periphery, other two ±2/3 spore radius long, curvaturae not seen, inter-ray area with a 24 μ wide triangular thickening.

Comparison — The present specimens differ from the genotype *Hennellysporites diversiformis* (Balme & Hennelly) Tiwari (1968) in the absence of curvaturae. From *H. indicus* Tiwari (1968) it differs in having longer trilete rays and a comparatively ill-defined polar thickening.

Remarks — *Hennellysporites* apparently overlaps *Retusotriletes* as the latter genus contains a whole range of variations between forms possessing inter-radial thickening and those not possessing it. *Hennellysporites* is however, provisionally retained in view of the fact that the range of variations as now understood in the northern genus *Retusotriletes* (Lele & Streel, 1969) are yet unknown in the southern retusoid forms. Further comparative work is warranted to decide the issue.

Infraturma — *Apiculati* (Benn. & Kidst.) Pot. 1956
Subinfraturma — *Granulati* Dyb. & Jach. 1957

Genus — *Granulatisporites* (Ibr.) Pot. & Kr., 1954

Type species — Granulatisporites granulatus Ibr., 1933.

Granulatisporites sp.

Pl. 1, Fig. 2

Description — Miospore triangular, 44 μ in size; sides convex, apices bluntly rounded; trilete mark distinct, rays slightly wavy, reaching apices, accompanied by thin folds; exine thin, ornamentation granulose, grana uniformly and closely distributed.

Remarks — *Granulatisporites granulatus* Ibr. (1933) and *G. parvus* (Pot. & Kr.) Pot. & Lele (1961) lack folds along the trilete rays. *G. orbiculus* (Pot. & Kr.) Pot. & Lele (1961) differs in having subtriangular shape.

Genus — *Horriditriletes* Bharadwaj & Salujha, 1964

Type species — Horriditriletes curvibaculosus Bharadw. & Salujha, 1964.

Horriditriletes sp.

Pl. 1, Fig. 3

Description — Miospores roundly triangular with convex inter-radial sides and rounded apices, 43-47 μ in size; trilete mark indistinct; exine ornamented with 1-2 μ broad and 2-5 μ long bacula with bluntly conical to truncate or rarely ± spathulate tips, 12-15 bacula along margin. Figured specimen obliquely preserved (± laterally) with one overlapping arm.

Remarks — These specimens compare with *Horriditriletes* sp. *B* of Bharadw. & Salujha (1964) but differ in having lesser number of bacula and in the variability of the shape of element.

Subinfraturma — *Varitrileti* Venkatachala & Kar, 1965

Genus — *Microfoveolatispora* Bharadwaj, 1962

Type species — Microfoveolatispora raniganjensis Bharadw., 1962.

Microfoveolatispora directa (Bal. & Henn.) Bharadw., 1962

Pl. 1, Fig. 4

Lectoholotype — Balme & Hennelly; 1956a, p. 244, Pl. 1, Fig. 2.

Remarks — These specimens differ from those described by Bharadwaj (1962) and Balme and Hennelly (1956a) in having faint secondary folds along the trilete mark. The size range of the species (23-36 μ) as given by the original authors is quite different from that of Bharadwaj (36-80 μ). The present specimens fall within the latter range. Bharadwaj (1962, Pl. 2, Fig. 47) selects one of his own specimens (Pl. 2, Fig. 47) as holotype of this species which is not permissible under the International Code of Botanical Nomenclature. Henceforth, the specimen on Pl. 1, Fig. 2 of Balme and Hennelly (1956a) is designated as the lectoholotype of *Microfoveolatispora directa* (Balme & Hennelly) Bharadwaj.

Turma — *Zonales* (Benn. & Kidst.) Pot. 1954
Subturma — *Zonotriletes* Waltz, 1935
Infraturma — *Cingulati* Pot. & Klaus, 1954

Genus — *Dentatispora* Tiwari, 1964

Type species — Dentatispora indica Tiwari 1964.

cf. *Dentatispora*

Pl. 1, Fig. 5

Description — Single miospore, trilete, cingulate, 50 × 55 μ in size; cingulum crenate, ± 5 μ wide, thick, unevenly broad; trilete mark distinct, rays almost reaching body margin, somewhat wavy; central body exine proximally ± smooth, infrastructure indeterminable, distally crowded with globose to conical projections having pointed tips, 4-6 μ long × 2-5 μ broad, elements ± confluent at base, thin inner body present.

Remarks — The genotype *Dentatispora indica* Tiwari differs in having longer trilete rays and conical to verrucate distal ornament. The sculptural make-up of the present specimen is somewhat complex. Its reference to *Dentatispora* is only provisional.

Anteturma — *Pollenites* Pot. 1931
Turma — *Saccites* Erdtman, 1947
Subturma — *Monosaccites* (Chitaley) Pot. & Kr. 1954
Infraturma — *Apertacorpiti* Lele, 1964

Genus — *Plicatipollenites* Lele, 1964

Type species — Plicatipollenites indicus Lele, 1964.

Plicatipollenites densus Srivastava 1970

Pl. 1, Figs. 6-7

Description — Miospores 70-112 × 80-115 μ in size, mostly circular, sometimes subcircular, outline smooth to slightly wavy; central body dense, circular to subcircular, size range 50-72 × 55-70 μ, distinctly intramicroreticulate; trilete mark distinct rays ± equal, 1/2-2/3 central body radius long, rarely up to 2/5 radius long; saccus broad, width ± 1/2 radius of central body, ± frilled, frills very narrow and closely placed.

Comparison — The grains are closely similar to those of the type material except that their body size and saccus-width are comparatively greater.

Plicatipollenites stigmatus sp. nov.

Pl. 1, Fig. 8

Diagnosis — Size range 75-100 × 115-140 μ, circular to subcircular, body 60-100 × 80-110 μ, thin, shape similar to spore outline,

intramicroreticulum imperfect, trilete mark clear, rays ± 1/2 body radius, contact area differentiated as a ± denser, swollen up zone of sharp to diffused outline with relatively coarser and more irregular exine structure, secondary folds may develop in the contact area, more often near periphery; saccus narrow, width about 1/3-1/2 body radius, distal overlap narrow, associated with a weak subequatorial body-infold; saccus intrareticulum ± fine.

Holotype — Pl. 1, Fig. 8.

Locality — Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower Intercalation).

Description — The species is characterized by the development of a (?) contact area which is differentiated from the rest of the proximal exine by its denser and unevenly swollen appearance. The intramicroreticulum of this area is also coarser, irregular and more imperfect, often approaching a vermiculoid pattern. The contact area may be equal to or larger than the inter-ray area and is rather variable in outline. The body is large in relation to the saccus width and the distal infold is thin and weakly developed near the equator. The mark may be eccentric and may have assymetric rays.

Comparison — The known species of *Plicatipollenites* lack a differentiated contact area.

Plicatipollenites maculatus sp. nov.

Pl. 1, Fig. 9

Diagnosis — Size range 140-170 × 100-156 μ, circular to subcircular; body 65-90 × 100-115 μ, distinct, outline variable, secondary, folds present, intramicroreticulate; trilete mark weak, rays 1/3-1/2 body radius; saccus structure strong, reinforced by double reticulum, distal overlap of saccus deep, attachment zone irregular in shape; often ± eccentric, associated with prominent infold system of irregular shape.

Holotype — Pl. 1, Fig. 9.

Locality — Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower intercalation).

Description — The central body is distinct, occasionally somewhat denser but the exine is rather susceptible to compression folds which may obscure the trilete mark. The saccus shows a strong network of wide muri (4-10 μ wide) enclosing finer reticulum. The structure is occasionally more compact near saccus periphery. The saccus is inserted deep on the distal side of the body, the overlap ranging from 20-45 μ. Eccentric position of attachment zone apparently results from the tendency of oblique compression.

Comparision — *Plicatipollenites gondwanensis* (Balme & Henn.) Lele (1964) shows a somewhat deep distal saccus overlap but lacks a double reticulum in the saccus. *P. magnus* Tiwari (1965) is distinguishable by its regular subtriangular shape, circular saccus outline and nearly triangular saccus attachment distally. Other species of *Plicatipollenites* lack deep distal saccus attachment as well as a double saccus reticulum.

Infraturma — *Parasacciti* Maheshwari, 1967

Genus — *Parasaccites* Bharadwaj & Tiwari, 1964

Type species — *P. korbaensis* Bharadwaj & Tiwari, 1964.

Parasaccites sp. A.

Pl. 1, Fig. 10

Description — Some circular – oval specimens are characterized by a dense body, ± distinct mark and a ± wide saccus with heavy, overlapping, radial pleats; intrareticulum fine to obscure. Known *Parasaccites* species lack a dense body and heavily frilled bladder. Identical forms occur abundantly in the Talchir Needle Shales underlying the Lower Boulder Bed intercalation (Sample 34074).

Genus — *Tuberisaccites* Lele & Karim (in press)

Type species — *T. varius* Lele & Karim.

Tuberisaccites varius Lele & Karim

Pl. 1, Fig. 11

The figure of the genotype of *Tuberisaccites* along with its salient features were given by Lele & Karim (1969) in a short note as a prelude to the main paper awaiting publication.

In their original paper (manuscript in press), Lele and Karim define *Tuberisaccites*

as follows — "Monosaccate miospores, mostly radially symmetrical; body intra-microreticulate, trilete mark not observed, surface of body bearing conspicuous protuberances which are variable in number and shape, separate or coalescent; saccus showing paracondition of amphilateral attachment, structure obscure due to ± fleshy appearance of the saccus; saccus margin smooth, undulated or lobate, surface flat or frilled ".

In the Talchir Boulder Bed intercalations *Tuberisaccites* is very rare. A good example is figured here, showing a single central protuberance on the body. Similar grains are also found in the type-material. They are easily distinguished from *Plicatipollenites stigmatus* sp. nov. (Fig. 8) by the paracondition of saccus attachment and the absence of a body-infold system and probable lack of a tetrad mark.

Genus — *Caheniasaccites* Bose & Kar, 1966

Type species — *C. fiavatus* Bose & Kar, 1966.

Caheniasaccites densus sp. nov.

Pl. 1, Figs. 12, 13

Diagnosis — Miospores oval, disaccoid to monosaccate, 48-66 μ × 90-120 μ in size; central body dense, circular-oval, 34-50 μ × 34-66 μ in size; mark ± weak; saccus continuity much narrower along shorter axis, amphilateral attachment zones diffuse, sub-circular, saccus variably frilled.

Holotype — Pl. 1, Fig. 12.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower Intercalation, Sample 34074).

Description — Monosaccate miospores with very narrow (2-6 μ wide) lateral continuity, haploxylonoid, occasionally diploxylonoid; central body circular, subcircular or horizontally oval, dense, exine mostly smooth, occasionally fine intra-microreticulate; body margin may show a ± continuous rim; monolete mark weakly developed or absent; straight to bent; proximal saccus attachment relatively more diffused and closer to body periphery than distal attachment; saccus reticulation fine, muri radially arranged; frills variably present; occasionally more closely packed along lateral side.

Comparison — The species is characterized by a dense central body, so far unknown in the described species of *Caheniasaccites*.

Infraturma—*Vesiculomonoraditi* (Pant) Bharadwaj, 1954

Genus — *Vestigisporites* (Balme & Hennelly) Hart, 1960

Type species — *V. rudis* Balme & Hennelly, 1955.

Vestigisporites nigratus sp. nov.

Pl. 2, Figs. 14, 15

Diagnosis — Size range 45-55 × 80-100 μ, ± diploxylonoid, disaccate to monosaccoid, body 34-45 × 46-55 μ, dense, horizontally oval to subcircular, often with a peripheral rim (up to 2 μ wide), monolete mark short, weak, smooth to intramicroreticulate, sacci hemispherical or more, separate or laterally connected by a thin strip, distal attachment zone ± diffused, apparently straight, leaving 8-14 μ wide channel; saccus structure fine.

Holotype — Pl. 1, Fig. 14.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower Intercalation).

Description — The forms are typically disaccate and diploxylonoid, occasionally with narrow lateral connectives. Monosaccoid forms are rare. The body is thick (± 2 μ) and often horizontally oval. The density of the body obscures its structure which is probably finely intramicroreticulate.

Comparison — *Vestigisporites densus* Singh (1964) differs in having a small central body and a large monosaccus. *V. novus* Tiwari (1965) is haploxylonoid and monosaccate.

Genus–*Potonieisporites* Bharadwaj (1954) 1964

Type species — *Potonieisporites novicus* Bharad. 1954.

Potonieisporites magnus sp. nov.

Pl. 2, Fig. 16

Diagnosis — Miospores monosaccate, 110-140 μ × 160-180 μ in size; central body outline distinct, vertically oval, 90-100 μ × 105-120 μ in size; monolete mark ± clear; saccus narrow to broad along the shorter axis, folds near the margin of central body.

Holotype — Pl. 2, Fig. 16.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Upper intercalation).

Description — Miospores monosaccate, bilaterally oval; body vertically oval to rhomboid, exine intramicroreticulate; monolete mark distinct, straight, 25-37 μ long; saccus distinctly narrow (3-14 μ wide) along the shorter axis, distal attachment accompanied by two semilunar vertical folds or a fold rim near the central body margin; saccus reticulation coarse.

Comparison — The present species shows some resemblance with *Potonieisporites barrelis* Tiwari (1965) but differs in having a vertically oval central body with rounded ends. *P. lelei* Maheshwari (1967) differs in having a ± circular central body whereas *P. neglectus* Potonié & Lele (1961) differs in having a horizontally oval to trapezoid central body. *P. jayantiensis* sp. nov. has a dense, sub-hexagonal central body.

Potonieisporites jayantiensis sp. nov.

Pl. 2, Figs. 17, 18

Diagnosis — Size range 70-100 μ × 110-145 μ, haploxylonoid, body 60-70 μ × 60-85 μ, sub-hexagonal, distinct, often denser than saccus, intramicroreticulate, monolete ± clear, straight to bent, saccus laterally narrow (2-10 μ), distal saccus attachment associated with generally two convex to ± straight, prominent body infolds, distal saccus-free area ± wide; saccus structure fine to medium.

Holotype — Pl. 1, Fig. 17.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower intercalation).

Description — The monosaccate nature of the grains is indicated by the persistent, though narrow, lateral continuity of the saccus and the haploxylonoid form. The shape of the body is apparently influenced by compression, its outline grading from hexagonal to rhomboidal with variable amount of roundedness. The distal body infold system consists of usually two ± convex taper-pointed folds; each fold may often reveal 2-3 smaller components. Where the convexity of the folds is accentuated, the fold-system tends to close near one or both lateral ends. Occasionally the folds may be almost vertically straight.

Comparison — Comparable forms with dense body are *Potoniéisporites bilateralis* Singh (1964) and *P. congoensis* Bose & Maheshwari (1968). The former species differs in having an oval (probably subtriangular) body and in the nearly peripherial disposition of the body infolds. The latter species differs in having a horizontally oval body and a rectangular infold system.

Genus — *Rimospora* Lele & Maithy, 1969

Type species — *R. rimosa* Lele & Maithy, 1969.

cf. *Rimospora* sp.

Pl. 2, Fig. 19

Description — Miospore monosaccate, bilateral oval, 56-102 μ in size; central body subcircular, 46 × 48 μ in size; exine thin, intramicroreticulate, polygonal areas (3-6 μ wide) on both sides of body exine, saccus much narrower along shorter axis, muri showing double intrareticulation; distal body infold obscure, mark indeterminable but probably present.

Remarks — In the saccus attachement and polygonal areas, the specimen agrees with *Rimospora*, but differs in the lack of definite body-infolds and the apparent presence of saccus double reticulation.

Subturma — *Disaccites* Cookson, 1947
Infraturma — *Disaccitrileti* Leschik, 1955

Genus — *Illinites* (Kos.) Pot. & Kr., 1954

Type species — *Illinites unicus* Kosanke, 1950.

Illinites notus sp. nov.

Pl. 2, Figs. 20, 21

Diagnosis — Miospores disaccate, ± haploxylonoid, 40-45 μ × 60-67 μ in size; central body dense, circular with a marginal rim, 36-40 μ in size; trilete mark distinct; distal saccus attachment indistinct, saccus free area wide; saccus intrareticulation fine.

Holotype — Pl. 2, Fig. 20.

Type locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower Intercalation).

Description — Miospores disaccate, haploxylonoid, rarely diploxylonoid; central body dense, uniformly thick with a 1-4 μ broad marginal rim, exine intramicroreticulate; inter-ray area may be smooth (as in Holotype) trilete mark short, distinct, rays may be unequal (often two longer than the third); sacci ± hemispherical rarely narrow (crescent shaped), sometimes laterally continuous, distal zones of saccus attachment indistinct, ± straight to widely biconvex, sacci intrareticulation fine.

Comparison — *Illinites notus* sp. nov. resembles *I. parvus* Klaus (1963) *I. gamsi* Klaus (1963) *I. bentzi* Klaus (1963) in the absence of distal infolds of central body. However, all of them lack a dense body, besides other differences in the body structure.

Infraturma — *Disaccimonoleti* Klaus, 1963

Genus — *Limitisporites* Leschik, 1956

Type species — *Limitisporites rectus* Leschik, 1956.

Limitisporites diversus sp. nov.

Pl. 2, Figs. 22, 23

Diagnosis — Miospores disaccate, haploxylonoid, bilaterally symmetrical, 37-55 μ × 70-95 μ in size; central body 36-55 μ × 36-60 μ in size, shape very variable, exine intramicroreticulate; monolete ± long, distinct, lips often developed; distal sulcus broad, distal saccus attachment ± straight and associated with vertical folds.

Holotype — Pl. 2, Fig. 22.

Type locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower Intercalation).

Description — Miospores disaccate, oval; central body slightly darker than sacci, exine ± 1 μ thick, intramicroreticulate; shape considerably variable from subcircular, rhomboidal, subhexagonal to nearly vertically oval, monolete mark ± straight, 12-20 μ long, often associated with lips or folds which may overlap the mark on compression; distal saccus attachment ± straight to convex and usually associated with two vertical semilunar folds ± near margin of central body, distal sulcus broad, width 1/2-2/3 of central body radius, sacci hemispherical or more, intrareticulation fine.

Remarks — Very narrow fringe of saccus (1-2 μ wide) is sometimes seen laterally around the central body but the bisaccate nature of the spores is definite.

Comparison — This species differs from *Limitisporites rectus* Leschik (1956) in being larger and in the development of lips in the monolete mark and in the more widely spaced sacci attachment zones. *L. hexagonalis* Bose & Maheshwari (1968, Pl. 15, Fig. 4) is much larger.

Limitisporites elongatus sp. nov.

Pl. 2, Fig. 24; Pl. 3, Fig. 25

Diagnosis — Size range 110-135 μ × 60-75 μ, haploxylonoid, outline usually elongated oval; body horizontally oval to subcircular, 60-80 μ × 50-60 μ dense, often with a peripheral rim, smooth to indistinctly intramicroreticulate; monolete mark simple, straight to bent; distal saccus attachment associated with two widely placed vertical folds; sacci hemispherical or more, often horizontally expanded, may be laterally continued by a thin strip up to 6 μ wide, intrareticulum fine to medium.

Holotype — Pl. 2, Fig. 24.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower intercalation).

Description — Spores are characterized by their horizontally elongated oval appearance and a dense, ± horizontally oval body. The distal body infolds may be straight to ± convex and are generally wide apart.

Comparison — *Limitisporites monosaccoides* Bose and Maheshwari (1968) compares in overall shape but differs in the lack of a dense central body. *Limitisporites diversus* sp. nov. is smaller, has a ± subhexagonal body of rather variable outline and the monolete is ± sharp and shows frequent lip-development.

Genus — *Gigantosporites* Klaus, 1963

Type species — *Gigantosporites hallstatlensis* Klaus, 1963.

Gigantosporites indicus sp. nov.

Pl. 3, Fig. 26

Diagnosis — Miospores disaccate, diploxylonoid, 62-90 μ × 107-132 μ in size;

central body dense, 62-75 μ × 62-77 μ in size; exine intramicroreticulate; monolete present to absent; sacci hemispherical or more, saccus intrareticulation double.

Holotype — Pl. 3, Fig. 26.

Type locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower intercalation).

Description — Miospores bilateral, oval; central body distinct, dense, subcircular, exine thick, intramicroreticulate, proximally sometimes with a horizontal slit like structure, central body with a wavy, about 1 μ thick, equatorial rim, surface somewhat wrinkled; sacci distally inclined and sometimes laterally continuous; lateral connectives very narrow, zones of distal attachment ± distinguishable, straight and associated with narrow body infolds, distal sulcus ill-defined but wide, saccus intrareticulation double comprising 5-10 μ broad meshes enclosing fine meshes.

Comparison — The present spores agree with the genus *Gigantosporites* in that they are distinctly disaccate, the central body has a clear horizontal slit and the saccus double reticulum shows large meshes enclosing smaller ones. The Talchir species is, however, distinct from all the three known species of the genus *Gigantosporites* in having a darker central body which often shows a thick equatorial rim.

Remarks — *Gigantosporites* was originally recorded from the Permian of Southern Alps. The Talchir species constitutes the first record of the genus from the Lower Gondwana of India.

Infraturma — *Disacciatrileti* (Leschik) Pot., 1958

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

Type species — *V. wilsoni* Schemel, 1951.

Vesicaspora sp. A.

Pl. 3, Fig. 27

Diagnosis — Rare specimens, figured example broadly oval, haploxylonoid, size 120-94 μ; body outline ill-defined, apparently vertically oval, size 50-84 μ, exine intramicroreticulate, sacci ± crescent-shaped, laterally coming close or often continued by a thin connective, saccus ± coriaceous, surface uneven, structure indistinct, distal attachment ill-defined, apparently close to body periphery, leaving a broad channel.

Remarks — *Vesicaspora wilsonii* Schemel (1951) is smaller and has a spherical, finely granulose body. The thick texture and indistinct structure of the sacci distinguish the present specimen from *Vesicaspora distincta* Tiwari (1965) and *V. indica* Tiwari (1965).

Subturma —*Disaccites* Cookson, 1947
Infraturma — *Podocarpoiditi* Pot. Thomson & Thierg. 1950

Genus — *Valiasaccites* Bose & Kar, 1966

Type species — *Valiasaccites validus* Bose & Kar, 1966.

Valiasaccites densus sp. nov.

Pl. 3, Figs. 28, 29

Diagnosis — Miospores disaccate, 30-45 μ × 70-100 μ in size; central body horizontally oval, dense, 40-60 μ × 28-40 μ in size; exine intramicroreticulate, lateral folds usually two in number, parallel to longer axis.

Holotype — Pl. 3, Fig. 28.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed. (Lower intercalation).

Description — Central body distinct, dense, folds (' lateral ridges ' in the description of Bose & Kar, 1966) prominent, usually two in number, sometimes one (Pl. 2, Fig. 21), parallel to longitudinal axis of central body; exine intramicroreticulate, distal saccus attachment obscure, not associated with any vertical infolds, distal sulcus broad, sacci more than hemispherical, saccus reticulation fine.

Comparison — *Valiasaccites densus* differs from *V. validus* (genotype) and *V. elilaensis* Bose & Kar, 1966 in having darker central body and in lacking vertical folds. *Valiasaccites* sp. (Kar & Bose, 1967; Pl. 8, Fig. 3) may belong to *V. densus* sp. nov.

Valiasaccites indicus sp. nov.

Pl. 3, Figs. 30, 31

Diagnosis — Miospores oval with slight constriction in the middle, 60-70 μ × 120-132 μ in size; central body oval, 65-80 μ

× 50-60 μ in size, exine intramicroreticulate; 1-2 horizontal folds on central body, distal sacci attachment associated with prominent body infolds.

Holotype — Pl. 3, Fig. 30.

Type locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower intercalation).

Description — Miospores disaccate, oval with slight constriction in the middle, lateral continuity of saccus occasionally seen, sometimes 3 μ broad; central body distinct, horizontally oval with a tendency to become ± hexagonal, body exine generally intramicroreticulate, without any vermiculate or reticuloid pattern, 1-2 horizontal folds (so-called, "ridges" of Bose and Kar) across the body in the middle part, no mark present; distal attachment associated with prominent body infolds, distal saccus free area broad, ± half of longer axis of central body, sacci hemispherical or more, reticulum fine to medium, muri somewhat radially orientated.

Comparison — *Valiasaccites densus* sp. nov. differs from this species in having a dense central body. *V. validus* Bose & Kar (1966) has ± rectangular central body. *V. elilaensis* is ± rectangular in overall shape and distal infolds are not so prominent.

Infraturma — *Striatiti* Pant, 1954

Genus — *Strotersporites* Wilson, 1962

Type species — *S. communis* Wilson, 1962.

Strotersporites rhombicus sp. nov.

Pl. 3, Figs. 32, 33

Diagnosis — Miospores disaccate, 100-140 μ × 60-85 μ in size; central body distinct, ± dense, hexagonal to ± rhomboid, 52-80 μ × 60-80 μ in size; proximally bearing 7-9, mostly simple horizontal striations, median laesura discernible, may be associated with folds, distal saccus attachment zones distinct, straight to convex.

Holotype — Pl. 3, Fig. 32.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower intercalation).

Description — Miospores haploxylonoid, bilateral central body distinct with a 1-2 μ thick marginal rim, typically rhomboid, but in some example the lateral ends may be flattened to various degree on compression (Pl. 3, Fig. 33) producing a subhexagonal shape; exine in between the striations intramicroreticulate; striations rarely branched or with vertical connections, a median slit-like structure observed in several specimens on the proximal body exine; sacci usually more than hemispherical, distal saccus attachment associated with vertical semilunar to lenticular infolds of central body, distal sulcus, 8-25 μ broad, saccus intrareticulation medium to coarse.

Comparison — The known species either lack a dense central body or differ in the body outline.

Strotersporites sp.

Pl. 3, Fig. 34

Description — Few specimens, figured example 78 × 90 μ, outline subcircular; body distinct, large, 68 × 76 μ, rhomboid with slightly flatter lateral ends, proximally bearing 7-9 weak striations and a ± clear median lasura; sacci sub-hemispherical, ± crescent-shaped, overlap exceeds offlap, distal channel ± narrow, saccus intrareticulum medium, muri strong.

Remarks—Specimens show some resemblance with *Strotersporites rhombicus* sp. nov. However, it is preferred to keep this type distinct in view of its subcircular outline, larger body and narrow, crescent-shaped sacci. *Strotersporites* sp. (Maithy, 1966, Pl. 4, Fig. 27) shows a comparable body/saccus relationship but differs in being larger and in having a thinner body.

Genus — *Faunipollenites* Bharadwaj, 1962

Type species — *F. varius* Bharadwaj, 1962.

Faunipollenites sp.

Pl. 3, Fig. 35

Description — Specimens rare, figured example 64 × 44 μ, bilateral; body thin, indistinct, probably large in relation to sacci, proximally bearing about 12 striations, distal attachment of sacci well-defined, straight, leaving about 20 μ wide channel.

Remarks — *Faunipollenites prexiguus* Bharadwaj & Salujha (1964) is subcircular and the distal channel is extremely narrow. *Faunipollenites parvus* Tiwari (1965) and

Faunipollenites varius Bharadwaj (1962) differ in their obscure zones of distal saccus attachment.

Subturma — *Palysaccites* Cookson, 1947

Genus — *Crustaesporites* Leschik, 1956

Type species — *C. globosus* Leschik, 1956.

Crustaesporites sp.

Pl. 3, Fig. 36

Description — Solitary specimen, size about 72 μ, roundly triangular; body dense, intramicroreticulate, roundly triangular, size 64 × 56 μ; 3-4 thin striations decipherable on one surface; sacci three, subhemispherical to crescent-shaped, subequatorially attached, laterally ± continuous.

Group — *Acritarcha* Evitt 1963
Subgroup — *Sphaeromorphitae* Downie Evitt & Sargeant 1963

Genus — *Leiosphaeridia* (Eis.) Downie & Sargeant 1963

Type species — *L. baltica* (Eisenack) Downie & Sargeant 1963.

Leiosphaeridia talchirensis sp. nov.

Pl. 3, Figs. 37, 38

Diagnosis — Vesicles ± circular, 32-45 μ × 35-50 μ in size; tetrad mark absent, exine thin, smooth to fine infrapunctate, strongly folded, folds irregular; pilome not seen.

Holotype — Pl. 3, Fig. 37.

Locality — Patharjore Nala, Jayanti Coalfield, Bihar.

Horizon — Talchir Boulder Bed (Lower Intercalation).

Description — Vesicles thin-walled with irregularly arranged strong folds, wall intrapunctation, minute and indistinct.

Comparison — These microfossils of uncertain affinity are best referable to the achritarch genus *Leiosphaeridia* on grounds of general similarity. Among the known Indian Lower Gondwana species, *Leiosphaeridia crescentica* Sinha, 1969 differs in having a regular semicircular fold.

CONCLUSIONS

Quantitative Analysis

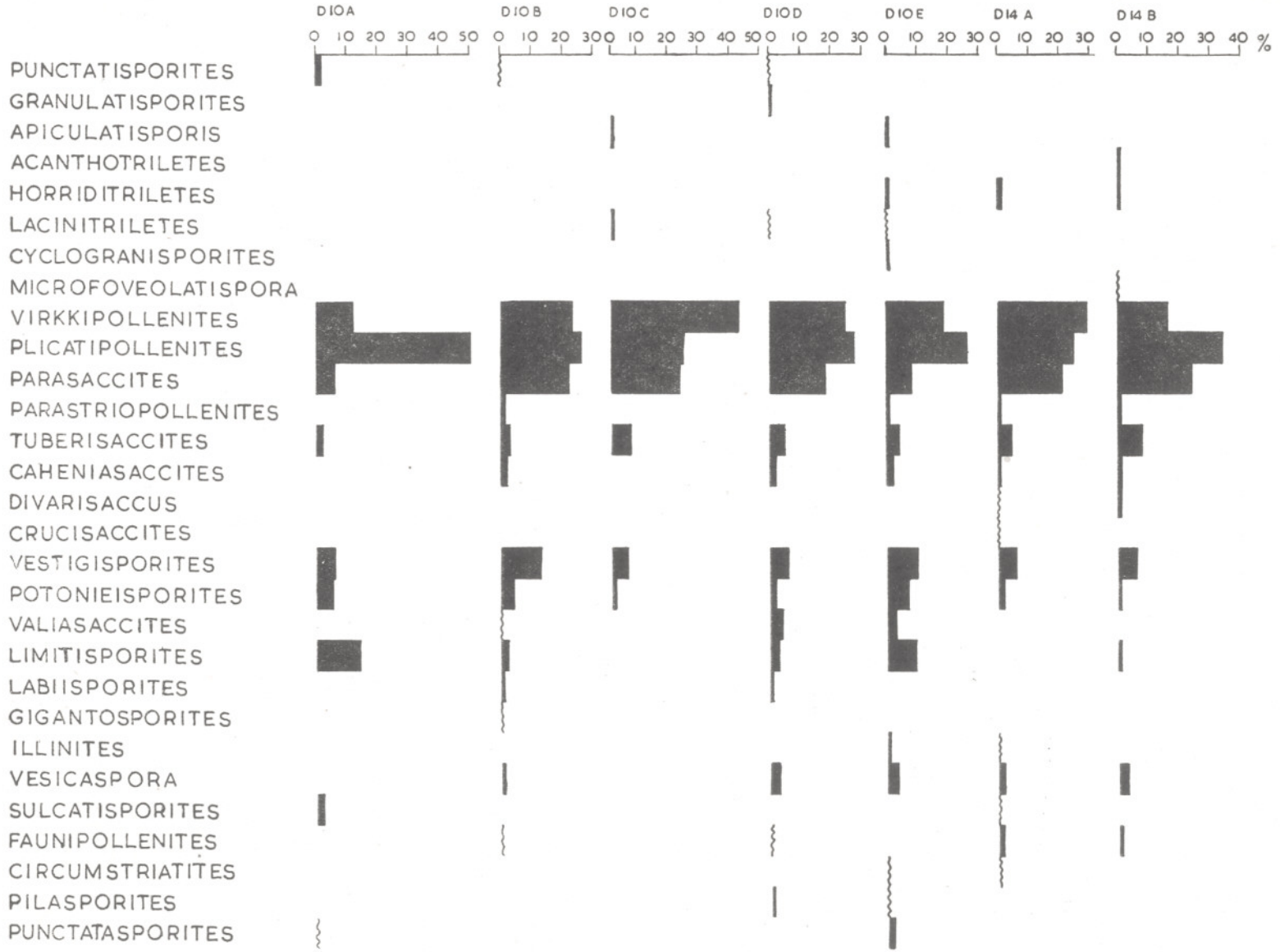
The miospore assemblages of the two intercalated Talchir Boulder Beds comprise a total of 59 recognizable species and 40 genera. The distribution of the genera in the different samples of the two beds is shown in Text-fig. 2. It will be noticed that the distribution pattern of the genera in the five samples of the Lower Boulder Bed (D10) is not similar; the difference is more striking between samples D10A and the rest. The pattern of distribution in two samples of the Upper Boulder Bed (D14) shows more uniformity. The composition of the major taxonomic groups (Text-fig. 3) reveals that in all the samples monosaccates or disaccates (with trilete to monolete mark) occupy a dominant position, being represented by 76 to 98 per cent of the total population. Striate or non-striate disaccates have a subordinate representation while triletes, aletes and monocolpates are very scanty. The two boulder beds are therefore microfloristically interlinked in a broader sense.

The following genera are present in all the samples of the two beds (D10 and D14) and are quantitatively important — *Virkkipollenites, Plicatipollenites, Parasaccites, Tuberisaccites, Vestigisporites* and *Potonieisporites*. Next in significance are *Caheniasaccites, Limitisporites* and *Vesicaspora*.

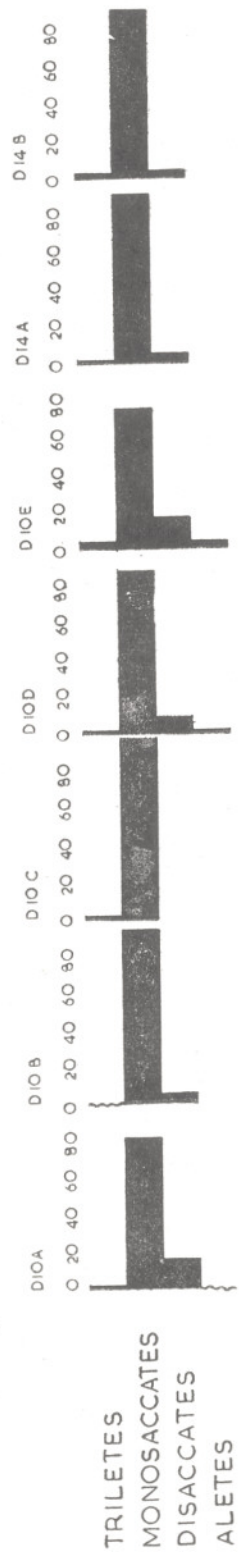
As far as we have examined, the following genera are present in low proportions in the Lower Boulder Bed (D10) but have not been found in the Upper Boulder Bed (D14) : *Punctatisporites, Valiasaccites, Labiisporites* and *Gigantosporites*. On the contrary, the following genera are apparently confined to the Upper Boulder Bed (D14) : *Microfoveolatispora, Acanthotriletes, Divarisaccus* and *Crucisaccites*. Their representation is however very low.

The following genera are quantitatively significant in particular samples : *Punctatisporites, Parastriopollenites, Valiasaccites, Sulcatisporites* and *Leiosphaeridia*.

Genera of insignificant occurrence are *Granulatisporites, Apiculatisporis, Acanthotriletes, Horriditriletes, Lacinitriletes, Cyclogranisporites, Microfoveolatispora, Divarisaccus, Crucisaccites, Labiisporites, Gigantosporites, Illinites, Faunipollenites, Circumstriatites* and *Pilasporites. Leiotriletes,*



TEXT-FIG. 2 — Percentage frequencies of significant genera in the samples of the two Boulder Bed Intercalations.



TEXT-FIG. 3 — Composition of the major taxonomic groups in the samples of the two Boulder Bed intercalations.

Callumispora, Hennellysporites, Verrucosisporites, Brevitriletes, Dentatispora, Rimospora, Stroterspories, Ginkgocycadophytus and *Crustaesporites* did not appear in counting.

Qualitative Analysis

The monolete mark shows considerable variation (from straight to bent) in specimens of *Limitisporites* which are otherwise identical. In view of this separation between *Limitisporites* and *Jugasporites*, as maintained by Klaus, was found impracticable. We have also preferred to assign all such specimens to *Potonieisporites* which consistently show a monosaccate tendency in having a recognizable lateral continuity of the saccus although the body infold system may tend to be bilateral. Obviously certain larger *Limitisporites* forms with imperfect development of lateral connectives between the two sacci tend to approach *Potonieisporites*. The assemblage has, however, typical *Limitisporites* of smaller size. *Illinites* has been maintained on the basis of noticeable trilete mark. *Gigantosporites*, a northern hemisphere genus, is for the first time recorded from the Gondwana sediments.

Comparison — The best known Talchir spore assemblage is from the needle shales of Johilla Coalfield, South Rewa Gondwana basin. Following genera are common to the present assemblage and to the Johilla assemblage (Potonié & Lele, 1961; Lele, 1964, 1965, 1966; Bharadwaj, 1966) : *Leiotriletes, Punctatisporites, Granulatisporites, Horriditriletes, Cyclogranisporites, Apiculatisporis, Parasaccites, Virkkipollenites, Plicatipollenites, Potonieisporites, Vestigisporites, Faunipollenites, Labiisporites, Vesicaspora* and *Sulcatisporites*.

Following genera reported by Potonié & Lele (1961) and Lele (1966) are absent in the present assemblage : *Lophotriletes, Quadrisporites, Pityosporites, Protohaploxy pinus* and *Succinctisporites*.

The Giridih assemblage (Lele, 1966) has following genera in common with the present assemblage : *Leiotriletes, Punctatisporites, Granulatisporites, Apiculatisporis, Plicatipollenites, Virkkipollenites, Punctatasporites, Potonieisporites, Vestigisporites* and *Crucisaccites*.

The miospore assemblage recorded from the Dudhi river section (Lele, 1966) has

following genera in common with the present assemblage : *Apiculatisporis, Punctatasporites* (probably *Leiosphaeridia*), *Plicatipollenites, Virkkipollenites, Parasaccites* and *Potonieisporites*.

Following 23 genera are being reported for the first time from the Talchir Stage, viz. *Callumispora, Hennellysporites, Lacinitriletes, Acanthotriletes, Microfoveolatispora, Brevitriletes,* cf. *Dentatispora, Rugasaccites, Rimospora, Parastriopollenites, Tuberisaccites, Caheniasaccites, Divarisaccus, Valiasaccites, Limitisporites, Gigantosporites, Illinites, Circumstriatites, Stratersporites, Crustaesporites, Ginkgocycadophytus Pilasporites* and *Leiosphaeridia*.

The above comparisons show that the Jayanti assemblage is broadly comparable with other assemblages in the general prevalence of monosaccate taxa. However, the parallelism does not go any further in view of the fact that the Jayanti mioflora has for the first time revealed as many as 23 new elements. A number of these new elements, especially, *Caheniasaccites* and *Limitisporites* are quite significant from quantitative standpoint. Other types are represented in very low proportions but their presence is qualitatively important in making the assemblage sufficiently distinct from other Talchir miofloras.

As regards assemblages from other parts of Gondwanaland, comparisons can be drawn in a general way between the Jayanti mioflora and the Baccus Marsh Tillite assemblage (Virkki, 1946; Pant and Mehra, 1963) in the characteristic dominance of the monosaccates and poverty of other groups. The same is true for the mioflora from Assise glaciares et periglaciares at Fundi Sadi Congo (Bose and Kar, 1966). The Epulu River assemblage probably equivalent of the Talchir Stage from Congo (Bose and Maheshwari, 1966) is so far poorly known to permit detailed comparisons.

Biostratigraphical Considerations

Sahni (1939) believed that the earlier phases of the Glossopteris flora overlapped with the later phases of Gondwana glaciation. Although this appears to have been the case, no concrete evidence, especially from the Talchir Boulder beds had so far been found to substantiate Sahni's contention. Thus the present discovery of spores and pollen from the Talchir boulder beds of Jayanti Coalfield is full of biostratigraphical and palaeobotanical interest.

Firstly, in the Jayanti basin, the Talchir boulder beds occur in repetitions, a feature known in some other areas as well (Lele, 1966). Secondly, the sequence, as far as is known in the Patharjore Nala, indicates that the Talchir Boulder bed intercalations (two of which are recognizable), do not form the base of the Talchir formation, for the sequence begins with a few alternations of Talchir shales and fine-grained sandstones. In view of the faulted nature of the Talchir-Metamorphic contact, it is very likely that the basal sequence of the Talchirs is concealed in the Patharjore nalla. If this surmise is correct, the two Talchir boulder beds (containing the mioflora) would appear to be much above the real base of the Talchir Stage.

In the neighbouring Bhagdaru Nala and Ghusko Nala sequences, there are more than two boulder bed intercalations which indicates that here the sequence exposes more sediments than in the Patharjore Nala. Unfortunately, however, the sediments including the boulder beds of these neighbouring nalas have so far proved barren of miospores. This difficulty has precluded palynological correlation of the Patharjore Nala beds with those of the Bhagdaru and Ghusko sections. Further attempts, both palynological and otherwise, are being continued to relate the Talchir sequence in the three nala sections.

As regards the boulder beds of Patharjore Nala, it has been pointed out in the introduction that the geological aspects of these sediments indicate a predominantly fluviatile or at the most a fluvioglacial environment. There is no direct evidence of glacial activity. The more or less stratified and current-bedded nature of the boulder sediments cannot be mistaken. Moreover, the presence of thin black layers which are composed of abundant vegetable debris indicate a favourable habitat for the growth of plants in the neighbouring region. Generally larger plants have not been preserved, except for stems, etc., but apparently considerable plant matter has floated down and deposited at quieter intervals during the Boulder Bed sedimentation. It is therefore not surprising to find microremains such as spores and pollen in the boulder bed matrixes and in sediments

above or below them in the Patharjore sequence. Such palynological evidence may, therefore, have little direct value with regard to the question of the coexistence of the Glossopteris flora and the Glaciation.

The miospore assemblage of the two boulder beds is peculiar to itself as is evident from its comparison with known Talchir miofloras of South Rewa or with those of the neighbouring field of Giridih. The Jayanti boulder bed assemblage has 23 new taxa, hitherto unknown from the Talchirs. Their incidence is admittedly very modest or even insignificant, but what is more interesting is that some of these taxa, notably *Callumispora, Hennellyisporites, Microfoviolatispora, Brevitriletes, Lacinitriletes,* cf. *Dentatispora, Rugasaccites, Parastriopollenites, Divarisaccus,* are more familiar constituents of the younger miofloras (Karharbari-Barakar) which developed in a gradually warming climate.

The presence of the above mentioned miospore elements in the Boulder Beds raises some questions of stratigraphical and palaeo-environmental interest. Stratigraphically, the taxa seem to give a younger look to the Boulder Bed assemblages indicating probably a higher position of the strata in the Talchir Stage, as is also surmised from field geological observations. At the same time, it is not improbable that such peculiarities in assemblages may be produced by local environmental factors (ecology, climate, etc.) along the same time line. Thus it may be alternatively imagined that the Jayanti basin was apparently a more hospitable (less cold) area where the Glossopteris flora could thrive better as compared to some other colder places of the Talchir times.

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EXPLANATION OF PLATES

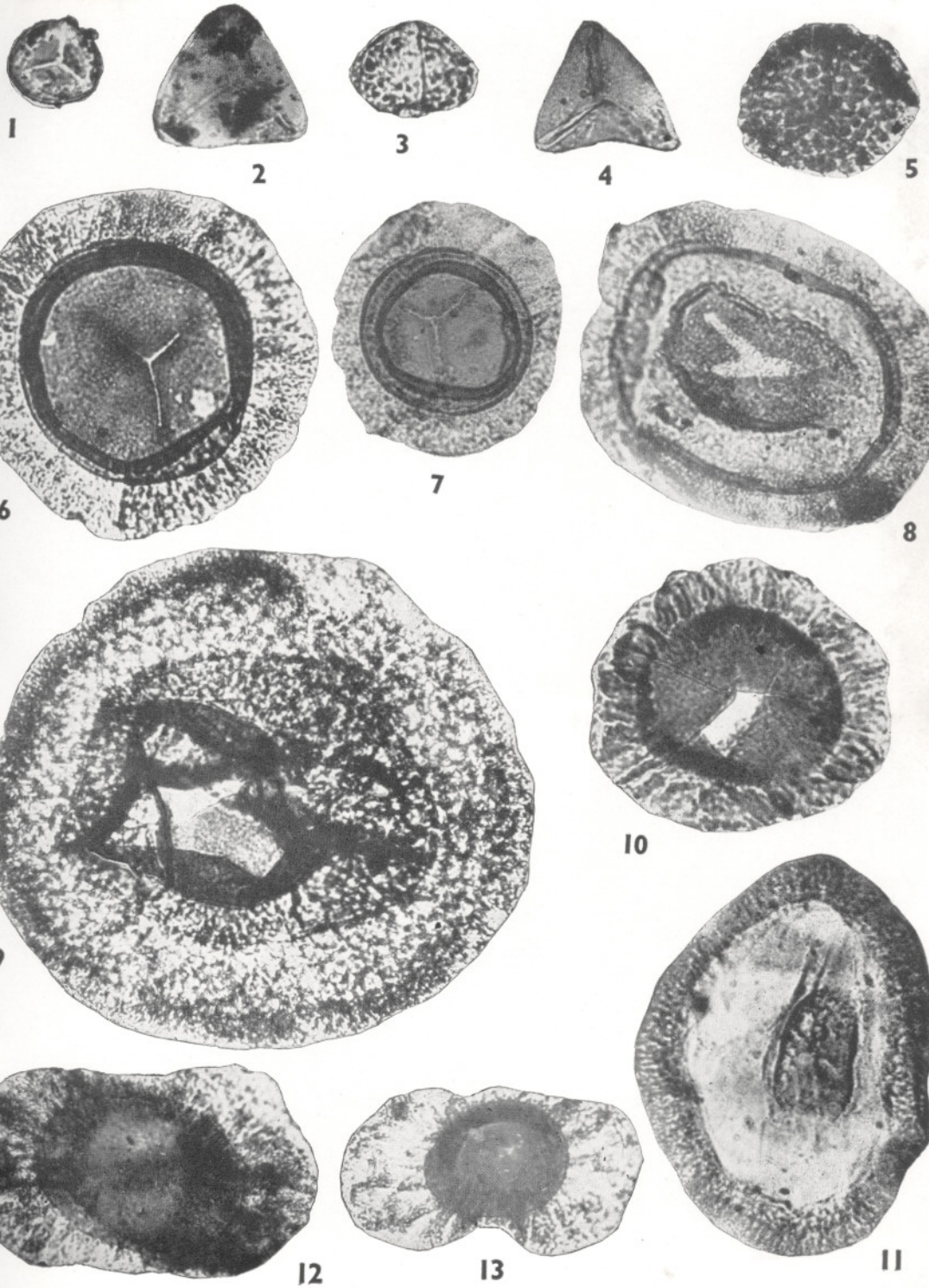
(All photomicrographs are magnified 500 times. The negatives and type-slides are preserved at the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow).

PLATE 1

1. *Hennellysporites* sp. Slide Regd. No. 3994.
2. *Granulatisporites* sp. Slide Regd. No. 4006.
3. *Horriditriletes* sp. Slide Regd. No. 3993.
4. *Microfoveolatispora directa* (Bal. & Henn.) Bharadwaj. Slide Regd. No. 4007.
5. Cf. *Dentatispora*. Slide Regd. No. 3990.
6,7. *Plicatipollenites densus* sp. nov. (Holotype, fig. 6). Slide Regd. Nos. 3985, 4005.
8. *Plicatipollenites stigmatus* sp. nov. (Holotype). Slide Regd. No. 3988.
9. *Plicatipollenites maculatus* sp. nov. (Holotype). Slide Regd. No. 3986.
10. *Pachysaccus* sp. A. Slide Regd. No. 4000.
11. *Tuberisaccites varius* Lele & Karim. Slide Regd. No. 4002.
12,13. *Caheniasaccites densus* sp. nov. (Holotype, fig. 12). Slide Regd. Nos. 3988, 3996.

PLATE 2

14,15. *Vestigisporites nigratus* sp. nov. (Holotype, fig. 14). Slide Regd. Nos. 3990, 3998.
16. *Potonieisporites magnus* sp. nov. (Holotype). Slide Regd. No. 4001.
17, 18. *Potonieisporites jayantiensis* sp. nov. (Holotype, fig. 17). Slide Regd. Nos. 3998, 4003.
19. Cf. *Rimospora* sp. Slide Regd. No. 3982.
20, 21. *Illinites notus* sp. nov. (Holotype, fig. 20). Slide Regd. No. 3997.
22,23. *Limitisporites diversus* sp. nov. (Holotype, fig. 22). Slide Regd. Nos. 3991, 3993.
24. *Limitisporites elongatus* sp. nov. (Holotype). Slide Regd. No. 3993.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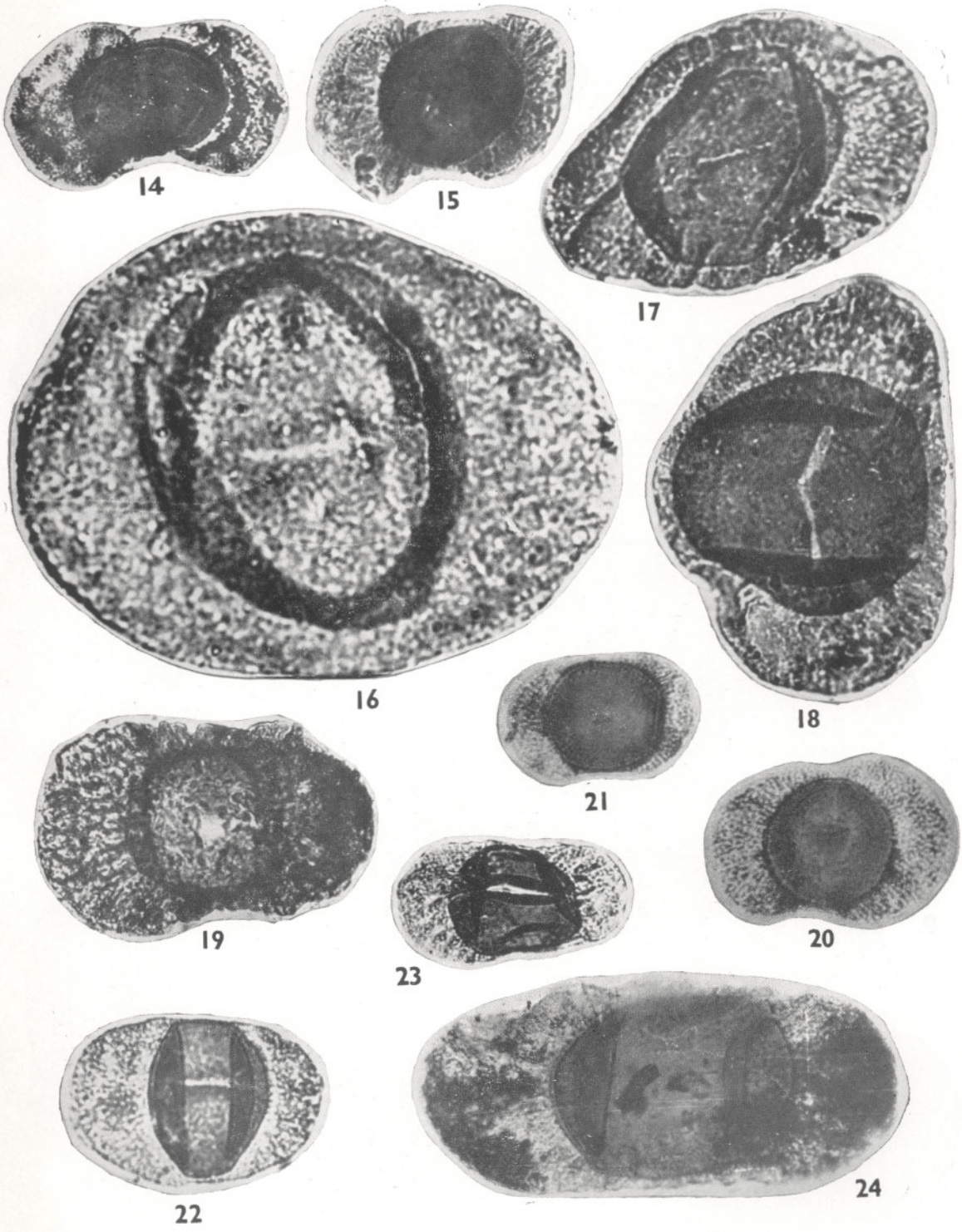
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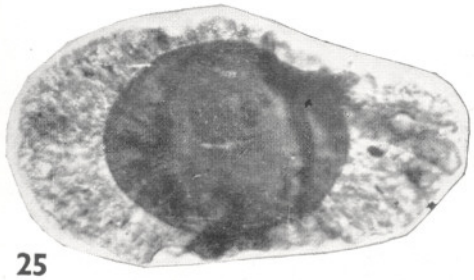
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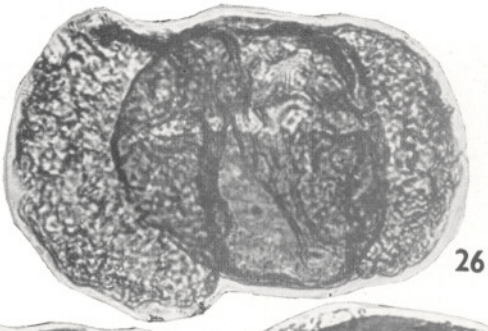
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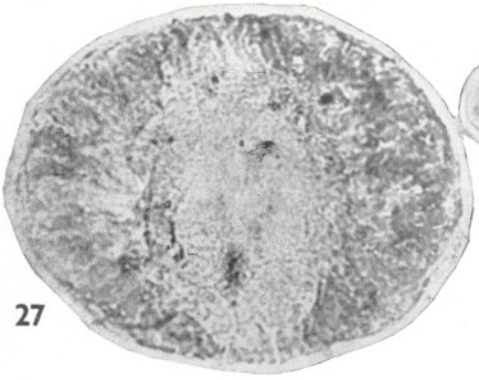
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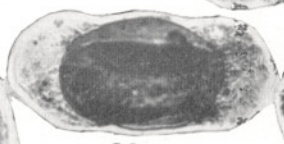
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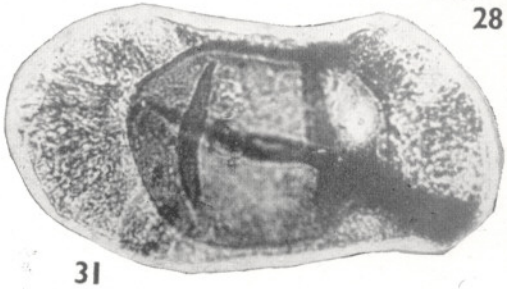
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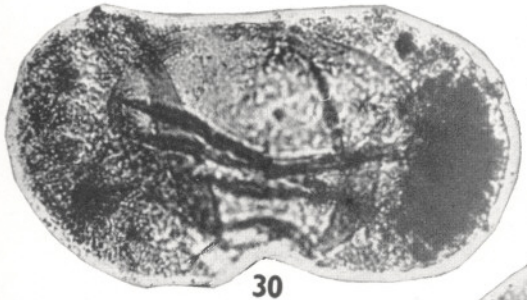
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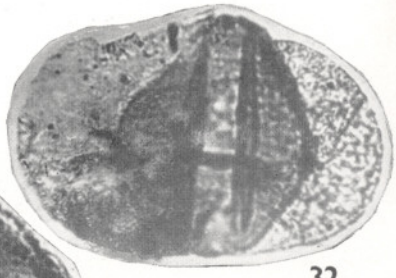
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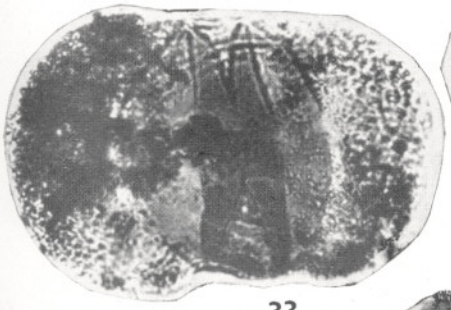
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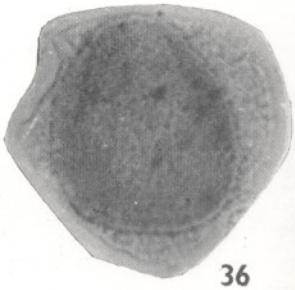
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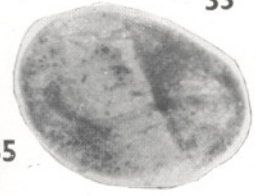
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PLATE 3

25. *Limitisporites elongatus* sp. nov. Slide Regd. No. 3984.
26. *Gigantosporites indicus* sp. nov. (Holotype). Slide Regd. No. 3983.
27. *Vesicaspora* sp. A. Slide Regd. No. 3999.
28,29. *Valiasaccites densus* sp. nov. (Holotype, fig. 28). Slide Regd. Nos. 3993, 4005.
30,31. *Valiasaccites indicus* sp. nov. (Holotype, fig. 30). Slide Regd. Nos. 3989, 3990.
32,33. *Strotersporites rhombicus* sp. nov. (Holotype, fig. 32). Slide Regd. Nos. 3987, 4004.
34. *Strotersporites* sp. Slide Regd. No. 3982.
35. *Faunipollenites* sp. Slide Regd. No. 3997.
36. *Crustaesporites* sp. Slide Regd. No. 3988.
37,38. *Leiosphaeridia talchirensis* sp. nov. (Holotype, fig. 36). Slide Regd. Nos. 3990, 3995.