STUDIES IN THE TALCHIR FLORA OF INDIA—10. EARLY AND LATE TALCHIR MICROFLORAS FROM THE WEST BOKARO COALFIELD, BIHAR

K. M. LELE

Birbal Sahni Institute of Palaeobotany, Lucknow-226007

ABSTRACT

Two miofloral assemblages — one from the base and the other from the top of the Talchir Formation — are described from a single sequence in the Dudhi River, West Bokaro Coalfield. The impoverished nature of the early Talchir assemblage is reflected by very limited number and variety of taxa (8 genera & 14 species) — chiefly *Parasaccites, Plicatipollenites* and *Potonieisporites* and some apiculate triletes. Disaccates — especially Striatiti — are strikingly absent. *Leiosphaeridia* and spicule-like microfossils are significantly associated.

The late Talchir mioflora, on the contrary demonstrates distinct improvement both in diversity and quantity of miospores (14 genera & 29 species). Besides the stronghold of *Parasaccites, Plicatipollenites* and *Potonieisporites*, several genera make new appearance, viz., *Jayantisporites, Tuberisaccites, Caheniasaccites, Limitisporites* and especially all the striate disaccates like *Crescentipollenites, Faunipollenites* and *Striatoparvisaccites* gen. nov. A number of species are apparently represented only in the late Talchir. *Leiosphaeridia* are rare and spicule-like bodies are absent.

In the light of the present study, and from an assessment of the better known Talchir miofloras, it is suggested that not one but two miofloral assemblages — of early and late Talchir age respectively — are evident in the Talchir Formation.

INTRODUCTION

THE earliest Lower Gondwana microfloras from India are found in the Talchir Formation. Although extensively developed in almost all coalfields, the Talchir sediments reveal relatively scanty evidence of plant life, especially in the earlier part of the formation. This is due obviously to the severe conditions initiated by the Permo-Carboniferous glaciation. In the later part of the Talchir, miofloral evidences are comparatively more widespread and they provide a glimpse of a definite improvement and diversification in the flora with the progressive ameleoration of climate. It is thus clear that for a proper understanding of the floral history, climatic setting and palynostratigraphic implications of the Talchir flora, every piece of evidence, especially from the earlier Talchir, should be well documented both by appropriate descriptions and illustrations of the fossils so as to make the data sufficiently expedient for an open appraisal of stratigraphical as well as morphological problems.

The Talchir mioflora from the Dudhi River section in the West Bokaro Coalfield was rather briefly reported in an earlier review by me (Lele, 1966). This stratigraphic section is important because here we have found some evidence of what may be one of the very oldest known Talchir miofloras, occurring close to the base of the formation. Furthermore, in the same section towards its top (and close to the Barakar junction) a thick siltstone bed has yielded a substantially rich mioflora that obviously represents the later part of the Talchir. The whole miofloral evidence has thus considerable implication on the floristics and palynostratigraphy of the Talchir Formation. It is, therefore, considered appropriate to present in this paper a more detailed and well-illustrated account of these early and late Talchir miofloral assemblages. New palynomorphs are systematically described and the known ones are supplimented with brief descriptions or remarks.

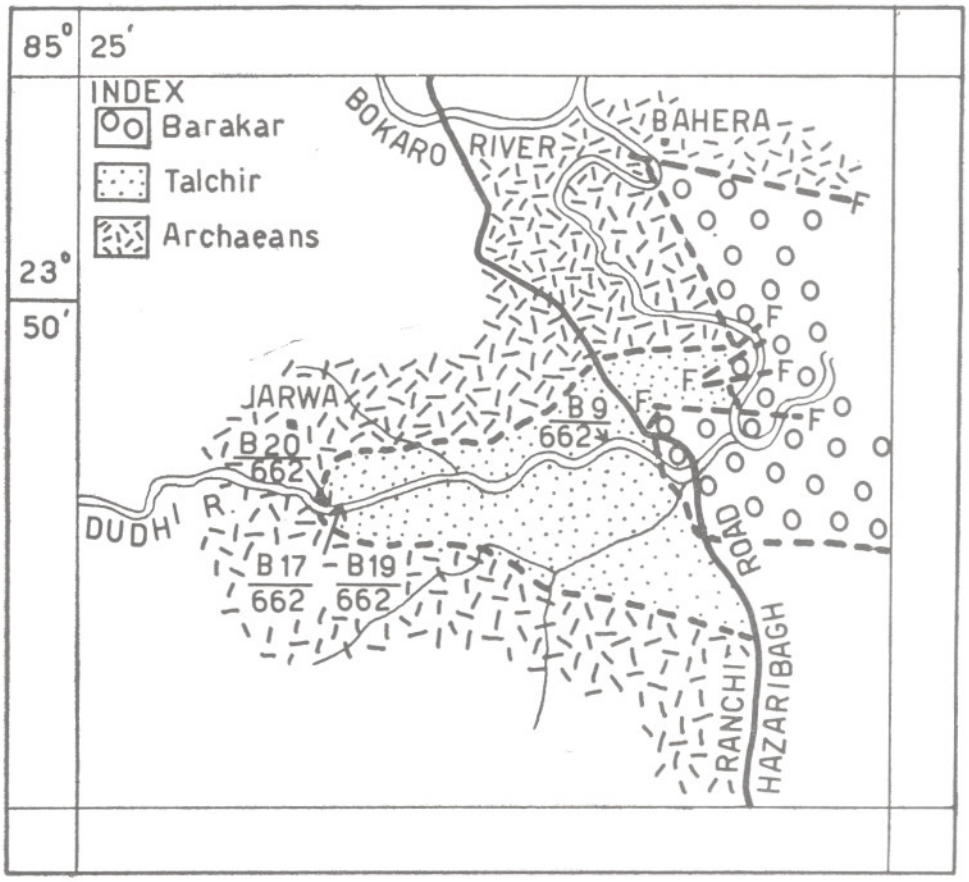
MATERIAL AND METHOD

Geological Background of Samples

[Text-fig. 1

The Talchir Formation, ideally exposed in the Dudhi River section of the West Bokaro Coalfield, has earlier been mapped by Dutt (1949). Ghosh (1962) carried out some sedimentological studies on this succession which is estimated to be about 700 ft thick.

From palynostratigraphic point of view, the salient features of the sequance were described by me (Lele, 1966). In brief,



TEXT-FIG. 1 — Portion of the geological map of the West Bokaro Coalfield showing location of palynological samples in the Talchir Formation exposed in the Dudhi River section.

the Talchir begins with a typical Talchir Boulder Bed-a tillite characterised by ill-assorted polymicts ranging from pebbles to huge boulders set in a greenish-gray clayey to sandy matrix. The bed rests unconformably on the Archaeans. Close to this junction, the following section is exposed (Lele, 1966, p. 87).

4. Siltstone (sample B17/662) . . . . . (Miospores) + few Leiosphaerids.
3. Fine sandstone (Sample B18/662)
2. Siltstone (Sample B19/662) . . . . . (Miospores) + Leiosphaerids + Spicules)
1. Talchir Boulder Bed (Sample B20/662)

Palynological contents from beds 2 and 4 were earlier recorded by me (Lele, 1966) but an error has crept in that record which is corrected here. Actually the assemblage of bed 2 belongs to bed 4 and *vice versa*. Thus, there are relatively very few miospores in sample B19/662 (Bed 2) which lies immediately above the tillite. In the sample B17/662 Bed 4), miospores increase in number, although the foral assemblage is still rather impoverished in aspect. The tillite (B20/662) and Bed 3 (B18/662) did not yield any recognisable palynomorphs so far.

The miospores from Beds 2 and 4 (Samples B19/662 & B17/662) constitutes the early Talchir assemblage.

Towards the middle part of the Dudhi River section, typical Talchir Needle shales, showing varying colours of blue, Khaki-green and violet are encountered in association with finely laminated siltstones, thin calcareous bands and occasional coaly streaks.

The terminal part of the Talchir sequence is also interesting. Near the Talchir-Barakar contact, which is apparently some what disturbed, the uppermost Talchir is represented by a thick bed of somewhat calcareous bluish-green siltstone (Sample B9/662). This bed has yielded a fairly rich population of miospores and fragmentary plants which, therefore, represent the late Talchir assemblage. Associated with the siltstone (B9/662) is another boulder bed (second and younger in the Dudhi River sequence). This boulder bed is closely similar to the one found at the Metamorphic boundary but it chiefly differs in the lack of out-sized boulders.

The palynostratigraphic interest of the Dudhi River section lies in the finding of two miospore assemblages — one close to the Talchir-Metamorphic boundary (Early Talchir) and the other near the Talchir-Barakar boundary (Late Talchir).

Method — For the extraction of microfossils the samples were generally treated with HF for 3-6 days. After several washings in water, the fine residues were spread on microslides in polyvenyl alcohol. Finally permanent mounts were made in canada balsam. Figured slides and holotypes are preserved in the Museum, Birbal Sahni Institute of Palaeobotany, Lucknow (Regd. Nos. 4744-4763).

SYSTEMATIC PALYNOLOGY

The basic scheme of Potonié & Kremp is followed for describing the miospores. However, in the classification of monosaccates, some concepts of Dibner (1973) are found useful.

Anteturma — *Sporites* H. Potonié, 1893
Turma — *Triletes* (Reinsch) Potonié & Kremp, 1954
Subturma — *Azonotriletes* Luber, 1935
Infraturma — *Laevigati* (Bennie & Kidston) Potonié & Kremp, 1956

Genus — *Leiotriletes* (Naumova) Potonié & Kremp, 1954

Leiotriletes sp.

Pl. 2, fig. 24

Remarks — Subtriangular spore. Size ± 40 μ. Exine laevigate, 1 μ thick, secondarily folded. Infrastructure obscure. Trilete rays thin, about 3/4 of spore radius in length.

Occurrence — Very rare; Sample B9/662 (Late Talchir).

Genus — *Callumispora* Bharadwaj & Srivastava, 1969

Remarks—Recently Bharadwaj and Varma (1974) have emended the diagnosis of *Punctatisporites* to include only such trilete-bearing forms that are triangular in outline and possess a finely *sculptured* punctate exine. In their view *Leiotriletes* is distinguishable by its sculptureless exine and *Callumispora* Bharadwaj & Srivastava, 1969 by its circular (spherical) shape and structured, laevigate exine. Admittedly, a clear-cut resolution of these genera would seem considerably difficult in practice with the light microscope, especially where fine features like infrapunctation (structure) is to be distinguished from fine punctation (sculpture). The need of combined scanning electron and transmission electron microscopy is imperative in resolving these genera. In the present material, simple unsculptured or finely structured spores are very few and the problem is less serious.

Callumispora gretensis (Balme) Bharadwaj & Srivastava, 1969

Pl. 2, fig. 23

Description—Thick-walled, circular spore. Size ± 80 μ. Rays 3/4 of spore radius in length, simple. Exine 2·5-3 μ thick, infrastructure indistinct. No structural or sculptural differentiation in inter-ray area.

Occurrence — Rare; Sample B9/662 (Late Talchir).

Infraturma — *Apiculati* (Bennie & Kidston) Potonié & Kremp, 1956

Genus — *Cyclogranisporites* Potonié & Kremp, 1954

Cyclogranisporites sp.

Pl. 1, figs. 2, 3

Description — Size 20-30 μ, circular to subcircular. Rays distinct, may be asso-

ciated with lip development, 2/3 of spore radius in length or slightly longer. Exine ±1 μ thick with minor folds. Comprehensive sculpture of irregular, closely packed grana, ±1 μ in diameter and nearly as much apart; generally rounded but occasionally mixed with conate to verrucate elements. Sculpture hardly visible along spore margin.

Occurrence — Very rare; Sample 17/662 (Early Talchir).

Genus — *Verrucosisporites* Ibrahim emend. Smith & Butterworth, 1967

Verrucosisporites cf. *donarii* Potonié & Kremp, 1955

Pl. 1, fig. 1

Description — Medium thick-walled, circular spore. Size 50-60 μ. Rays 2/3 of spore radius in length, simple, often obscured by sculpture. Comprehensive sculpture of closely set, ± uniform, hemispherical to conate verrucae, 1-2 μ high and 1·5-3 μ broad; about 50-70 μ elements along spore margin.

Comparison — Among the species of comparable size, *V. donarii* approaches closer to the present specimens in respect of ray features, and in the shape size and distribution of verrucae.

Occurrence — Rare; Sample 17/662 (Early Talchir).

Verrucosisporites sp.

Pl. 2, fiig. 25

Description — Size ± 40 μ; ± circular. Exine 1-1·5 μ thick. Trilete rays 2/3 to 3/4 of spore radius in length, elevated by folds. Comprehensive sculpture of closely packed small irregular verrucae occasionally mixed with baculate or conate elements, sculpture up to 1·5 μ (rarely slightly greater) in width and as high or less. About 50 elements seen along spore margin.

Remarks — The specimens differ from *Verrucosisporites* cf. *donarii* in their smaller size and in the finer grade and ± irregular shape of the ornament.

Occurrence — Very rare; Sample B9/662 (Late Talchir).

Genus — *Apiculatisporis* Potonié & Kremp, 1956

Apiculatisporis sp.

Pl. 1, fig. 4

Description — Medium thick-walled, circular to subcircular spore. Size 41-73 μ. Rays simple, 3/4 of spore radius in length. Exine 1·5-2 μ thick, secondary folds uncommon, covered with sparse conate to verrucate discrete elements, up to 3 μ broad and as high or higher, hardly visible at spore margin.

Remarks — The sculpture is not well-preserved due probably to erosion of exine.

Occurrence — Very rare; Sample B17/662 (Early Talchir).

Genus — *Jayantisporites* Lele & Makada, 1971

Jayantisporites cf. *conatus* Lele & Makada, 1971

Pl. 2, fig. 26

Description — Roundly triangular spore. Size 50 μ. Triangular inner body developed, size 30 μ. Pseudozonate structure almost continuous, appearing as a 4-5 μ wide border. Distal sculpture of discrete or partially fused broad-based conate elements, 2-5 μ broad and up to 5 μ high, occasionally with short setose tips (up to ·5 μ long); sculpture well projected at spore margin.

Remarks — The ornament is like *J. conatus* in shape. Enough specimens are, however, not available to confirm the strong fusion tendency in the elements which is characteristic of the species.

Occurrence — Very rare; Sample B9/662 (Late Talchir).

Anteturma — *Pollenites* Potonié, 1931
Turma — *Saccites* Erdtman, 1947
Subturma *Monosaccites* (Chitaley) Potonié & Kremp, 1954
Infraturma — *Dipolsacciti* Hart 1965 emend. Dibner, 1971
Subinfraturma — *Apertacorpini* Dibner, 1971

Genus — *Plicatipollenites* Lele, 1964

Plicatipollenites indicus Lele, 1964

Pl. 2, fig. 32

Remarks — Generally the saccus width is less than 1/2 body radius but there are

few exceptions which are included in the species.

Occurrence — Rare and ill-preserved; Sample B17/662 (Early Talchir).

Frequent; Sample B9/662 (Late Talchir); Pl. 2, fig. 32.

Plicatipollenites trigonalis Lele, 1964
Pl. 2, fig. 28

Occurrence — Common; Sample B9/662 (Late Talchir).

Plicatipollenites densus Srivastava, 1970
Pl. 2, fig. 30

Occurrence — Common; Sample B9/662 (Late Talchir).

Plicatipollenites gondwanensis (Balme & Hennelly) Lele, 1964
Pl. 1, fig. 5; Pl. 2, fig. 31

Remarks — Figured specimen from the early Talchir sample (Pl. 1, fig. 5) is ill-preserved but shows the characteristic angular body-infolds. Figured specimen from the late Talchir appears slightly oval due to compression.

Occurrence — Common; Sample B17/662 (Early Talchir), Pl. 1, fig. 5.

Rare; Sample B9/662 (Late Talchir); Pl. 1, fig. 31.

Plicatipollenites maculatus Lele & Karim, 1971
Pl. 2, fig. 29

Remarks — Size 150×137. Body size subcircular, 105×95 μ, infold-system irregular. Saccus roots deep distally; double reticulum not evident.

Occurrence — Rare; Sample B9/662 (Late Talchir).

Genus — *Virkkipollenites* Lele, 1964

Remarks — Some workers have regarded *Virkkipollenites* as a junior synonym of *Cannanoropollis* Potonié & Sah, 1961, while others have included both taxa under *Cordaitina* (see review by Lele, 1974). There is reason to believe that *Cannanoropollis* was created on reworked or contaminated grains of *Virkkipollenites* or *Parasaccites* type in the Tertiary lignites of Connanore. Recent studies carried out on cannanore lignite (Personal communication — Dr. C. G. K. Ramanujam) do not confirm the presence of *Cannanoropollis*. In view of this, it seems most appropriate to drop the use of *Cannanoropollis* in preference to the well-established genus *Virkkipollenites*. Monosaccate grains of *Virkkipollenites* type seem to occur as reworked fossils in post-palaeozoic deposits of south India at other-localities also, e.g. Mesozoic strata of Cauvery Basin (Venkatachala & Sharma, 1975). It is possible to identify such grains and place them in other known taxa instead of making them a basis for instituting new names which may create stratigraphic contradictions.

Virkkipollenites mehtae Lele, 1964
Pl. 2, fig. 33

Occurrence — Rare; Sample B9/662 (Late Talchir).

Virkkipollenites triangularis (Mehta) Lele, 1964
Pl. 2, fig. 34

Occurrence — Rare; Sample B9/662 (Late Talchir).

Virkkipollenites sp.
Pl. 1, fig. 6

Description — Oval miospore. Size 148×104 μ. Body apparently ± dark, oval; size 133×98 μ. Exine 2 μ thick, with ± peripheral compression folds. Tetrad mark not seen. Saccus conspicuously narrow, about 10-12 μ wide all around body, saccus roots obscure; intra-reticulum fine. Saccus surface ± unfrilled.

Remarks — Known species of *Virkkipollenites* (Lele, 1974) lack a thick and large oval body. There is some apparent resemblance with *Parasaccites* but para-condition of saccus attachment is not demonstrable in the grain.

Occurrence — Very rare; Sample B17/662 (Early Talchir).

Genus — *Potonieisporites* Bharadwaj, 1954 emend. 1964

Potonieisporites neglectus Potonié & Lele, 1964

Pl. 1, fig. 10

Occurrence — Rare; Sample B17/662 (Early Talchir). Pl. 1, fig. 10. Common; Sample B9/662 (Late Talchir).

Potonieisporites crassus Lele & Chandra, 1973

Pl. 1, fig. 9; Pl. 2, fig. 37

Remarks — The early Talchir specimens are larger than the Late Talchir ones.

Occurrence — Rare; Sample B19/662 (Early Talchir). Pl. 1, fig. 9. Rare; Sample B9/662 (Late Talchir), Pl. 2, fig. 37.

Potonieisporites lelei Maheshwari, 1967

Pl. 2, fig. 36

Occurrence — Rare; Sample B9/662 (Late Talchir).

Potonieisporites mutabilis Lele & Chandra, 1973

Pl. 1, fig. 8

Occurrence — Rare; Sample B17/662 (Early Talchir). Pl. 1, fig. 8. Rare; Sample B9/662 (Late Talchir).

Potonieisporites magnus Lele & Karim, 1971

Pl. 1, fig. 7; Pl. 2, fig. 35

Occurrence — Rare; Sample B17/662 (Early Talchir), Pl. 1, fig. 7. Rare; Sample B9/662 (Late Talchir); Pl. 2, fig. 35.

Potonieisporites monosaccoides (Bose & Maheshwari, 1968) comb. nov.

Pl 1, fig. 11

Remarks — From the descriptions and figures of this species (Bose & Maheshwari, 1968), the grains show a definite basic monosaccate construction. Therefore, they can be better allocated under *Potonieisporites* rather than *Limitisporites* which is distinctly disaccate. In this species there may be a couple of vertical crescentic body infolds which seem to show a tendency to close up towards their lateral ends. Such features of transition are common in *Potonieisporites*.

The figured specimen from W. Bokaro Coalfield is clearly haploxylonoid and shows a single continuous, laterally narrow saccus as in *Potonieisporites monosaccoides*. Monolete mark is not clear in the specimen. The body is circular to subcircular in outline in the present examples as well as in the original figures of the species.

Occurrence — Rare; Sample B17/662 (Early Talchir), Pl. 1, fig. 7. Rare; Sample B9/662 (Late Talchir).

Infraturma — *Parasaccini* Dibner, 1971

Remarks — The infraturuma *Clausicorpini* Dibner, 1971 is considered synonymous with *Parasaccini* as the differences are chiefly quantitative in nature.

Parasaccites densicorpus sp. nov.

Pl. 1, figs. 13, 14; Pl. 3, figs. 42-47

1964 — *Virkkipollenites densus* Lele, Pl. 2, figs. 20. Rephotographed here in Pl. 3, fig. 46.

1968 — *Parasaccites* sp. A., Maheshwari; Pl. 43; Pl. 8, fig. 6.

Holotype — Pl. 3, fig. 42.

Type locality — West Bokaro Coalfield, Bihar; Dudhi River Section. Sample B9/662 (Late Talchir).

Age & Horizon — Talchir Formation (Permo-Carboniferous), Lower, Gondwana.

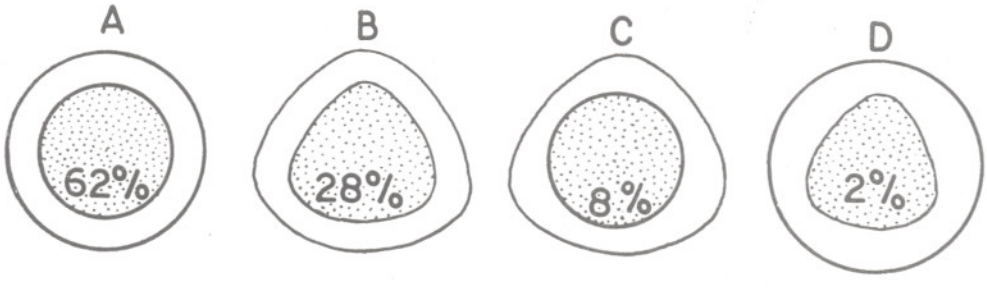
Diagnosis — Circular-oval or roundly triangular miospore. Size 50-100 μ. Central body intramicropunctate to intramicroreticulate, 1·5-2 μ thick, outline distinct and smooth. Shape circular to roundly triangular, generally conforming with overall outline. Size 45-60 μ. Tetrad mark simple, weak to ± clear, rays 1/2 to 2/3 of body radius in length, with a tendency to become bilete or rarely monolete. Saccuwidth about 1/2 of body radius or more, prominently frilled by radial pleats arising from saccus roots, especially distally. Distal saccus overlap deep (about 2/3-1/3 of body radius), ± clear, roots ± fimbriate and may be associated with partial exine folds or thickening (compressional); proximal saccus overlap narrow and relatively indistinct.

Remarks — The body and the saccus both show a variation in shape from roundly triangular to circular or slightly oval. Usually the outline of the body follows the saccus outline but exceptionally some examples may have a triangular body but a round saccus or *vice versa*. Thus, there are at least four body/saccus shape variants (Text-fig. 2) of possibly intra-specific nature. Biometric analysis reveals that (i) spores with conformable body/saccus outline are in majority (90%). Among these the circular outline predominates (62%) and the triangular shape follows next (28%). (ii) spores with disconformable body/saccus outline (Text-fig. 2—C, D) are strikingly minor in proportion, probably of transitional, character (10%). The general impression gained from the study is that the variation in the shape of the body may be due to its somewhat anisopolar construction.

Observations on the heteromorphism of the tetrad mark suggest that a trilete suture is more linked with a triangular body whereas the shift towards monolete finds favour with a circular to oval body (Pl. 3, fig. 44). Similar heteromorphism is well known in other monosaccate genera like *Plicatipollenites* (e.g. *P. indicus* Lele, 1964) and *Potonieisporites* (*P. neglectus* Potonié & Lele, 1961). The shift in tetrad symmetry appears to be related to a corresponding shift in the tetrad symmetry (Lele, 1974).

The states of preservation of the grains appear to give rise to a variety of artifacts and were it not for the abundant material available for study, some more species or even genera could be mistaken. For instance, a considerable number of specimens in the preparation are very probably immature grains which is borne out by their underdeveloped saccus size and structure (Pl. 3, fig. 47). Such specimens tend to resemble *Pachysaccus* Lele & Maithy, 1969. The central body tends to get partly or wholly detached from the saccus and such bodies with tetrad mark may appear like simple trilete or monolete spores. Saccus frills, features of saccus roots and the general infrastructure is found to be variously obliterated or nearly lost by preservation factors (Pl. 3, figs. 43, 45). Specimen in Pl. 1, fig. 14 is probably an extreme case where the whole appearance of the grain has been smoothened out causing loss of some important generic details. In Pl. 1, fig. 13, although the preservation is relatively better, an artifact is evident in the window-like oval gap of the polar body exine. The outline of the window is fairly regular, being situated close to the saccus root, but still the artifact is likely to give wrong impression.

Comparison — *Virkkipollenites densus* Lele, 1964 is superficially very similar to *Parasaccites densicorpus*. sp. nov. Re-examination of the type material reveals that the specimen in Pl. 2, fig. 10 (Lele, 1964 and rephotographed here in Pl. 3, fig. 46) does show a para-condition of saccus attachment identical with that of *parasaccites densicorpus* sp. nov. besides other similarities in body exine thickness saccus frills and in the extent and natutre of saccus overlap on the two sides of body. The holotype of *Virkkipollenites densus* Lele (1964, Pl. 2, fig. 19), however, fails to demonstrate a para-condition with any degree of certainty and the saccus lacks prominent frills, though the muri are radially disposed. In view of this situation, *Virkkipollenites densus* is provisionally retained but the specimen in



TEXT-FIG. 2 — Four types of body/saccus shape variants of *Parasaccites densicorpus* sp. nov. and their reative proportion.

Pl. 2, fig. 20 of Lele (1964) is reallocated under *Parasaccites densicorpus* sp. nov.

Parasaccites talchirensis Lele & Makada, 1971 differs in the possession of a distinct trilete mark which is practically without any heteromorphism. Other important differences are that the body outline of *P. talchirensis* is visibly broken and ± flared in appearance where as it is quite smooth and continuous in *P. densicorpus* sp. nov.

Occurrence — Rare; Sample B17/662 (Early Talchir), Pl. 1, figs. 13, 14. Frequent; Sample B9/662 (Late Talchir). Pl. 3, figs. 42-45 & 47.

Parasaccites bilateralis Tiwari, 1965

Occurrence — Rare; Sample B9/662 (Late Talchir)

Parasaccites fimbriatus Maheshwari, 1969

Pl. 2, fig. 38

Remarks — Miospores are characterised by a ± indistinct body, weak trilete mark and conspicuously frilled broad saccus, showing fimbriate roots.

Occurrence — Common; Sample B9/662 (Late Talchir).

Parasaccites diffusus Tiwari, 1965

Pl. 1, fig. 12; Pl. 2, fig. 39

Occurrence — Very rare; Samples B17/662, B19/662 (Early Talchir), Pl. 1, fig. 12. Frequent; Sample B9/662 (Late Talchir), Pl. 2, fig. 39.

Genus — *Tuberisaccites* Lele & Makada, 1972

Tuberisaccites tuberculatus (Maheshwari) Lele & Makada, 1972

Pl. 2, fig. 40

Remarks — Three small, rounded to hemispherical, partly hollow protuberances are seen in the contact area. Each protuberance appears to lie in inter-radial position of what may be rays of a possible trilete mark. The saccus shows para-condition of attachment and radial frills.

Occurrence — Very rare; Sample B9/662 (Late Talchir).

Genus — *Caheniasaccites* Bose & Kar, 1966

Caheniasaccites densus Lele & Karim, 1971

Pl. 2, fig. 41

Remarks — Para-condition of saccus attachment is discernible by L. O. analysis. The thick body shows a 2-3·5 wide rim at the margin. The grains are somewhat larger than recorded from the type material.

Occurrence — Rare; Sample B9/662 (Late Talchir).

Infraturma — *Disaccimonoleti* Leschik, 1956

Genus — *Limitisporites* Leschik, 1956

Limitisporites diversus Lele & Karim, 1971

Pl. 3, fig. 49

Description — Overall size range 70-87 μ (length) ×85-55 μ (breadth). Body size range 37-44×44-55 μ. Outline of the body varies from subhexagonal to subcircular or vertically oval. Sacci roots widely separated. Monolete mark not always clear.

Occurrence — Rare; Sample B9/662 (Late Talchir).

Limitisporites (*Sahnites*) *thomasi* (Pant) comb. nov.

Pl. 3, fig. 48

1955 — *Sahnites thomasi* Pant. p. 760, pl. 19, figs. 1, 2, 6, 7.

Description — Haploxylonoid, disaccate miospore. Size 82×73 μ. Body characteristically ellipsoid-rhomboid, size 42×72 μ; infrastructure fine, indeterminate. Proximal monolete mark long, ± irregular. Distal body infolds along sacci roots crescentic, circumscribing a fusiform sulcoid germinal area. Sacci hemispherical or less, overlap equal or less than off-lap, intrareticulation fine to medium-sized.

Remarks — The figured specimen is close to the holotype of the species. In view of the clearly disaccate construction, the species is better reallocated under *Limitisporites*.

Sahnites Pant was probably meant for monolete-bearing bilateral monosaccates, showing para-condition of attachment, the saccus-roots being distally associated with a body infold system (Bharadwaj & Tiwari,

1964). If this concept is true, the genotype *Sahnites gondwanensis* (Mehta) Pant would seem to fall within the circumscription of *Gondwanopollis* Lele & Maithy, 1969 which occurs in the same locality (Ganjra Nala, South Rewa Basin). Since the genoholotype of *Sahnites* is lost, it is now preferable to use *Gondwanopollis* instead.

Occurrence — Very rare; Sample B9/662 (Late Talchir).

Subturma — *Disaccites* Cookson, 1947
Infraturma — *Disacciatrileti* (Leischik) Potonié 1958

Genus — *Pityosporites* (Seward) Manum, 1960

Pityosporites sp.
Pl. 1, fig. 15

Description — Diploxylonoid miospore. Size 72×50 μ. Body obscure, probably circular, about 40 μ; striations or other features on the proximal side apparently absent. Sacci more than hemispherical, one of them appears to be pinched into a neck-like structure near root. Germinal area ± straight, narrow.

Occurrence — Very rare; Sample B17/662 (Early Talchir).

Faunipollenites cf. *parvus* Tiwari, 1965
Pl. 3, fig. 50

Description — Size 82×58 μ. Body broadly elliptical, ± indistinct; size 54×44 μ. Striations 6-7, mostly simple. Germinal area narrow, tending to widen towards one of the lateral sides.

Remarks — *Faunipollenites varius* Bharadwaj, 1962 has a comparable size but differs in its wide germinal area. *Faunipollenites parvus* Tiwari, 1965 is somewhat smaller (53-70 μ×33-51 μ) but agrees in the more important character of the germinal area

Occurrence — Very rare; Sample B9/662. (Late Talchir).

Genus — *Crescentipollenites* Bharadwaj, Tiwari & Kar, 1975

Crescentipollenites talchirensis sp. nov.
Pl. 3, figs. 51-53

Holotype — Pl. 3, fig. 51.

Type Locality — West Bokaro Coalfield, Bihar; Dudhi River Section. Sample B9/662 (Late Talchir).

Age & Horizon — Talchir Formation (Permo-Carboniferous), Lower Gondwana.

Diagnosis — Haploxylonoid miospore. Size 65-88×42-72 μ. Central body broadly elliptical, occasionally slightly denser, intramicroreticulate, proximally bearing 6-8, simple to rarely branched striations. Sacci hemispherical, overlap nearly equal to or smaller than off-lap, distal roots ± straight to slightly convex, associated with distinct body infolds. Sulcus nearly half of body width or narrower (5-10 μ wide).

Comparison — *Crescentipollenites* (*Leuckisporites*) *limpidus* (Balme & Hennelly, 1955) comb. nov. has thinner body and indistinct striations. *Crescentipollenites brevis* (Bose & Kar) Bharadwaj et al., 1975 is smaller (50-54×42-54 μ), has a more fusiform body, distinctly biconvex sulcus and fewer and more obscure striations. *Crescentipollenites globosus* (Maithy, 1965) comb. nov. is much larger (120-136 μ).

Occurrence — Rare; Sample B9/662 (Late Talchir).

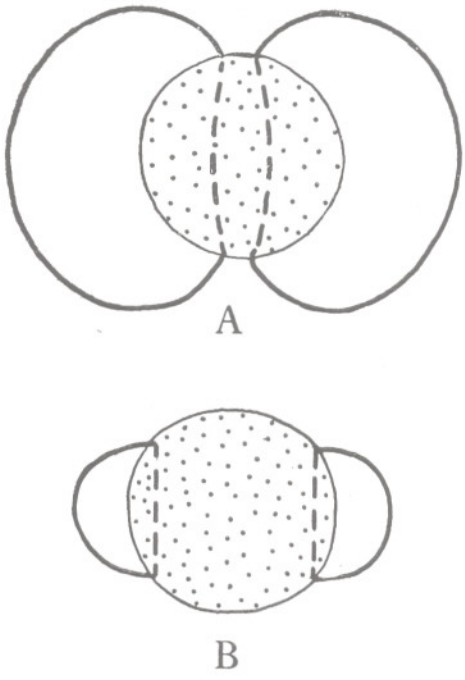
Genus — *Striatoparvisaccites* gen. nov.

Type species — *Striatoparvisaccites indicus* sp. nov.

Diagnosis — Under-diploxylonoid, disaccate, striate miospore; characterised by a large, infrastructured, distinct central body and relatively dwarfed sacci. Proximal striation so nbody sample or branched, generally without vertical partitions. Distal germinal area ill-defined and unspecialised, variably wide.

Discussion — In disaccate miospores, a diploxylonoid condition can result in two important manners: (1) where the sacci are wider than the body. This condition (Text-fig. 3A), here called 'over-diploxylonoid', is prevalent in disaccates and (2) where the body is wider than the sacci. This condition (Text-fig. 3B), here called 'under-diploxylonoid', is comparatively less widely known in fossil miospores. The nonstriate Permo-Triassic genus *Abiespollenites* Thiergart demonstrates this condition very characteristically (see Hart, 1965, p. 69). In the extant pollen of *Abies* the sacci are typically smaller than the body and are distinctly placed on the distal (ventral) side.

In the first kind of sacci/body relationship (over-diploxylonoid) the sacci are, generally attached along the full width (vertical extent



TEXT-FIG. 3 — Two distinct modes of diploxylonoid condition A-Over-diploxylonoid and B-Under-diploxylonoid.

in polar view) of the body on the distal side and the corresponding germinal area or sulcus is also generally coextensive. However, in the second kind of sacci/body relationship (under-diploxylonoid) where the distal roots of the sacci are essentially shorter than body width, there need not exist any correlation between the extent (width) of the sacci roots and the germinal area (if present).

The two catagories are thus distinct from organizational and evolutionary points of view and can be recognised at least at the level of the genus, if not higher.

The above considerations have necessitated the institution of the new taxon *Striatoparvisaccites* which clearly demonstrates the contrast between the stubby sacci and the large body, exemplifying an 'under-diploxylonoid' condition. There are other differences ralating to the germinal area which distinguish these miospores from other striated disaccates, including *Striatites* (Pant) Bharadwaj. It is notable, for instance, that *Striatoparvisaccites* shows no recognisable sulcus; the germinal area is ill-defined and unspecialised (like a leptoma). On the contrary, several Lower Gondwana striate disaccates, including *Striatites*, have a well-defined sulcoid, germinal area.

The distal sacci roots in *Striatoparvisaccites* are not far removed from the body equator which suggests that the sacci have a small distal inclination. Sometimes the small sacci almost over-ride the large body during compression. Occasionally the sacci tend to be partly or wholly detached from the body — the latter appearing somewhat like a polyplicate grain.

Comparison — Two genera, viz., *Protodiploxypinus* and *Protocedrus*, instituted by Samoilovich (1961) from the Russian Permian are closely similar to *Striatoparvisaccites* gen. nov. in having typically under-diploxylonoid contour. However, these genera are essentially distinct as they apparently possess on the body a proximal cap-like thickening ('crest' *sensu* Samoilovich, e.g. pl. 7, figs. 1a & 2) which is differentiated into ribs of taeniate appearance (e.g. Samoilovich, pl. 7, fig. 1c). In both taxa the body is granular (or 'ribbed-granular' *sensu* Samoilovich) and in *Protocerdrus*, the sculpture may be absent on the distal side of the body. As opposed to these features the body of *Striatoparvisaccites* is evenly smooth all over and is finely infrastructured. It is also apparent that *Protodiploxypinus* and *Protocedrus* have more ventrally (distally) placed sacci on the body than in *Striatoparvisaccites* Lastly, *Protodiploxypinus* has a much greater size range (36-172 μ). In view of these differences, the present miospores are placed under a new generic name.

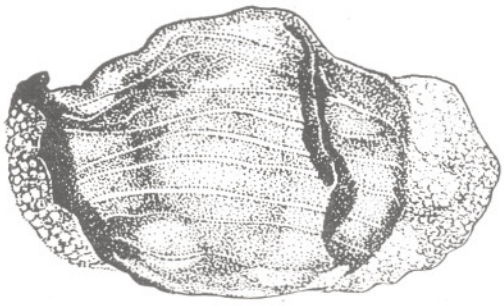
Striatoparvisaccites indicus sp. nov.
Pl. 3, figs. 54, 55; Text-fig. 4

Holotype — Pl. 3, fig. 54.

Type Locality — West Bokaro Coalfield, Bihar; Dudhi River Section. Sample B9/662 (Late Talchir).

Age & Horizon — Talchir Formation (Permo-Carboniferous); Lower Gondwana.

Diagnosis — Under-diploxylonoid miospores. Size 55-70×35-40 μ. Central body horizontally oval, indistinctly intrapunctate to intramicroreticulate, 2-2·5 μ thick, dense, with occasional compression folds. Size 45-50×34-40 μ. Proximal striations 8-10, distinct, simple or occasionally branched,



TEXT-FIG. 4 — Line drawing of *Striatoparvisaccites indicus* gen. et sp. nov. (type species). Ca. × 1000.

without vertical partitions. Sacci subhemispherical or smaller, distinctly dwarfed and thinner in contrast to body, width of sacci 24-30 μ (about 1/2-2/3 of body width); proximal attachment along the body equator, distal roots not very deep. Germinal area (leptoma), ill-defined, ± broad. Saccus intrareticulation fine.

Remarks — The grains are easily distinguishable by their characteristically large oval, dense body and rather stubby sacci. The distal sacci roots are not accompanied by any clear body-infold system. A sulcus is not developed in these grains; the germinal area is more like an ill-defined, ± broad leptoma. The body appears externally smooth but may indistinctly show a fine infrastructure of microreticulum or micropuncta. Minor exinal folds of irregular orientation may develop on the body by compression. In some cases, the sacci have apparently been detached, party or wholly, from the body (Pl. 3, fig. 55).

Comparison — *Striatoparvisaccites* (*Leuckisporites*) *multistriatus* (Balme & Hennelly, 1955) comb. nov. (Lectoholotype Pl. 2, fig. 16 as selected by Tiwari, 1965 p. 192) is distinguishable by its ± circular (subhexagonal) and relatively thinner body and a larger number of striations (13-17). This species was earlier allocated under *Striatites* by Tiwari (1965). However, the characteristic under-diploxylonoid contour of the grains and the ill-defined germinal area of this species make its transfer possible under *Striatoparvisaccites*. Some specimens in the original photographs of Balme and Hennelly (1955) possess an oval body, which conforms more with the description of the original authors rather than with the lectoholotype. In both forms, with oval or circular body, the number of striations is, however, uniformly larger than in *Striatoparvisaccites indicus* sp. nov.

Occurrence — Rare; Sample B9/662 (Late Talchir).

Striatoparvisaccites circularis sp. nov.
Pl. 3, figs. 56, 57

Holotype — Pl. 3, fig. 56.

Type Locality — West Bokaro Coalfield, Bihar, Dudhi River Section. Sample B9/662 (Late Talchir).

Age & Horizon — Talchir Formation (Permo-Carboniferous), Lower Gondwana.

Diagnosis — Under-diploxylonoid miospores. Size 80-100 μ × 50-62 μ. Body large, circular to subhexagonal or subcircular, ± 50-60 μ in diameter, distinct, occasionally slightly dense. Exine about 1·5-2 μ thick with occasional compression folds; intramicroreticulate. Proximal striations simple, 6-8 not consistently clear. Sacci hemispherical or less, distal overlap usually smaller than off-lap. Germinal area ill-defined, broad (22-28 μ). Minor compression folds present on body.

Comparison — This species is distinguishable from the type species (*S. indicus* sp. nov.) by the circular to subhexagonal (radial) configuration of the body and its somewhat larger size. Occasionally the body is detached from the sacci and bears scars of sacci roots (Pl. 3, fig. 57). As expressed earlier, *Striatoparvisaccites multistriatus* (Balme & Hennelly) comb nov. has a thinner body and a conspicuously larger number of striations.

Occurrence — Rare; Sample B9/662 (Late Talchir).

Trisaccate miospore
Pl. 3, fig. 58

Description — Outline subtriangular, size ± 117 μ (average). Body ± 64 μ, subtriangular, dense, intramicroreticulate. No tetrad mark or striations seen. Sacci three, one of them smaller than others (52 × 75 μ); attachment apparently on both sides of body subequatorially, roots on one side associated with triangular body-infold system.

Remarks — *Crustaesporites* Leschik is trisaccate but has striations on body. The solitary specimen represents a distinct form

but it remains uncertain if it was a normal grain.

Occurrence — Very rare; Sample B9/662 (Late Talchir).

Group — *Acritarcha* Evitt, 1933
Subgroup — *Sphaeromorphitae* Downie & Sargeant, 1963

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

Leiosphaeridia bokaroensis sp. nov.

Pl. 1, figs. 16-18; Pl. 3, fig. 60

Holotype — Pl. 1, fig. 18.

Type Locality — West Bokaro Coalfield, Bihar; Dudhi River section. Sample B17/662 (Early Talchir)

Age & Horizon — Talchir Formation (Permo-Carboniferous), Lower Gondwana.

Diagnosis — Vesicles originally spherical, shape variously modified by compression. Size range 50-100 μ (diameter). Wall ±2 μ thick, laevigate to indistinctly infrastructured (infrapunctate?), strongly folded; folds irregular, prominent. Pilome absent.

Comparison — *Leiosphaeridia* sp. described by Maithy (1969) from the Vindhyan is comparable in wall compression folds but the forms are described to have a densely punctate wall which is not seen in the present species. *Leiosphaeridia indica* Lele & Chandra (1972) compares in size but distinguishes by its thinner wall and lack of prominent folds.

Occurrence — Frequent; Sample B-17/662 (Early Talchir), Pl. 1, figs. 16-18. Rare; Sample B9/662 (Late Talchir), Pl. 3, fig. 60.

Leiosphaeridia talchirensis Lele & Karim, 1971

Pl. fig 22; Pl. 3, fig. 59

Remarks — This species is characterised by small-sized moderately thin vesicles with strongly folded wall.

Occurrence — Common; Sample B17/662 (Early Talchir), Pl, 1, fig. 22. Rare; Sample B9/662 (Late Talchir), Pl. 3, fig. 59.

INSERTAE SEDIS

Tracheids and Cuticles

Pl. 1, fig. 21; Pl. 2, fig. 27

Some tracheids (Pl. 1, fig. 21) showing pits are present in the early Talchir samples (B19/662 & B17/662). They also occur in the late Talchir sample (B9/662) but in addition, there are a few fragments of leaf cuticles (Pl. 2, fig. 27) with well-preserved epidermal cells but no stomata.

Spicule-like Microfossils

Pl. 1, figs. 19, 20

Description — One early Talchir sample contains a large number of a kind of spicule-like acicular microfossils in association with few monosaccate miospores. The bodies are narrow, ± lenticular with sharp ends. The noted size range is 75-250 μ in length and 4-20 μ in width. They are transparent and almost colourless. A median line is often clearly seen running across the entire length which recalls the central canal of spicules. One or more structures of similar kind may grow out of a larger body from one or more random points along the side (Pl. 1, fig. 20). Sometimes the ends may be forked (Pl. 1, fig. 19). Other manifestations of developmental stages are also encountered. The bodies are probably calcareous.

Remarks — Calcareous spicules of four distinct kinds were recently recorded from the Talchir marine intercalations in the Daltonganj Coalfield (Lele & Srivastava, 1974). The present structures are quite distinct and represent a new type.

Occurrence — Common; Sample B19/662 (Early Talchir).

DISCUSSION

Miofloral Composition — In general composition the miofloras of the Dudhi River section are characterized by a striking dominance of monosaccate miospores. Triletes (Pteridophytic) and disaccates are in contrasting minority.

From comparative standpoint the miofloral aspect of the early Talchir samples (B19/662 & B17/662) is significantly different

from that of the late Talchir sample (B9/662). The differences are not only quantitative but obviously of qualitative nature as well.

In the early Talchir sample, the miospore assemblage is markedly poor, being restricted to 8 genera and 14 species (Tables-1 & 2). The population does not permit a reliable percentage assessment of the distribution pattern of these taxa. Miospores commonly seen belong to *Verrucosisporites* (1 sp.), *Parasaccites* (2 spp.), and *Potonieisporites* (5 spp.). *Plicatipollenites* (2 spp.) and *Virkkipollenites* (1 sp.) stand next. Only one example of *Pityosporites* is found, but striate disaccates are strikingly missing. Equally noteworthy is the common association of *Leiosphaeridia* and in one sample of spicule-like microfossils.

In sharp contrast to the above, the late Talchir mioflora is not only quantitatively rich but is also substantially diversified in genera and species. A total of 15 genera and 29 species is recognisable (Tables 1 & 2). Of these 10 genera are represented in the frequency counts based on 200 specimens. The rare, unaccounted genera are *Leiotriletes*, *Verrucosisporites*, *Jayantisporites* and *Tuberisaccites*. As is clear from Table 2 and Histogram-1A & B, the monosaccates

TABLE 1 — OCCURRENCE (+) AND PERCENTAGE DISTRIBUTION OF PALYNOMORPHS IN THE EARLY AND LATE TALCHIR SAMPLES, WEST BOKARO COALFIELD

Palynomorphs	Early Talchir B17/662	Early Talchir B19/662	Late Talchir B9/662
1. *Callumispora gretensis*			1·0
2. *Plicatipollenites indicus*		+	23·0
3. *P. densus*			3·0
4. *P. gondwanensis*		+	4·5
5. *P. trigonalis*			2·0
6. *P. maculatus*			0·5
7. *Virkkipollenites triangularis*			1·5
8. *V. mehtae*			2·0
9. *Potonieisporites neglectus*		+	4·0
10. *P. magnus*		+	1·0
11. *P. monosaccoides*		+	1·0
12. *P. lelei*			1·0
13. *P. crassus*		+	0·5
14. *P. mutabilis*		+	0·5
15. *Parasaccites diffusus*		+	20·0
16. *P. densicorpus*		+	25·0
17. *P. fimbriatus*			4·5
18. *P. bilateralis*			0·5
19. *Caheniasaccites densus*			1·5
20. *Limitisporites diversus*			1·0
21. *Faunipollenites cf. parvus*			1·0
22. *Crescentipollenites talchirensis*			0·5
23. *Striatoparvisaccites indicus*			0·5
24. *S. circularis*			+
25. *Leiotriletes* sp.			+
26. *Verrucosisporites* sp.			+
27. *Jayantisporites* cf. *conatus*			+
28. *Tuberisaccites tuberculatus*			+
29. *Limitisporites thomasi*			+
30. *Cuticles*			+
31. *Cyclogranisporites* sp.		+	
32. *Verrucosisporites* cf. *donarii*		+	
33. *Apiculatisporis* sp.		+	
34. *Virkkipollenites* sp.		+	
35. *Pityosporites* sp.		+	
36. Spicule-like bodies		+	
37. *Leiosphaeridia bokaroensis*		+	+
38. *L. talchirensis*		+	+
39. *Tracheids*		+	+

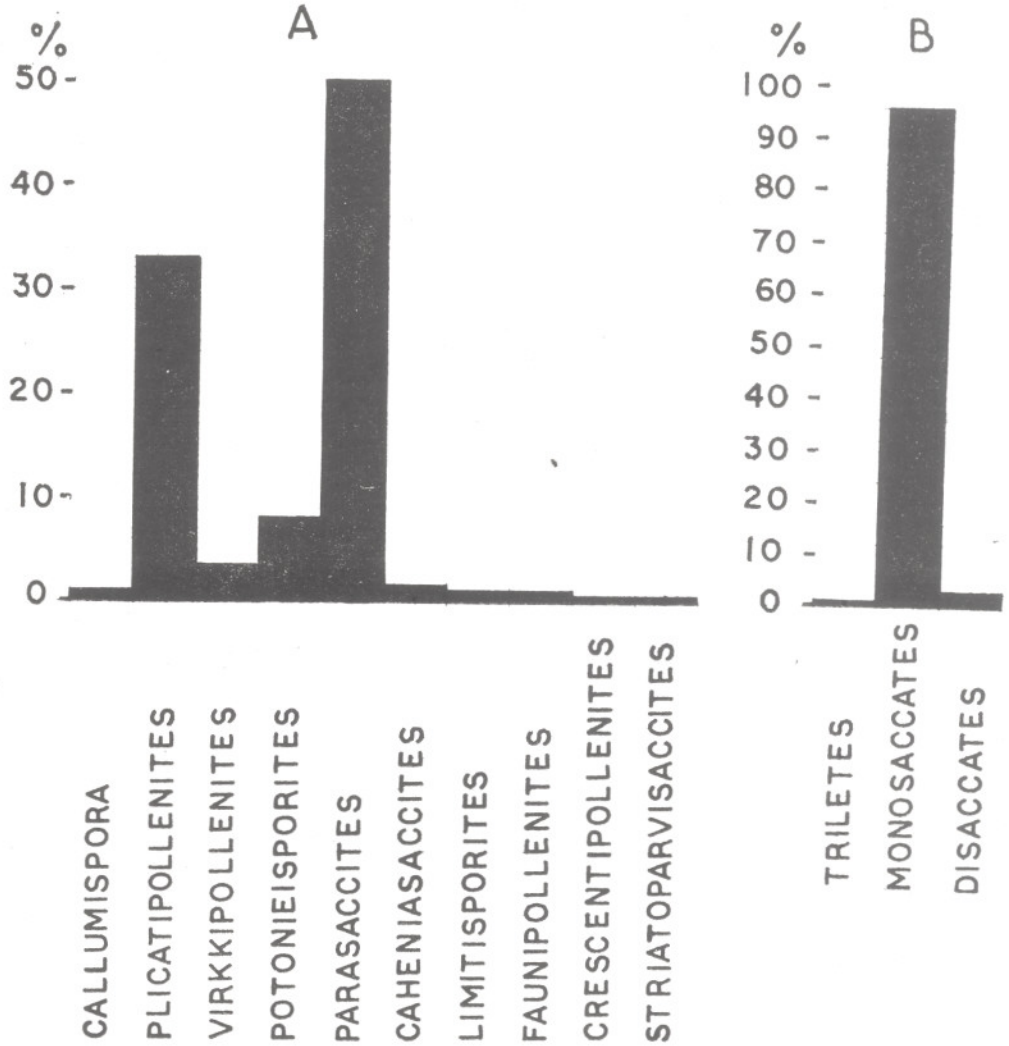
TABLE 2 — OCCURRENCE (+) AND PERCENTAGE DISTRIBUTION OF MIOSPORE GENERA AND MAJOR GROUPS IN THE EARLY AND LATE TALCHIR SAMPLES, WEST BOKARO COALFIELD

Early Talchir B17/662	Early Talchir B19/662	Genera	Late Talchir B/9662	Major Groups	
		1. *Callumispora*	1·0	Triletes	1
+		2. *Parasaccites*	50·0		
+		3. *Plicatipollenites*	33·0		
+		4. *Potonieisporites*	8·0	Monosaccates	96
+		5. *Virkkipollenites*	3·5		
		6. *Caheniasaccites*	1·5		
		7. *Limitisporites*	1·0		
		8. *Faunipollenites*	1·0	Disaccates	3
		9. *Crescentipollenites*	0·5		
		10. *Striatoparvisaccites*	0·5		
		11. *Leiotriletes*	+		
		12. *Jayantisporites*	+		
		13. *Tuberisaccites*	+		
+		14. *Cyclogranisporites*			
+		15. *Apiculatisporis*			
+		16. *Pityosporites*			
+		17. *Verrucosisporites*	+		

are the predominant constituents whereas the disaccates and triletes are very rare, though significant by their presence. Among the monosaccates, *Parasaccites* (50%) *Plicatipollenites* (33%) and *Potonieisporites* (8%) make the major contribution. Several species of these genera are unknown in the early Talchir sample, viz., *Plicatipollenites densus, P. maculatus, Potonieisporites lelei, Parasaccites fimbriatus* and *P. bilateralis*. A number of genera also make their first appearance in the late Talchir sample, viz., *Jayantisporites, Caheniasaccites, Tuberisaccites,* and *Limitisporites*. Above all, the disaccate Striatiti is for the first time recognisable in the late Talchir by the genera *Faunipollenites, Crescentipollenites* and *Striatoparvisaccites* gen. nov. *Leiosphaeridia* become very rare and spicule-like microfossils are not encountered.

Comparisons — Mioflorules representing earlier part of the Talchir are known from very few places, e.g. in the Manendragarh Coalfield (Lele & Chandra, 1972). This assemblage, containing only 7 genera, also gives the impression of a more or less impoverished flora similar to the early Talchir assemblage from West Bokaro Coalfield (Sample B19/662, B17/662). Both are essentially monosaccate-dominant (± 96%) miofloras characterised by a very limited number of species belonging chiefly to *Parasaccites, Plicatipollenites* and *Potonieisporites*. Very low amount of *Caheniasaccites* (2%) and *Faunipollenites* (1%) is also present in the Manendragarh assemblage but these genera are not found in the early Talchir of West Bokaro. On the whole, the nonstriate and striate disaccates appear to be inconsistent or absent in the earlier Talchir sediments. Trilete spores are very sporadic.

The late Talchir mioflora is so far best known from the South Rewa Basin (Potonié & Lele 1961; Lele, 1966) in the Johilla River section where it occurs close to the Barakar (or Karharbari) boundary — a situation closely paralleling that of the West Bokaro Coalfield. Perhaps, the Talchir assemblage from Mangthar in the same area (Lele & Chandra, 1973) may also be fairly younger than the early Talchir in view of the fact that the samples lie almost at the Barakar junction rather than the Archaean boundary. Another good mioflora of late Talchir appearance is known from the Jayanti Coalfield (Lele & Karim, 1971; Lele & Makada, 1972). These floras of more or less later Talchir age, despite their differences in stratigraphic levels and local floristic peculiarities, are by and large of the same kind as the late Talchir assemblage now found in the West Bokaro Coalfield (Sample B9/662). Clearly all of them show a definite and substantial improvement by way of proliferation and diversification in the population. *Parasaccites, Plicatipollenites* and *Potonieisporites* continue to maintain their



HISTOGRAM 1 (A, B) — Percentage frequency distribution of miospore genera (in A) and major groups (in B) in the late Talchir sample (B9/662) from West Bokaro Coalfield.

stronghold, but additionally several genera and species and more especially the striate disaccates seem to make a recognizable appearance in the late Talchir and become stable constituents of the miofloras. This is also borne out by the evidence from the West Bokaro Coalfield.

BIOSTRATIGRAPHIC CONSIDERATIONS

An important point that emerges from the above discussion is that there seem to exist recognizable differences of qualitative and quantitative nature between the miofloras of the early and late Talchir. These differences have an obvious correlation with the changing pattern of climate in the Talchir Stage-commencing with adverse cold but subsequently ameliorating to a cool, temperate condition towards the late Talchir. Plant life was conceivably more restricted in the early Talchir with limited manifestations, but after a considerable lapse of time, in the later part of

the Talchir a number of new elements appeared on the scene and proliferated rather rapidly. It would not, therefore, be surprising to expect distinct differences between the early and late Talchir floras.

It seems now highly probable, especially in the light of the eivdence from the West Bokaro Coalfield, that there could be two miofloral assemblages — and not one as hitherto believed — in the Talchir Formation: one occurring in the early Talchir and the other in the late Talchir. Precise biostratigraphical circumscription of these assemblages, based both on ranges of taxa and their frequencies, is a task worthy of further detailed investigation.

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EXPLANATION OF PLATES

Plate 1

(Early Talchir Mioflora)

1. *Verrucosisporites* cf. *donarii* Pot. & Kr. Slide Regd. No. 4753. × 500.

2, 3. *Cyclogranisporites* sp. Slide Regd. Nos. 4752, 4753. × 500.

4. *Apiculatisporis* sp. Slide Regd. No. 4748. × 500.

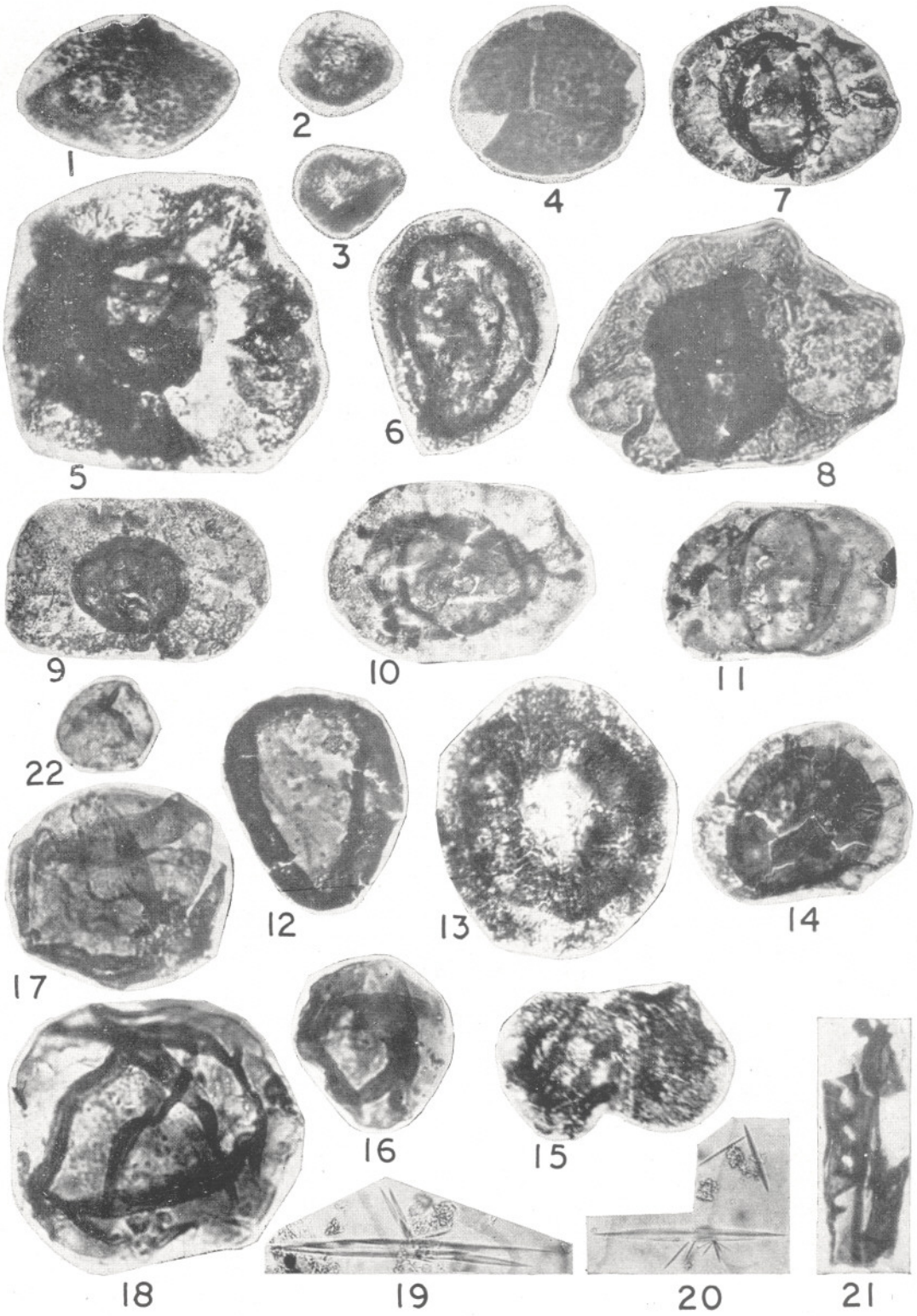
5. *Plicatipollenites gondwanensis* (B. & H.) Lele. Regd. Slide. No. 4747. × 500.

6. *Virkkipollenites* sp. Regd. Slide. No. 4746. × 250.

7. *Potonieisporites magnus* Lele & Karim. Slide Regd. No. 4749. × 250.

8. *Potonieisporites mutabilis* Lele & Chandra. Slide Regd. No. 4745. × 500.

9. *Potonieisporites crassus* Lele & Chandra. Slide Regd. No. 4747. × 250.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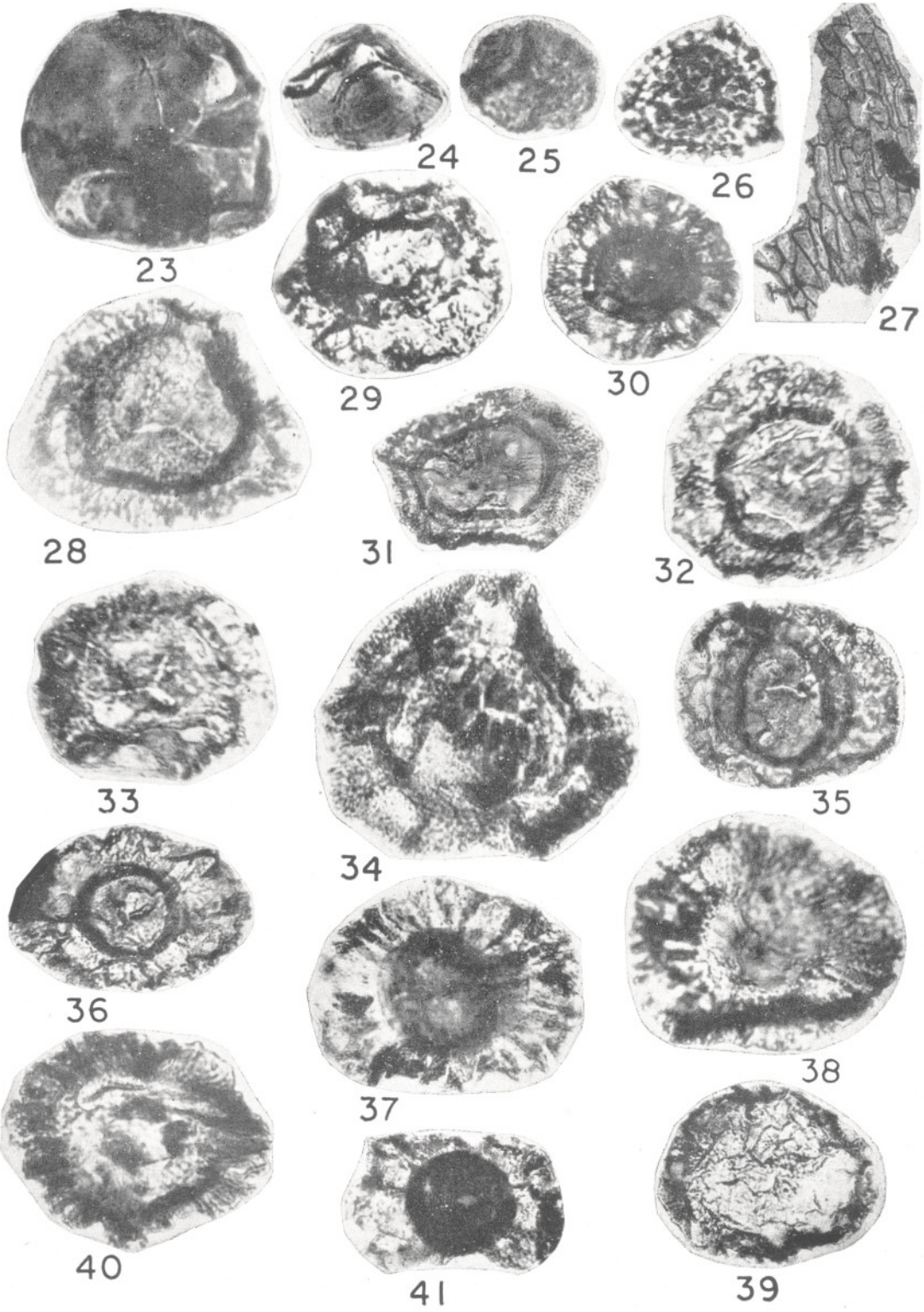
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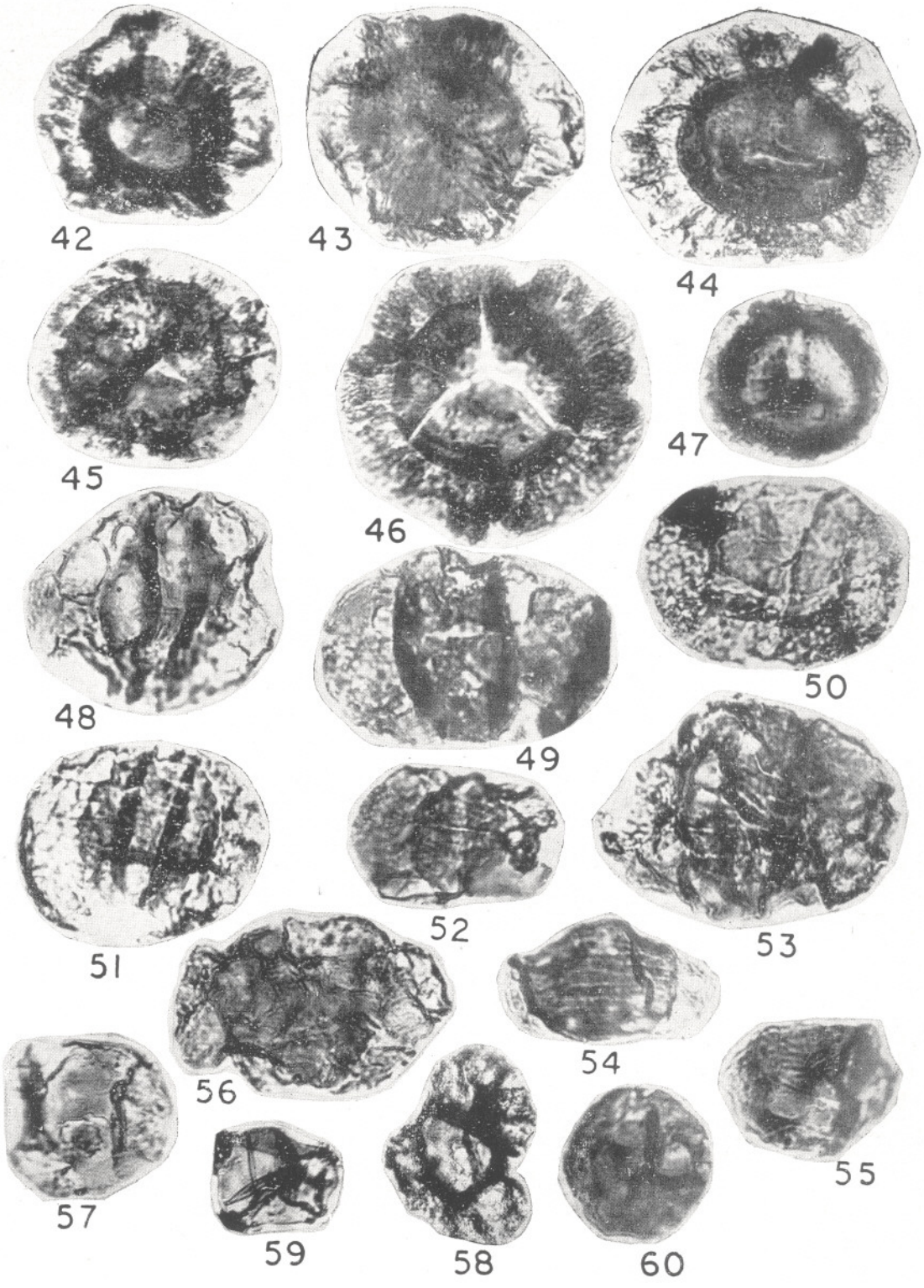
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10. *Potonieisporites neglectus* Pot. & Lele. Slide Regd. No. 4751. × 250.
11. *Potonieisporites monosaccoides* (Maheshwari) comb. no. Slide Regd. No. 4753. × 250.
12. *Parasaccites diffusus* Tiwari. Slide Regd. No. 4744. × 250.
13. *Parasaccites densicorpus* sp. nov. Slide Regd. No. 4752. × 500.
14. *Parasaccites densicorpus* sp. nov. Slide Regd. No. 4749. × 500.
15. *Pityosporites* sp. Slide Regd. No. 4746. × 500.
16-18. *Leiosphaeridia bokaroensis* sp. nov. Slide Regd. Nos. 4753, 4750 (Holotype). × 500.
19,20. *Spicule-like microfossils.* Slide Regd. No. 4744. Ca. × 128, Ca. × 120.
21. Tracheid with simple pits. Slide Regd. No. 4753. × 500.
22. *Leiosphaeridia talchirensis* Lele & Karim. Slide Regd. No. 4752. × 500.

Plate 2
(Late Talchir Mioflora)

23. *Callumispora gretensis* (B. & H.). Bharadw. & Srivast. Slide Regd. No. 4759. × 500.
24. *Leiotriletes* sp. Slide Regd. No. 4760. × 500.
25. *Verrucosisporites* sp. Slide Regd. No. 4757. × 500.
26. *Jayantisporites* cf. *conatus* Lele & Makada. Slide Regd. No. 4755. × 500.
27. Cuticle with distinct epidermal cells. Slide Regd. No. 4761. × 100.
28. *Plicatipollenites trigonalis* Lele. Slide Regd. No. 4761. × 500.
29. *Plicatipollenites maculatus* Lele & Karim. Slide Regd. No. 4762. × 250.
30. *Plicatipollenites densus* Srivastava. Slide Regd. No. 4755. × 250.
31. *Plicatipollenites gondwanensis* (B. & H.) Lele. Slide Regd. No. 4757. × 250.
32. *Plicatipollenites indicus* Lele. Slide Regd. No. 4761. × 500.
33. *Virkkipollenites mehtae* Lele Slide Regd. No. 4761. × 500.
34. *Virkkipollenites triangularis* (Mehta) Lele. Slide Regd. No. 4762. × 500.
35. *Potonieisporites magnus* Lele & Karim. Slide Regd. No. 4761. × 250.
36. *Potonieisporites lelei* Maheshwari. Slide Regd. No. 4763. × 250.
37. *Potonieisporites crassus* Lele & Chandra. Slide Regd. No. 4762. × 500.
38. *Parasaccites fimbriatus* Bose & Maheshwari. Slide Regd. No. 4757. × 500.
39. *Parasaccites diffusus* Tiwari. Slide Regd. No. 4762. × 250
40. *Tuberisaccites tuberculatus* (Maheshw.) Lele & Makada. Slide Regd. No. 4761. × 500.
41. *Caheniasaccites densus* Lele & Karim. Slide Regd. No. 4762. × 250.

Plate 3
(Late Talchir Mioflora)

42-45 & 47. *Parasaccites densicorpus* sp. nov. Slide Regd. Nos. 4762, 4757, 4755, 4762, 4756, 4762. × 500.
46. *Parasaccites densicorpus* sp. nov. (al. *Virkkipollenites densus* Lele, 1964). Goraia, S. Rewa Basin. Talchir Fm. Slide Regd. No. 702. × 500.
48. *Limitisporites thomasi* (Pant) comb. nov. Slide Regd. No. 4757. × 500.
49. *Limitisporites diversus* Lele & Karim. Slide Regd. No. 4761. × 500.
50. *Faunipollenites* cf. *parvus* Tiwari. Slide Regd. No. 4761. × 500.
51-53. *Crescentipollenites talchirensis* sp. nov. Slide Regd. Nos. 4763 (Holotype), 4758, 4762. × 500.
54. *Striatoparvisaccites indicus* gen. et sp. nov. Slide Regd. No. 4757 (Holotype). × 500.
55. *Striatoparvisaccites indicus* gen et. sp. nov. The body is apparently detached from sacci. Slide Regd. No. 4755. × 500.
56. *Striatoparvisaccites circularis* gen. et. sp. nov. Slide Regd. No. 4761 (Holotype). × 500.
57. *Striatoparvisaccites circularis* gen. et sp. nov. The body is apparently detached from sacci. Slide Regd. No. 4657. × 500.
58. Trisaccate miospore. Slide Regd. No. 4758. × 250.
59. *Leiosphaeridia talchirensis* Lele & Karim. Slide Regd. No. 4760.× 500.
60. *Leiosphaeridia bokaroensis* sp. nov. Slide Regd. No. 4757. × 500.