PALYNOLOGICAL INVESTIGATIONS OF SOME COAL SEAMS IN THE IB-RIVER COALFIELD (ORISSA), INDIA

R. S. TIWARI

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

A palynological analysis of some coals from Ib-river (Rampur-Hingir) Coalfield, Orissa, has been done. The samples investigated were collected from four different collieries (pits), representing the locally called Hingir-Rampur seam (Pit Nos. 5 and 11, Orient incline) and Ib-seam incline near Brijraj Nagar. These coals have been found to be quite rich in the microspore and pollen grain contents. The *Sporae dispersae* has been assigned to 34 genera and 51 species out of which 2 genera and 15 species have been described as new. A qualitative analysis based on distribution of species has shown that there are two distinct assemblages represented in the seams under study.

INTRODUCTION

IB-RIVER (or Rampur-Hingir) Coalfield is a part of the eastern end of a large area of Gondwana rocks which crosses the north eastern part of Madhya Pradesh and South Rewa. It is restricted to the extreme eastern tip of this area, where it is traversed by the Ib-river, which shows a narrow band of Talchirs connecting the Talchir Coalfield with that of the Ib-river areas North of Sambalpur (21°27′ : 83°58′). The Ib-river or Rampur coalfield named after the village Rampur (21°47′N : 83°56′ E) is a part of Raigarh Hingir field and belongs to the Mahanadi group of Gondwana outlier.

The Gondwana rocks in this field are represented by Talchir Series, Damudas and Mahadevas. The productive coalseams have been considered to belong to the Barakar Stage (Lower Permian) of Damuda Series (Fox, 1934). The present investigation is based upon the coal samples from four collieries near Brijraj Nagar (21° 48′ N: 83°44′ E).

In the following pages a systematic description of *Sporae dispersae* in some coals of Ib-river coalfield, has been given. A qualitative comparison with some miofloras has also been attempted. The correlation aspect including the statistical comparison will be discussed elsewhere.

MATERIAL AND METHODS

Four overall samples were prepared out of a number of channel samples from four different collieries. The details are as given below:

Overall sample No.	*Location*	*No. of Channel samples*
1	Hingir-Rampur Seam, Pit No. 11	7
2	Hingir-Rampur Seam, Pit No. 5	12
3	Hingir-Rampur Seam, Orient incline	7
4	Ib-seam incline	7

These four overall samples were extensively analysed to get a representative picture of miospore assemblage in each of these seams.

The maceration was carried out by the usual method. The samples took 3-5 days of acid treatment. Slides were prepared in glycerine jelly. All the slides are stored in the Museum at Birbal Sahni Institute of Palaeobotany, Lucknow.

SOME MORPHOGRAPHICAL OBSERVATIONS

In the present investigations a number of finer morphographic characters and their hitherto unknown associations have been brought to light. This could be determined after a thorough study of large number of specimens from the present assemblage as well as similar specimens from other Indian Lower Gondwana miofloras (TIWARI, 1964, 1965). It is important that the new taxonomic units, which are being proposed in this paper on the basis of the characters they bear, are of stratigraphical significance also, when viewed upon by their known dispersal.

Punctatisporites, a characteristic genus of the Upper Karharbari and Lower Barakar Stages (BHARADWAJ, 1966) has been grouped so far in to a single species named as *P. gretensis* Balme & Henn. (1956b). The present study has revealed that the distribution of intra-punctation in the spore exine can help in identifying two species — *P. gretensis* with restricted distribution of puncta only in the inter-ray-regions and *P. uniformis* sp. nov. (PL. 1, FIGS. 4 & 5) with puncta spreading uniformly all over the body. A third species *P. indicus* sp. nov. (PL. 1, FIGS. 6-8; TEXT-FIG. 1) shows a much smaller size range and indistinct punctation.

The restricted distribution of ornamentational processes has also been recorded in other trilete genera. In the species *Horriditriletes unicus* Tiwari (1965), the processes are present only on the distal face and the margin of the spore body, the proximal face being laevigate-intrapunctate. Similar type of restriction in the placement of coni has been seen in the specimens described under the genus *Apiculatisporis* as *A. levis* B. & H., which led to its emendment (PL. 1, FIGS. 12-16). In accordance with this observation, it has to be noted that such forms are significant for Barakar Stage in general and show meagre representation elsewhere.

A trilete genus has been instituted on the basis of the confluence of bacula-pila like ornamentational processes in various degrees. This spore named as — *Brijrajisporites* gen. nov. (PL. 1, FIGS. 23, 25-27; TEXT-FIG. 3) resembles with those referred to *Cyclobaculisporites* from Indian miofloras excepting the fusion of bacula forming channels. The latter genus is of a stratigraphical significance since it has been reported to be quite abundant in the North Karanpura miospore assemblage (BHARADWAJ, 1966). In this light, the presence of *Brijrajisporites* in this assemblage is quite interesting.

A further study of the disaccate genera such as *Rhizomaspora* Wilson, *Primuspollenites* Tiwari, and similar forms, has revealed some important features to understand their organizations. The laterally flattened pollen grains although rare, have also been proved to be very useful to determine the nature of attachment of the sacci to the central body and their mode of distal inclination. In the specimens referable to various species of *Rhizomaspora* Wilson, the encroachment of the sacci on the proximal face of the body is evident, which ranges from an incipient degree to a well-marked condition. This, as well as the nature of central body in laterally flattened specimens, suggests that the sacci usually cover the equatorial region of the central body. In other words the exoexine forming the sacci begins to separate itself from the body, well within the equator (proximally). This is evident due to the small, radiating folds of the sacci which are perceptible up to the median region of the proximal cap. This also suggests that the reticuloid type of pattern on the proximal face of the central body is exoexinal in origin and is very much related to the merging saccus zones (TEXT-FIG. 5D). This position of sacci can be termed as an incipient trend towards the "Para-condition of saccus attachment" but not the real one since the saccus free area on the proximal face is much more than the saccus free area on distal side, the body in lateral view is sub-ovoidal with proximal portion broader than the distal one thereby shifting the position of 'equator' towards the proximal pole, and also because the proximal and distal invasions of sacci are not of equal extent. In addition to this, the attachment zones on the subequatorial region of the proximal face are also irregular, not well-defined and usually appear merging with the body exine. These observations have been interpreted in Text-fig. 5.

In the same genus the distal saccus-free area shows a variation in its nature, being vertically elongated (apparently slit-like to channel-shaped but usually ill-defined) to subcircular with laterally continuous sacci. Another stage of this series comes when we come across a species showing ± circular saccus free area on distal side and sacci with lateral continuations. In the latter stage the specimen acquires a monosaccoid condition with apparent disaccate orientation as well as symmetry. However, a study of large number of specimens has suggested that this condition of sulcus is nothing but a stage in the series of range of variation (TEXT-FIGS. 5-A to C) and therefore a status of generic character has not been given to it. This report of monosac coid condition of sacci in normally disaccate specimens is not new but the former trend in the distal sulcus is significant and noteworthy especially in relation to the

evolutionary tendencies in the morphographical characters of dispersed saccate pollen grains.

Another genus, *Ibisporites* gen. nov., shows an important construction as far as the nature of saccus attachment has been determined. The grains (PL. 6, FIGS. 67-74) are non-striate disaccate, diploxylonoid with sacci encroaching the body both proximally and distally well upto the median area, thus leaving an ill-defined, apparently vertically elongated area uncovered. Organizationally, *Ibisporites* is similar to *Primuspollenites* (TIWARI, 1965) to some extent. This is more so to the species *P. obscurus* Tiwari, since in the latter the nature of distal sulcus unlike other species of *Primuspollenites* is somewhat obscure. But the presence of reticuloid striations in the median region of the central body on the proximal face in *Primuspollenites* and their absence in *Ibisporites* determine the identity. The presence of otherwise more or less similar grains, i.e. *Primuspollenites obscurus* and *Ibisporites* species in the same population is striking and their similarity (except the presence or absence of reticuloid striations) is too close to be a mere incident.

As far as understood at the present stage, the distribution of *Ibisporites* is same as that of *Primuspollenites*.

Similar conditions of saccus attachment in various degrees (proximal encroachment of sacci on the central body) have also been suspected in some of the striated and non-striated disaccate grains, along with the 'exact equatorial' position. This indicates that such modes have been a trend of variation which on further study may give important clues to some of the problems in morphography.

The following account of taxonomy forms its base on the system proposed by Potonié (1956, 1958, 1960) and on the lines suggested by Bharadwaj (1962, 1966) in general.

SYSTEMATIC DESCRIPTION

Anteturma — *Sporites* H. Pot. 1893
Turma — *Triletes* (Reinsch) Pot. & Kr. 1954
Subturma — *Azonotriletes* Luber 1935
Infraturma — *Laevigati* (B. & K.) Pot. 1956

Genus *Leiotriletes* (Naum.) Pot. & Kr.1954

Genotype — Leiotriletes sphaerotriangulatus (Loose) Pot. & Kr.

Leiotriletes sp.
Pl. 1 Fig. 1

Remarks — The specimens included in this species are 45-50 μ, triangular with mostly convex or straight sides and round ends. Trilete mark is distinct with rays more than 2/3 the radius long, and generally accompanied by exine folds. Exine is mostly 1 μ thick, finely intrapunctate to structureless and laevigate.

Specimen referred to *Leiotriletes* sp., by Bharadwaj and Salujha (1964, PL. 1, FIG. 1) is similar to the present species.

Genus *Punctatisporites* (Ibr.) Pot. & Kr. 1954

Genotype — Punctatisporites punctatus Ibr. 1933

Punctatisporites gretensis Balme & Henn. 1956b
Pl. 1, Figs. 2, 3

Remarks — The specimens referable to *P. gretensis* show a wide range of variation as far as their size and the thickness of the exine in optical section are concerned. Thus, the size range so far recorded is 60-110 μ and the thickness of the exine is 1-4 μ. However, the important character determined in the specific delimitation of these spores, is the distribution of intrapunctation on the exine. In the present species only those spores have been included which show a more or less restricted intrapunctation along the inter-ray areas, the remaining portion being almost unstructured.

Punctatisporites uniformis sp. nov.
Pl. 1, Figs. 4, 5

Holotype — Pl. 1, Fig. 4.

Diagnosis — Holotype 72 μ. Circular, subcircular or roundly — triangular spores in flattened condition with a distinct Y-mark and uniformly disposed intrapunctation all over the body exine.

Description — Size variation 58-72 μ; trilete-mark well defined, rays reaching almost up to the 2/3 length of the body-radius. Labra thin or sometimes slightly thick, puncta being distinct, all over the exine, sometimes adjacent puncta fusing to give coarse appearance. Thickness of the exine in optical section 1-2·5 μ. *Extrema*

lineamenta smooth. Folds in the body may present.

Comparison — As already stated *P. gretensis* B. & H. can be identified on the basis of restricted distribution of puncta and so also the species *P. priscus* Bharadwaj & Salujha (1965). In *P. punctatus* (Ibr.) Pot. & Kr., the trilete rays reach almost up to the corners. *P. fungosus* Balme, has a very thick exine. A specimen illustrated by Balme & Hennelly (1956b, PL. 2, FIG. 13) appears to find its place in the present species.

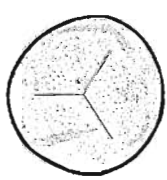
Punctatisporites indicus sp. nov.
Pl. 1, Figs. 6-8

Holotype — Pl. 1, Fig. 6.

Diagnosis — Trilete bearing, very small and subcircular spores with finely intrapunctate, thick exine. Holotype 33 μ.

Description — Size-range noted 24-35 μ. Miospores subcircular or sometimes roundly subtriangular (TEXT-FIG. 1), Y-mark distinct in most of the cases, rays 1/2-2/3 radius long with thin labra and low vertex. Mark may as well be open. Exine 1-1·5 μ thick in optical section, finely intramicropunctate, sometimes appearing as structureless, outline completely smooth.

Comparison — The species discussed earlier are much bigger in size and hence differ from the present one. *P. minutus* Kosanke (1950) is identical with the present species in over all size, but differs in having much thinner exine which is generally subjected to secondary folds.



TEXT-FIG. 1 — Sketch line drawing of *Punctatisporites indicus* sp. nov., showing the overall shape, nature of trilete mark and intrapunctation.

Genus *Hennellysporites* Tiwari 1968

Genotype — *Hennellysporites diversiformis* (Balme & Henn. 1956b) Tiw.

Hennellysporites indicus Tiw. 1968
Pl. 1, Fig. 9

Remarks — The specimens referable to *H. indicus*, conform to the description given by me (TIWARI, 1968). The figure illustrated here (PL. 1, FIG. 9) shows a slightly obliquely flattened spore. It is noteworthy in this specimen that the Y-mark along with the distinct triangular inter-ray thickening has shifted to one side, pointing out thereby that this thickened area is an inter-ray thickening.

Infraturma — *Apiculati* (Benn. & Kids.) Pot. 1956

Subinfraturma — *Nodati* Dyb. & Jach. 1957

Genus *Lophotriletes* (Naum.) Pot. & Kr. 1954

Genotype — *Lophotriletes gibbosus* (Ibr.) Pot. & Kr.

Lophotriletes sp.
Pl. 1, Fig. 18

Description — Triangular with concave sides and round ends, 33-37 μ in size. Rays distinct, more than 2/3 of the radius long Exine covered with closely set 1-2 μ × 1-2 μ pointed, cuvred or straight coni. ± 36 coni counted along the border. A thickened border present around the trilete area.

Comparison — Cf. *Lophotriletes rarus* Bharad. & Salujha (1964) resembles the present species in almost all other characters except in the distribution of ornamentational processes.

Genus *Apiculatisporis* (Ibr.) Pot. & Kr. 1956

Genotype — *Apiculatisporis aculeatus* (Ibr.) Pot. & Kr. 1956

Apiculatisporis levis (Balme & Henn. 1956b) emend.
Pl. 1, Figs. 12-16

Holotype — Balme & Hennelly, 1956b, pl. 2, fig. 20.

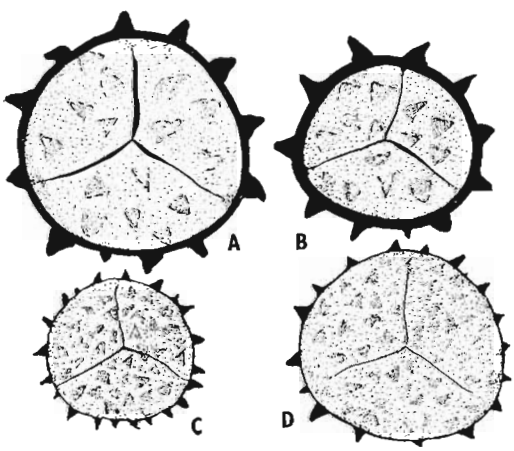
Diagnosis (emend.) — Small spores, subcircular, roundly subtriangular to subtriangular in shape. Y-mark distinct, rays 2/3 or equal to the radius thus reaching up to the margin. Exine thin, finely structured, ornamented with sparse 1-4 μ long × 1-4 μ broad at the base, conical, blunt or pointed processes all over the distal face and the margin.

Description — (TEXT-FIG. 2 c, d) known size 18-37 μ. Shape mostly roundly subtriangular, rarely subcircular, Y-mark dis-

tinct, rays reaching upto the corner, thin and less often accompanied by thin narrow secondary folds, at the terminal ends showing a tendency to widen up. Proximally exine smooth, finely intrapunctate or sometimes indistinctly structured or even unstructured. Distal side as well as the margin beset with pointed or round-tipped blunt coni. No ornamentation on proximal face in a normal proximo-distally oriented spore found. Exine in optical section upto 1 μ thick. 12-25 coni counted on *extrema lineamenta*.

Remarks — The holotype and other photographs of *Apiculatisporis levis* B. & H. (1956b, PL. 2, FIGS. 19-21) reveal on a careful look that the presence of ornamentational processes is only on one face of the spore.

Horriditriletes brevis Bharad. & Salujha (1964) and *Apiculatisporis inconspicuous* Salujha (1965) must be incorporated in this species as junior synonyms, as they also show the restricted distal and marginal ornamentations. In other characters too, these latter species find their place in *Apiculatisporis levis* (B. & H.) emend.



TEXT-FIG. 2 — Nature of ornamentation. A, B— *H. unicus* Tiwari, showing a thick exine, massive bacula on margin and on distal side and slightly folded trilete rays. C, D — *A. levis* (B. & H.) emend. showing thinner exine, smaller processes and faint unfolded rays.

Subinfraturma — *Baculati* Dyb. & Jacho. 1957

Genus *Horriditriletes* Bharad. & Salujha 1964

Genotype — Horriditriletes curvibaculosus Bharad. & Salujha 1964

Cf. *Horriditriletes unicus* Tiwari 1965

Pl. 1, Figs. 10, 11

Remarks — The size-range found in the specimens from the present assemblage is 27-38 μ. They are triangular to roundly triangular in flattened conditions. Y-mark is distinct. Rays reach upto the corners (8-18 μ long), and are generally (if not always) accompanied by thin narrow secondary folds. The ray-ends, where touch the periphery, become broader. The distal and marginal elements are 2-6 μ × 2-6 μ, broad based conical, obtuse or blunt processes. The bacula are sparsely arranged (11 to 19 counted on margin) and at places fuse at their bases on the margin of the spore body. Spore-exine is 2-3 μ thick in optical section and is finely intramicropunctate in structure. Text-figure 2 a, b, shows the nature of Y-mark, exine and bacula in *Horriditriletes unicus*.

Horriditriletes rampurensis sp. nov.

Pl. 1, Fig. 17

Holotype — Pl. 1, Fig. 17.

Diagnosis — Triangular. Holotype 29 μ Y-mark distinct ± 2/3 radius long. Sparsely arranged upto 1·5 μ long and 1μ wide bacula.

Description — Miospores triangular generally with straight or concave sides and broad round ends. Y-mark may sometimes open as in holotype, rays do not exceed normally the 2/3 of the radius. Ornamentational processes are mostly bacula, very rarely intermixed with few blunt coni. 18-22 processes counted along the outline.

Comparison — *H. curvibaculosus* the closely comparable species differs in having much bigger bacula. *H. elegans* Bharad. & Salujha, also differs in being bigger in size and having bigger processes.

Horriditriletes sp.

Pl. 1, Fig. 19

Description — Triangular, Y-mark clear, rays ending before the corners, ornamentation consisting 2-3·5 μ long and 1-1·5 μ wide cylendrical bacula rarely with few blunt conical processes, ± 30 processes on the margin.

Comparison — This species differs from others in the nature and disposition of ornamentational processes.

Genus *Cyclobaculisporites* Bharadwaj 1955

Genotype — *Cyclobaculisporites grandiverrucosus* (Kos.) Bharad. 1955

Cyclobaculisporites minutus Bharad. & Salujha 1964

Pl. 1, Fig. 20

Remarks — Spore is subcircular and folded, measuring 44 μ. Y-mark is not clear. Exine is thin and covered with 1 × 1 μ uniformly placed bacula thus imparting a negative reticulum in deep focus.

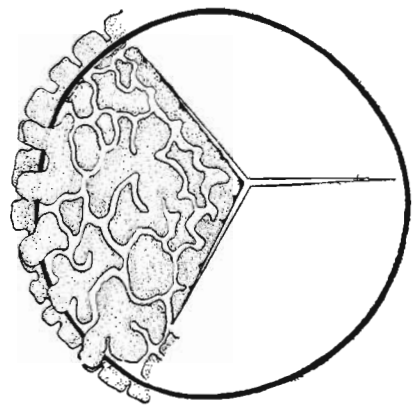
Genus *Brijrajisporites* gen. nov.

Genotype — *Brijrajisporites distinctus* sp. nov.

Generic Diagnosis — Trilete bearing spherical spores, attaining a more or less circular or subcircular shape on flattening. Exine covered with blunt or obtuse bacula-like processes, which generally confluent in various degrees with each other.

Generic Description— Spores spherical as suggested by the inconstant position of Y-mark in flattened form; circular or subcircular on flattening. Y-mark usually distinct, rays 2/3 or more than 2/3 the radius long. Labra apparently thick due to ornamentational fusing, vertex not high. Exine covered with small or big (2-6 μ long × 2-6 μ wide throughout, so far seen) bacula and pila like processes fusing at their various (1/3-2/3) heights as apparent from their position on outline (TEXT-FIG. 3) where apparently looking like a wavy ridge. In proximo-distal view the fusion of processes resulting in the formation of inter-processes-areas varied in shapes and sizes, generally linear, pit-like or irregular, wavy blind canals, thus in deep focus appearing as incomplete negative reticulum. The tips of the fusing processes blunt, obtuse or dome shaped.

Comparison — The partial fusion of the massive bacula-pila like processes and the spherical shape of the spore have not been described so far in any genus. The closely comparable genus *Cyclobaculisporites* differs in having separate and ± uniform bacula all over the body, thus the inter-bacula regions forming a complete negative reticulum. *Verrucosisporites* has verrucose ornamentation which is definitely distinct in having verrucae rather than the fusing blunt or slightly dome-tipped processes, as it is in the present genus. *Converrucosisporites* is a triangular spore and differs in the nature of sculptural elements. So also the genus *Cristatisporites* Pot. & Kr., is a triangular spore with coni or spinae fused at the bases and arranged in a more or less regular manner. *Camptotriletes* (Naum.) Pot. & Kr., differs from the present genus in having cristae and strips as ornamentation, in triangular shape, and in the nature of Y-mark. *Eupunctisporites* Bharad. (1962) apparently a similar spore, differs in having pits rather than baculo-pilate sculpture.



TEXT-FIG. 3 — *Brijrajisporites* gen. nov. in proximo-distal orientation showing slightly accentric position of Y-mark thereby suggesting a spherical shape. A one-third portion showing baculo-pilate ornamentation usually fusing with each other forming irregular, blind cannals in interspaces.

Brijrajisporites distinctus sp. nov.

Pl. 1, Figs. 23, 25

Holotype — Pl. 1, Fig. 25.

Diagnosis — Holotype 70 μ. ± circular. Y-mark clear, rays more than 2/3 radius long. Exine covered with 3-6 μ × 3-6 μ blunt bacula like process, fusing variably in most of their length with each other.

Description — Size range 70-80 μ. Miospore subcircular or circular. Y-mark not constant in position (TEXT-FIG. 3). Rays line accompanied by 4-6 μ wide thick irregular zone of fused ornament. Bacula are blunt or slightly curve-tipped, closely placed and mostly confluent, inter-processes spaces linear narrow and zig-zag cannals.

At border up to 6 μ wide fusion zone apparent.

Brijrajisporites fusus sp. nov.

Pl. 1, Figs. 26, 27

Holotype — Pl. 1, Fig. 27.

Diagnosis — Holotype 65 μ folded, processes 1-3 μ × 1-3 μ in size closely packed, and slightly fused at the base with each other.

Description — Subspherical, Y-mark accentric, rays 2/3 radius long, labra thin. Bacula close, usually fused up to a small height, confluence clear at the margin.

Comparison — In this species the confluence of the bacula is much lesser and only up to a little height at the base. The labra of the rays do not show a much thickened zone of fused sculpture.

Infraturma — *Murornati* Pot. & Kr. 1954

Genus *Microfoveolatispora* Bharad. 1962

Genotype — Microfoveolatispora raniganjensis Bharad.

Microfoveolatispora directa (B. & H.) Bharad. 1962

Pl. 1, Figs. 21, 22

Turma — *Zonales* (Benn. & Kids.) Pot. 1956
Subturma — *Zonotriletes* Waltz. 1935
Infraturma — *Zonati* Pot. & Kr. 1954

Genus *Indotriradites* Tiwari 1964

Genotype — Indotriradites korbaensis Tiwari 1964

Indotriradites sparsus Tiwari 1965

Pl. 1, Fig. 24

Remarks — *Indotriradites* is very meagerly represented in the present assemblage. The specimens assigned to this species show sparsely placed distal ornamental processes.

Turma — *Monoletes* Ibr. 1933
Subturma — *Azonomonoletes* Luber 1935
Infraturma — *Laevigatomonoleti* Dyb. & Jacho. 1957

Genus *Latosporites* Pot. & Kr. 1954

Genotype — Latosporites latus (Kos.) Pot. & Kr. 1954

Latosporites colliensis (B. & H.) Bharad. 1962

Pl. 2, Figs. 28, 29

Anteturma — *Pollenites* R. Pot. 1931
Turma — *Saccites* Erdm. 1947
Subturma — *Monosaccites* (Chit.) Pot. & Kr. 1954
Infraturma — *Aletesacciti* Lesch. 1956

Genus *Densipollenites* Bharadwaj 1962

Genotype — Densipollenites indicus Bharad. 1962

Densipollenites indicus Bharad. 1962

Pl. 7, Fig. 80

Remarks — This genus is relatively less abundant in the present assemblage and is represented by only one species.

Infraturma — *Amphisacciti* Lele 1965

Genus *Parasaccites* Bharad. & Tiwari 1964a

Genotype — Parasaccites korbaensis Bharad. & Tiwari

Parasaccites korbaensis Bharad. & Tiwari 1964a

Pl. 2, Fig. 30

Remarks — The specimens studied here are mostly circular or subcircular in shape, the size range being 104-130 μ. The paracondition of saccus attachment is very clearly seen in all the specimens. Saccus varies in total width from 22-35 μ and shows radially arranged narrow meshes and elongated muri. The outline of the spore is wavy in appearance.

Parasaccites diffusus Tiwari 1965

Pl. 2, Fig 31

Remarks — Specimens are relatively bigger, ranging from 125 to 148 μ in size. The central body outline is not shaply seen. The exine is highly thin, resulting in many microfoldings and shows distinctly to indistinctly intramicroreticulate structure. Y-mark does not seem to be prominent, usually represented by very short folds, thinner area or an opening.

Parasaccites bilateralis Tiwari 1965

Pl. 2, Figs. 33, 34

Remarks — A study of a large number of grains of the genus *Parasaccites* from various localities has suggested that there is a tendency of certain grains to acquire bilaterally oval shape. This trend is incipient in those subcircular specimens which have the monosaccus slightly broader at two sides of the subcircle while narrower at the remaining two sides. This widening of the saccus increases in another set of similar grains. Thus, it is clear that only on this basis these two forms can not be separated at the generic level. At the specific level these forms, in which the saccus is two or more than two times wider at the two sides than the saccus at the remaining two sides, thus giving an ovoidal tendency, can be separated as the present species. Similarly, the nature of Y-mark is variable. The Y-mark in this genus is either well defined, sometimes represented by thin folds or thinner area, or may even be absent. In view of these observations, the absenee or presence of vestigial mark in the form of a fold in bilateral grains, does not suffice to give them a separate generic status.

Parasaccites invasus sp. nov.

Pl. 2, Fig. 35

Holotype — Tiwari 1965, Pl. 4, Fig. 78.

Diagnosis — Circular subcircular or bilaterally oval; central body visible, saccus incipiently encroaching ± equally but at opposite sides of the body circle.

Description — The encroachment of the saccus may or may not be prominent at both the sides but incipient trend usually seen. No body infoldings at the zone of saccus attachment seen. Saccus finely intrareticulate.

Remarks — Similar specimens have been described by me from Barakar of Korba and W. Bokaro coalfields (TIWARI 1965, PL. 4, FIG. 78) as *Parasaccites* sp. This species shows general characters of *Parasaccites* along with a tendency to exhibit a partial *Crucisaccites*—like invasion of sac. Since such forms are rare among a population rich in *Parasaccites* and having no *Cruisaccites*, they have been considered as a species of the former genus.

Genus *Parastriapollenites* Maheshw. 1967

Genotype — *Parastriapollenites rajmahalensis* Maheshw. 1967

Parastriapollenites sp.

Pl. 2, Fig. 32

Remarks— This genus is very scantily represented in the present assemblage. The distinct nature of reticuloid striations, the para-condition of saccus attachment and the subtriangular shape of the body as well as of the grain, are some of the important characters of the species. Trilete mark is faint and meshes of the monosaccus are fine and radially arranged.

Infraturma — *Apertacorpiti* Lele 1964

Genus *Plicatipollenites* Lele 1964

Genotype — *Plicatipollenites indicus* Lele 1964

Plicatipollenites indicus Lele 1964

Remarks — This species is very scantily represented and restricted to the sample No. 4.

Plicatipollenites gondwanensis (B. & H.) Lele 1964

Pl. 2, Fig. 36

Remarks — This species is also poorly represented in the present assemblage.

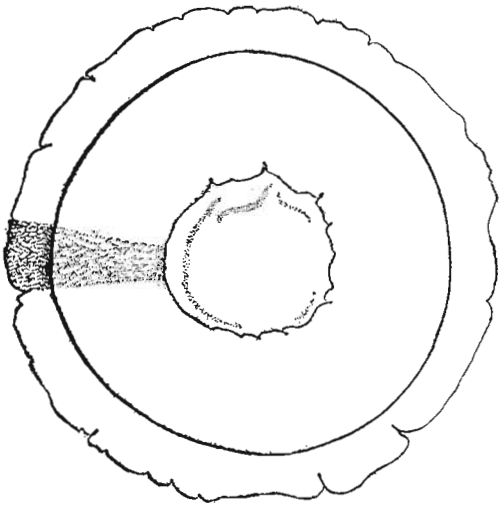
Genus *Virkkipollenites* Lele 1964

Genotype — *Virkkipollenites triangularis* (Mehta) Lele 1964

Virkkipollenites triangularis (Mehta) Lele 1964

Pl. 3, Fig. 37

Remarks —The overall shape of this species has been described by Lele (1964) as roundly triangular, and that for *V. mahtae* Lele, as circular to subcircular and only on this character these two species have been separated. In my openion the latter species should be considered as the junior synonym of the former in view of the fact that such forms show a circular to subtriangular shape. Since no other character of differentiation is present and as admitted by Lele (1964, p. 100), the width of the saccus becomes somewhat variable in different parts which may lead to a roundly



TEXT-FIG. 4 — Sketch line drawing of the species *Virkkipollenites orientalis* approx. to the scale, to denote the distal extent of saccus inclination and narrower saccus extent at the equator: A small portion showing the details of saccus structure. Central subcircular area indicates the distal saccus free area of the central body.

triangular shape, these two species cannot be separated.

Virkkipollenites orientalis sp. nov.

Pl. 3, Figs. 38-40

Holotype — Pl. 34, Fig. 38.

Diagnosis — Pollen grains subcircular to roundly subtriangular, holotype 88 μ. Central body big, distinct, without any distinct trilete mark. Saccus narrow proximally but very broad distally invading the body more than 1/2 the radius from all sides thus leaving a very small distal area uncovered. Meshes radially arranged.

Description — Size range 75-100 μ, central body distinct, subcircular or roundly subtriangular 60-80 μ in size, 68 μ in holotype. Exine thin, opaque, apparently smooth without any structure, sometimes folded; Y-mark not seen. Monosaccus 8-15 μ wide uniform or slightly variable from the equator proximally but inclined distally to encroach the body upto the central region (TEXT-FIG. 4); distal width of saccus from equator 15-28 μ almost equal from all sides. The zone of distal attachment sharply defined slightly irregular due to radial nature of thicker muri. The distal sac free area 20-32 μ subcircular, 32 μ in holotype. Saccus intrareticulation fine-medium, meshes being upto 4 μ and muri 1-2 μ thick radially arranged giving the outline a wavy appearance.

Comparison — All the species of *Virkkipollenites* as described by Lele (1964), differ from the present species in the nature and extent of distal encroachment of the saccus apart from other details. Thus, *V. triangularis* has a visible Y-mark and distinctly intrareticulate structure of the exine. *V. obscurus* and *V. densus* have apart from a Y-mark, an obscure and a denser body respectively.

In the present species, narrow saccus with wider distal inclination, the narrow distal saccus free area of the body and obscurity in Y-mark and exine structure are noteworthy (*see* TEXT-FIG. 4).

Infraturma — *Vesiculomonoradi* (Pant) Bharad. 1956

Genus *Potonieisporites* (Bharad.) Bharad. 1964

Genotype — *Potonieisporites novicus* Bharad.

Potonieisporites sp.

Pl. 3, Fig. 41

Description — Bilateral. Size 130 × 166 μ. Central body distinct, horizontally oval 60 × 47 μ. Exine finely intrareticulate. Monolete mark small, faint. Saccus narrower at lateral sides, somewhat encroaching the equator but not uniformly, distally inclined and attached subequatorially. Sac width at terminal sides 34 μ, at lateral sides 10 μ. Intrareticulation fine.

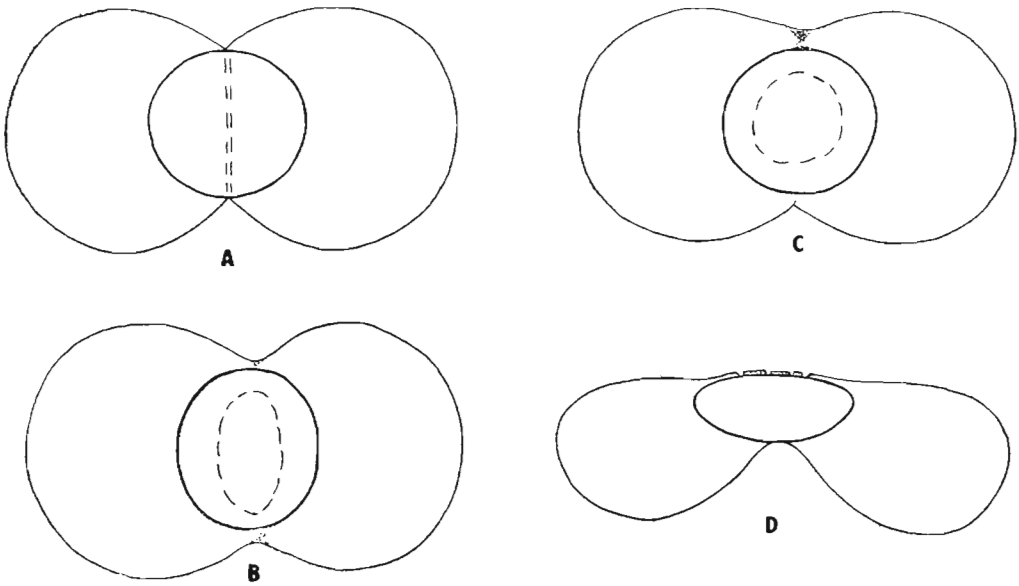
Subturma — *Disaccites* Cookson 1947
Infraturma — *Striareticuloiditi* Tiwari 1964
Genus *Rhizomaspora* Wilson 1962

Genotype — *Rhizomaspora radiata* Wilson 1962

Rhizomaspora indica Tiwari 1965

Pl. 3, Fig. 42

Remarks — As observed in the specimens from Korba Coalfield and West Bokaro Coalfield (TIWARI 1965), the present specimens referred to *Rhizomaspora* also show an invariable tendency of saccus to invade the central body proximally (TEXT-FIG. 5-A—D). Apart from this other important characteristic variations have also been observed.



TEXT-FIG. 5 — Nature of attachment and extent of saccus encroachment in *Rhizomaspora* Wilson. A — *Rhizomaspora indica* Tiwari, showing a slit-like narrow ill-defined distal saccus free area. B, C — *R. monosulcata* exhibiting an ovoid to subcircular saccus free area on distal face. D — Lateral view showing the general concept of the proximal and distal invasion of the body by saccus. Reticuloid striations seen proximally as islands.

The present observations suggest that the specimens with thin body and irregular or faintly marked reticuloid grooves can also find their place in the present species. These forms show an ill-defined, apparently channel shaped saccus free area and doubly intrareticulate, more than hemispherical, laterally adjacent sacci.

Rhizomaspora monosulcata sp. nov.

Pl. 3, Figs. 43-45; Pl. 4, Fig. 46

Holotype — Pl. 3, Fig. 44.

Diagnosis — Bilateral with generally monosaccoid construction of sacci. Central body subcircular or sub-oval; proximal and distal saccus free areas subcircular, and subequatorial. Holotype 123 × 93 μ.

Description—Pollen grains bilateral, size range 82-127 μ × 66-100 μ Central body circular, subcircular or sub-oval, 33-50 μ, thin or mediumly thick; reticuloid striations proximally on the saccus free area, 1-5 μ wide, irregular, faint or distinctly marked. Sacci encroaching the body proximally almost up to 1/3 the body radius, merging with the body exine, distally inclined and invading the body from all sides forming a circular to sub-oval saccus free area as shown in Text-figs. 5-B, C. The distal zone of saccus attachment ill-defined or apparent but never accompanied by thickening or folds. Laterally sacci united or adjacent; in former case narrow to wide, notched unions present. Sacci shape generally hemispherical or more than that, fine to mediumly coarse, often doubly intrareticulate.

Comparison — The present species shows a tendency to form a monosaccoidal distal saccus-free area, thus, the zone of attachment acquiring a circular or ovalish shape. Apart from this the proximal encroachment of sacci, the shape and nature of body, and the nature of reticuloid striations (binding the polygonal areas) make this species an individualistic.

Remarks — On the basis of what has been so far studied in the genus *Rhizomaspora* Wilson, it may be concluded that this genus includes both disaccate and monosaccoidal disaccate species. The proximal encroachment of sacci is more or less a constant character in almost all the forms studied in the genus. As discussed earlier, the polygonal areas on the proximal face

seem to be the exoexinal islands, and the saccus forming exoexine splits from the body as soon as the polygonal areas (a group of islands of exoexine placed together) cease to exist. Apart from this the nature of distal saccus-free area varies from vertically elongated channel or slit-like as in *R. indica*, to oval or subcircular as in the species just described. These stages are shown in Text-fig. 5-A to D. However, in view of the chained transitions, no new generic designation can be given to the present species.

Genus *Primuspollenites* Tiwari 1964

Genotype — Primuspollenites levis Tiwari 1964

Note — The genotype specimen of *Primuspollenites levis* gen. et. sp. nov. has been written as *Primuspollenites novus* per mistake in the explanation of plates (Tiwari 1964, pl. 1, fig. 9. Photo 221/26). Per correction *Primuspollenites novus* should be read as *Primuspollenites levis*).

Primuspollenites levis Tiwari 1964

Pl. 4, Figs. 47, 48

Primuspollenites linterus Tiwari 1964

Pl. 4, Fig. 53

Primuspollenites obscurus Tiwari 1964

Pl. 4, Figs. 49-52

Remarks — A further study of this species suggests that the nature of central body is very thin and the outline remains either invisible or partially seen as in Pl. 4, Fig. 49, the shape being apparently vertically oval. The sacci encroach equatorial margin of body proximally with a merging tendency with the body exine as clearly seen in Pl. 4, Fig. 52. The reticuloid striations are mostly faint and restricted to the proximal central portion of the body; beyond that the microfolds in the sacci start appearing. The sacci are more than hemispherical with usual narrow lateral continuations and double intrareticulation.

Infraturma — *Striatiti* Pant 1954

Genus *Striatites* (Pant) Bharad. 1962

Striatites sp.

Pl. 5, Fig. 60

Genus *Lahirites* Bharadwaj 1962

Genotype — Lahirites raniganjensis Bharad. 1962

Lahirites levicorpus sp. nov.

Pl. 5, Figs. 54-56

Holotype — Pl. 5, Fig. 56.

Diagnosis — Central body ± circular thin, horizontal striations 5-8 (observed) no vertical partitions. Equatorial rim 2 μ wide all round. Distal saccus free area 10-15 μ wide. Sacci subcircular, laterally apart.

Description — Known size 88-100 μ × 50-60 μ. Central body thin, distinct, 33-42 μ, circular or subcircular with ununiformly wide thin rim. Proximally 5-8 branched or unbranched striations present. Exine finely and uniformly intramicropunctate. Distal zones of attachment 10-15 μ apart more or less straight. Sacci big, subcircular, finely intrareticulate.

Comparison — Closely comparable species *L. incertus* Bharad. & Salujha, differs from the present species in having vertical partitions inbetween the horizontal striations. *L. lepidus* Bharad. & Salujha, also distinguishes from the present species in having vertically oval to rhomboidal bigger and thicker body, coarser intrapunctations of the exine and smaller sacci. *L. rhombicus* Maithy, differs in having rhomboidal, thick central body.

Genus *Lunatisporites* (Lesch.) Bharad. 1962

Genotype — Lunatisporites acutus Lesch.

Lunatisporites fuscus Bharad. 1962

Pl. 5, Fig. 57

Genus *Strotersporites* Wilson 1962

Genotype — Strotersporites communis Wilson 1962

Strotersporites indicus Tiwari 1965

Pl. 5, Fig. 61

Remarks The grains are bilaterally oval with ± hemispherical, laterally continuous sacci. The distal channel is wide, delimited by two distinct attachment zones, which usually are accompanied by secondary body folds. The tendency of the median horizontal striation to form a slit like opening is always there.

Genus *Striatopodocarpites* (Soritsch. & Sed.) Bharad. 1962

Striatopodocarpites magnificus Bharad. & Salujha 1964

Pl. 5, Figs. 58, 59

Remarks — The present specimens show an irregular and unconstant rim like extension around the body and the sacci are bigger than the body. However, in over all characters they resemble very much to the species they have been referred to.

Genus *Faunipollenites* Bharad. 1962

Genotype — *Faunipollenites varius* Bharad. 1962

Faunipollenites varius

Pl. 5, Fig. 63

Faunipollenites parvus Tiwari 1965

Pl. 5, Fig. 62

Remarks — The specimens studied here are smaller in size-range than *F. varius* Bharad., being 65-70 $\mu \times$ 42-50 μ in size. They are bilaterally oval with 4-6 horizontal striations and 5-10 μ wide distal channel. *F. perexiguus* Bharad. & Salujha (1964) is subcircular with narrower distal saccus free area. *F. minor* Salujha (1965) is a junior synonym of *F. parvus* Tiwari (1965).

Infraturma — *Disaccimonoleti* Klaus 1963

Genus *Illinites* (Kosanke) Pot. & Kl. 1954

Genotype — *Illinites unicus* Kosanke 1950

Illinites delasaucei (Pot. & Kl.) Grebe & Schweitz. 1962

Pl. 5, Figs. 64-66

Remarks — Specimens here recorded show a wide range of variation in the body shape, size, nature of distal zones of attachment, saccus, their lateral unions and in the nature of monolete mark. The specimens are bilateral with vertically roundly-oval (Pl. 5, Figs. 65, 66) or rhomboidal with flat ends (Pl. 5, Fig. 64) central body. The sacci are either laterally continuous (Pl. 5, Figs. 64, 65) or distinctly appart (Pl. 5, Fig. 66). The distal zones of sacci attachment are widely apart or close and with (Pl. 5, Fig. 64) or without (Pl. 5, Figs. 65, 66) secondary folds. Saccus generally as high as the body. A median vertical slit and a faint to ill-defined horizontal slit (Pl. 5, Fig. 65) is sometimes present. Intrareticulation of saccus is fine.

The varied forms have been included in the same species since similar extent of variation has been recorded by Grebe and Schweitzer (1962) in the *in situ* grains.

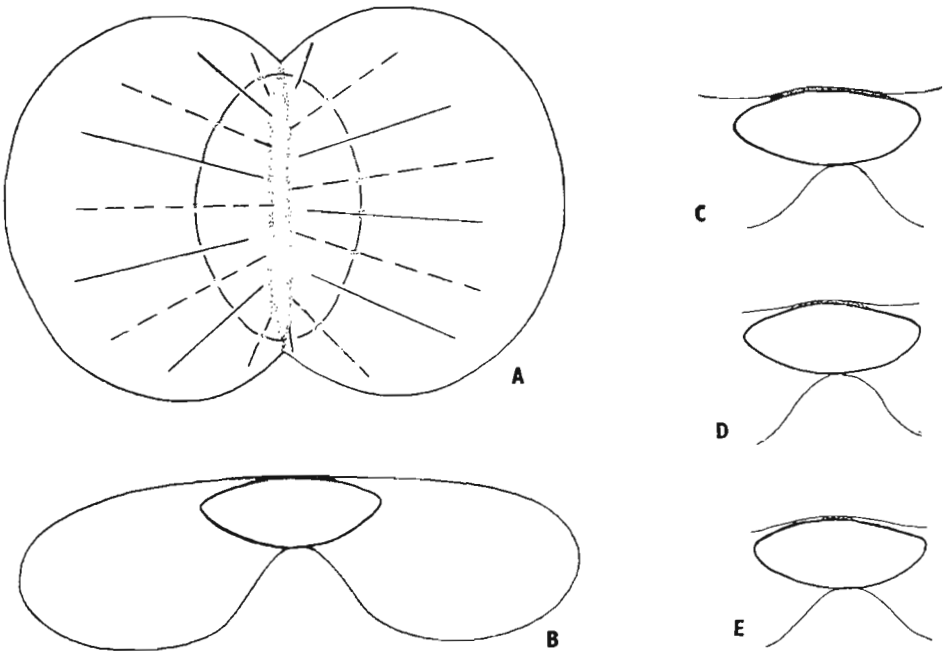
Infraturma — *Disacciatrileti* (Lesch.) Pot. 1958

Genus *Ibisporites* gen. nov.

Genotype — *Ibisporites diplosaccus* sp. nov.

Generic Diagnosis — Pollen grains bilateral, sacci construction disaccate to monosaccoid having lateral continuations. Central body subcircular, oval to elliptical in polar view, lense-shaped to ellipsoid in meridional view, bearing no mark or striation on either sides. Body exine laevigate, structured intramicroreticulate to indistinct intramicropunctate. Sacci enveloping the body equator, proximally invading the body cap up to varied degrees, usually appearing as merging with body exine, leaving a somewhat distinctly defined or indistinct area of the cap free. Distally sacci deeply inclined to leave a narrow straight furrow like area uncovered. Sacci hemispherical to subcircular, with or without lateral unions, intrareticulate.

Description — Bilateral symmetry. Overall shape oval with or without lateral notches; type species distinctly diploxylonoid, central body usually vertically elongated, oval with narrow ends or ellipsoid, usually thin, may be distinct, partially seen or completely invisible, in latter case also extents of the body outline somewhat apparent in oil immersion. Absence of any folding in central body as well as its shape in laterally preserved specimens suggesting the narrow elliptic or lense-shaped construction in lateral view (*see* Text-fig. 6). Sacci proximally sub-equatorially attached, encroaching more from the two sides of longer axis of the grain thus leaving a narrow to wide, laterally elongated area of the proximal body-face uncovered; in some cases proximal invasion being such as to result in the closely lying sacci zone, or some times merging with the body to appear as proximal continuation of sacci. All these stages suggesting the separation of saccus exoexine in various degrees from



TEXT-FIG. 6 — Organization and variation in genus *Ibisporites* gen. nov. A — Proximal view — complete and broken lines show the extent of saccus encroachment on proximal and distal side of the body respectively. B — Meridional section. C-E — Three stages of variation in proximal saccus encroachment, C showing the minimum and E showing the maximum degree.

the body, well within the body equator in proximo-distally flattened grains, are shown in Text-figs. 6-C, D, E. Sacci laterally continuous, (usually notched) or adjacent, hemispherical, more than hemispherical or subcircular. Intrareticulation of saccus fine to coarse, single or even double, in latter the finer meshes being enclosed in the coarser ones. The distal inclination prominent, attachment zones being usually straight, traceable or may be ill-defined, but never prominently thickened or accompanied by secondary body folds.

Comparison — This genus is comparable to *Sulcatisporites* (Lesch.) Bharad., in having a thin or indistinct body and in the nature of ill-defined distal attachment zones. However, a study of large number of specimens of the present genus and those of *Sulcatisporites* has suggested that these two forms show a different trend of variation. *Sulcatisporites* as such should include only big and small forms usually with a circular or subcircularly oval overall shape with hemispherical less than hemispherical, small sacci while *Ibisporites* ranges from oval to distinctly notched, diploxylonoid forms with bilateral symmetry. The small nature of sacci and their distal attachment in *Sulcatisporites*, result in most of the cases in the formation of typical infoldings in sacci along their attachment roots (as given by BHARADWAJ 1962, p. 98). These two folds lie close in median region while slowly widen apart at the lateral ends of the grain. In *Ibisporites* on the other hand the distal attachment zones are more or less straight and do not show the lateral widening tendency. *Vesicaspora* (Schemel) Wils. & Venkat., differs in having a distinct sulcus, a circular (spherical) central body and subcircular proximal attachment of sacci. *Platysaccus* also distinguishes itself in having thick circuar (spherical ?) central body and much bigger sacci in comparison to the latter. *Cuneatisporites* and *Alisporites* differ in having well-defined broader distal sulcus and in the absence of proximal invading cover on the body by sacci. *Erdtmania* Pant & Mehra (1963), differs from *Ibisporites* in having well defined sulcus, arcuate folds or thickening along the zones of

distal attachment, and equatorial attachment of sacci. Thus, *Erdtmania* closely resembles *Cuneatisporites* Lesch.

Ibisporites diplosaccus sp. nov.

Pl. 6, Figs. 67-74

Holotype — Pl. 6, Fig. 67.

Diagnosis — Bilateral, diploxylonoid, holotype 112 × 87 μ, central body vertically oval, usually hardly discernible, thin; sacci subcircular, proximally encroaching the body upto a greater extent, distally also leaving a narrow, ill-defined uncovered area. Lateral continuations present or absent, reticulation fine to mediumly coarse with upto 4 μ wide meshes.

Description — Size range 112-152 μ × 80-113 μ. Central body indistinct or partially and faintly visible, apparently vertically oval with round ends, small, 33 × 38 μ in holotype, proximal and distal saccus free area narrow, vertically elongated, not sharply defined. Sacci big, usually with lateral, notched, upto 10 μ wide continuations, proximally encroachment apparent due to continuous microfolds in sacci.

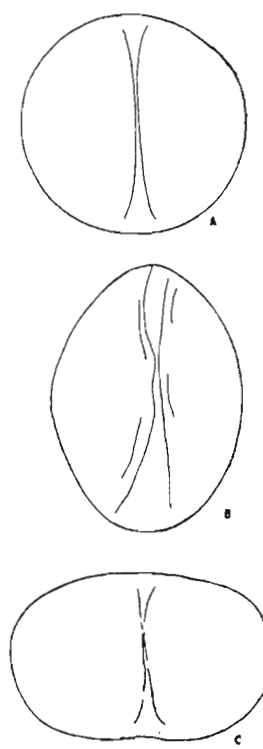
Remarks — The central body in this species is much smaller in comparison to subcircular sacci. The body outline is usually completely invisible or partly seen. Rarely it is completely visible. In any case the exine is thin and hence suggests a trend of variation.

Genus *Sulcatisporites* (Lesch.) Bharad. 1962

Genotype — *Sulcatisporites interpositus* Lesch. 1955

Remarks — A further study of the specimens referable to *Sulcatisporites* from Indian Gondwana horizons has suggested that the shape of the pollen grain is usually circular or subcircular but vertically oval or sub-oval forms showing the otherwise similar characters are also met with (Pl. 7, Figs. 78, 79). The gradual transition in shape and much similarity in distal folds (Text-figs. 7-A, B) do not allow their separation as two species. On the other hand some bilaterally oval grains without distal infolding typical of the genus, have also been found. On the basis of latter character and the nature of sacci reticulation, such specimens have been kept separate as *Sulcatisporites barakarensis* Tiwari (1965). Basically, the invisible body outline, the less than hemispherical or (rarely) hemispherical sacci and the obscure nature of distal zones of sacci attachments remain the important diagnostic features of this genus as has been described by Bharadwaj (1962).

However, in few specimens the body outline can be seen partially under the oil immersion, and an analysis of saccus position in such specimens suggests that there is a 'merging' lateral continuity of sacci. This continuation may be moderately wide, narrow or even absent. This fact becomes all the more clearer when the lateral extents of distal-sacci-attachments are carefully followed up. Lateral continuations are usually unnotched and straight to outwardly arch shaped and hence imparting a circular to subcircular or sub-oval shape to the grain (*see* Text-fig. 7).



Text-fig. 7 — Trends of variation in the overall shape of the genus *Sulcatisporites*. A, B — *Sulcatisporites maximus* (Hart) Singh. C — *Sulcatisporites barakarensis* Tiwari.

Sulcatisporites maximus (Hart) Singh 1964

Pl. 7, Figs. 75, 78, 79

Remarks — The specimens studied here are circular, subcircular or roundly sub-oval along the sulcus line. The central body is mostly with indistinct outline, apparently oval with broad round ends. Sacci merge with body or forming 2-10 μ wide apparent continuation without any notch; distally they lie close along the vertical region usually forming two prominent folds. Sacci rarely encroach a little in the subequatorial region but attachment lines are never sharp.

Regarding the shape, it is interesting to note how from a circular outline (PL. 7, FIG .75) a vertically elongated sub-oval shape (PL. 7, FIG. 79) is acquired. This trend in the shape of *Sulcatisporites* is gradual and hence no specific separation has been attempted here (*see* TEXT-FIG. 7).

Sulcatisporites barakarensis Tiwari 1965

Pl. 7, Figs. 76, 77

Remarks — As remarked earlier, this species embraces specimens which show a bilateral shape with more or less hemispherical sacci and which do not show distal infolding of sacci typical of *S. maximus* (Hart) Singh. The apparent double intrareticulation of saccus is also a noteworthy character.

Sulcatisporites tentulus sp. nov.

Pl. 7, Figs. 81-83

Holotype — Pl. 7, Fig. 81.

Diagnosis — Small, circular to subcircular; holotype 46 μ. Central body indistinct due to thinness, distal sacci-zone close in the centre but widening apart laterally, intrareticulation fine.

Description — Size-range 38-50 μ. Central body apparently oval, outline not clear, exine very thin. Sacci apparently with lateral continuations, merging with the body exine, distal lobing complete as clear by the two zones of attachment.

Comparison — *S. maximus* (Hart) Singh, resembles the present species except that the latter is much smaller in size-range than the former. Other specimens referable to this species — *see* Tiwari, 1965, pl. 8, figs. 178-180.

Infraturma — *Podocarpoiditi* Pot. Thoms. & Thierg.

Genus *Platysaccus* (Naum.) Pot. & Kl.

Genotype — *Platysaccus papilionis* Pot. & Kl. 1954

Platysaccus hingirensis sp. nov.

Pl. 8, Fig. 87

Holotype — Pl. 8, Fig. 87.

Diagnosis — Holotype 110 × 71 μ. Diploxylonoid. Central body mostly circular; distinct, exine unstructured. Sacci big, subcircular, laterally adjacent to each other. Distal zones of sacci attachment close and full-length.

Description — Size-range 95-115 μ. Central body 50-60 μ. Exine thin or thick, without any mark or striations, structure or sculpture, apparently laevigate. Distally saccus free area slit like, vertical. Sacci big, laterally close to each other, fine to mediumly coarse intrareticulate.

Comparison — Similar specimen with dense body has been photographed by Bharadwaj (1962, PL. 13, FIG. 184). *Platysaccus* sp. as figured by Bharadwaj & Salujha (1964; PL. 5, FIG. 81) has bigger body, smaller sacci and wider distal saccus free area. *P. ovatus* Maithy (1965) differs in having denser elliptical central body with microverrucose sculptur on exine.

Platysaccus brevizonatus sp. nov.

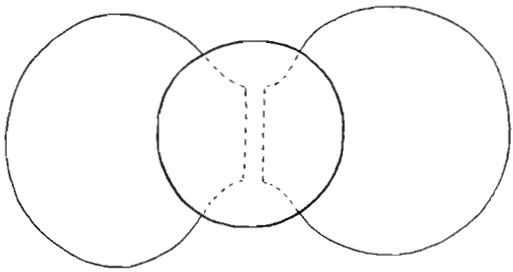
Pl. 8, Figs. 85, 86

Holotype — Pl. 8, Fig. 85.

Diagnosis — Bilateral, central body circular, big, 57 μ in holotype, narrow equatorial rim around; distal zones of sacci attachment partial (not full length in relation to the vertical axis of the body TEXT-FIG. 8), ± 15 μ apart in the centre. Laterally sacci widely apart.

Description — Size range 115-130 μ. Holotype 120 × 60 μ. Sacci more or less as big as the body. Body equatorial rim ± 2 μ wide, irregular but alround. Exine-thin finely intrapunctate. Sacci subcircular to pitcher shaped due to partial attachment on distal face of the sacci (*see* TEXT-FIG. 8). A median vertical slit generally seen. Saccus intrareticulation fine.

Comparison — This species shows partial attachment of sacci as seen in the genera



TEXT-FIG. 8 — Mode of saccus attachment in *Platysaccus brevizonatus* sp. nov.

Verticipollenites and *Hindipollenites* (BHARADWAJ, 1962). However, these genera possess horizontal striations on the central body. Such conditions are basically not described for the genus *Platysaccus*, yet the lack of sufficient number of specimens does not allow to raise this species to the generic level.

Genus *Cuneatisporites* Lesch. 1955

Genotype — *Cuneatisporites radialis* Lesch.

Cuneatisporites sp.

Pl. 8, Fig. 84

Remarks — Specimens referable to *Cuneatisporites* sp. range in size from 145 to 155 μ. The central body is vertically oval and thin without any striations. Distal sulcus is ± 10 μ wide, well defined with 4 μ wide arcuate folds along the zones of sacci attachment. Sacci are subcircular with narrow lateral continuations, or adjacent to each other, with fine to mediumly coarse intrareticulation.

Genus *Cuneatisporites* is poorly represented in the present assemblage.

Turma — *Plicates* (Naum.) Pot. 1960
Subturma — *Polyplicates* Erdm. 1952

Genus *Tiwariasporis* Maheshw. & Kar. 1967

Tiwariasporis gondwanensis (Tiwari) Maheshw. & Kar. 1967

Pl. 8, Fig. 92

Remarks — Grains are bilatrerally oval, 75-84 μ × 62-66 μ in size. Proximally 22 horizontal striations with few vertical partitions are present. Distally profuse interconnections give a verrucose appearance. Exine is thick, intrapunctate; at the terminal ends exine extension is 4-10 μ wide appearing as vestigial wings.

Subturma — *Monocolpates* Ivers. & Troels Smith 1950
Infraturma — *Intortes* (Naum.) Pot. 1938

Genus *Vittatina* (Luber) Wilson 1962

Genotype — *Vittatina subsaccata* Samoil.

Vittatina verrucosa sp. nov.

Pl. 8, Figs. 88-90

Holotype — Pl. 8, Fig. 88.

Diagnosis — Oval, holotype 85 × 75 μ. Exine smooth and unstructed to finely intrapunctate; on one face bearing many (20-26 counted) horizontal forked interconnecting striations with numerous vertical partitions, on other face still more irregular connections to appear as reticuloid to verrucose. Distally at each terminal regions 4-7 striations running perpendicular to the proximal horizontal striations.

Description — Size range 75-108 μ × 60-75 μ. The proximal horizontal striations and vertical partitions regular but distal one forming verrucose pattern the areas being 1-5 μ wide. At the perphery contour finely disected, without any rim or thickening. Distal-running terminal vertical striations appearing as continuations of the proximal ones.

Comparison — *V. striata* (Lub. & Walts.) Samoil. possesses lesser number of striations without any vertical partitions inbetween them. *V. permegna* Tiwari, is much bigger with terminal folds on the distal side rather than striations. So also *V. scutata* (B. & H.) Bharad., and *V. fasciolata* (B. & H.) Bharad., apart from being smaller in size range, differ in having thicker exine and closer or overlaping vertical folds.

Genus *Ginkgocycadophytus* Samoil. 1953

Genotype — *Ginkgocycadophytus caperatus* (Lub.) Samoil.

Remarks — Specimens referable to this genus are also present (PL. 8, FIG. 91). However, they are not significant, as far as their frequency is concerned but qualitatively their presence is noteworthy.

Infraturma — *Monoptyches* (Naum.) Pot. 1958

Genus *Decussatisporites* (Lesch.) Jans. 1962

Genotype — Decussatisporites delineatus Lesch. 1955

Decussatisporites obscurus sp. nov.

Pl. 8, Figs. 93, 94

Holotype — Pl. 8, Fig. 93.

Diagnosis — Bilaterally oval, holotype 57 × 35 μ, proximally 8-12 widely placed horizontal striations, few overturning distally at the terminal poles. Sulcus ill-defined, wide.

Description — Size 57-66 μ × 35-51 μ, usually folded. Exine thin, finely intramicropunctate. Holotype bearing 12 horizontal striations proximally and 4 striations perpendicular to the former distally, along the obscure sulcus. Specimens variously flattened.

Comparison — *D. delineatus* Lesch., has faint, closely set striations and a distinct narrower sulcus. *D. lucifer* Bharad. & Salujha, is circular with thicker exine and a more defined sulcus, hence differs from the present species.

DISCUSSION

The foregoing account of dispersed miospores in the Ib-river coalfield suggests that a diversified vegetation has been deposited during the formation of these coals. There are thirty-four genera and fifty-one species to which the *Sporae dispersae* has been assigned. Leaving aside some very poorly represented and qualitatively unimportant forms as such, the whole assemblage does not seem to be a coherent and homogeneous one in the qualitative distribution of its genera and species, in all the samples investigated. Some genera are fully represented with all their species recorded, in one sample or the other, while others are characteristic in being scanty. This type of restricted or partially restricted distribution has given a picture of qualitative associations within the whole mioflora. In such considerations, however, the throughout common species or very meagerly represented species has not been given portance due to obvious reasons, but still some of them have been incorporated because of their known stratigraphical significance.

The distribution of species thus considered important in the evaluation of qualitative groupings is given in Table 1. A perusal of this table suggests that among the trilete genera, only *Punctatisporites*, *Brijrajisporites* and *Indotriradites* show significant qualitative distributions of their species. *Punctatisporites gretensis* B. & H. and *P. uniformis* sp. nov. are important only in showing a marked prominenee in Sample No. 4 in comparison to their abundance in other samples. Moreover, *P. indicus* sp. nov. has not been found in any other sample except sample No. 4. This indicates a qualitative significance of this genus for Sample No. 4 in relation to other remaining samples. *Apiculatisporis levis* has been observed to be present in all the four samples while *H. unicus* is significantly represented in Sample No. 4. Similarly the only species of the genus *Indotriradites* has not been recorded from any other sample than Sample No. 4. On the other hand the species of the genus *Brijrajisporites* namely *B. distinctus* and *B. fusus*, have been supposed to be qualifying the assemblage from Sample Nos. 1, 2 and 3 only, since they are not encountered in the Sample No. 4. This indicates that qualitatively in the occurrence of trilete genera, Sample No. 4 behaves differently than Sample Nos. 1, 2 and 3.

The monosaccate pollen grains *Parasaccites*, *Plicatipollenites*, *Potonieisporites* and *Virkkipollenites* also tend to qualify Sample No. 4 rather than the remaining ones, as is evident from Table 1. If we do not consider the genera *Plicatipollenites* and *Potonieisporites* on the ground of their scanty occurrences, even then the distribution of remaining two genera is sufficient enough to conclude that in the assemblage of Sample No. 4, monosaccate genera have an upper hand.

Among the disaccate pollen grains, the striated genera have not been considered important here due to their meagre and/or more or less uniform specific occurrence. However, the incidence of *Lahirites* in Sample Nos. 1, 2 & 3 and that of *Stroterisporites* in Sample No. 4 is noteworthy.

The pollen grains, bearing reticuloid striations on the central body, are very significant in being fully represented in Samples 1, 2 and 3, while in Sample No. 4

TABLE 1

Miospore Species	Sample 1 Hingir-Rampur Seam Pit No. 11	Sample 2 Hingir-Rampur Seam Pit No. 5	Sample 3 Hingir-Rampur Seam Orient Incline	Sample 4 IB — Seam Incline
Brijrajisporites distinctus	+	+	+	
B. fusus	+	+	+	
Rhizomaspora indica	+	+	+	...
R. monosulcata	+	+	+	
Primuspollenites levis	+	+	+	...
P. linterus	+	+		
P. obscurus	+	+	+	
Lahirites levicorpus	+	+	+	
Ibisporites diplosaccus	+	+	+	...
Sulcatisporites maximus	+	+	+	+
S. barakarensis	+	+	+	
S. tentulus	+	+	+	.
Cuneatisporites sp.	+	+	+	
Platysaccus brevizonatus	+	+	+	
P. hingirensis		+	+	
Punctatisporites gretensis	...	...	...	+
P. uniformis		...		+
P. indicus				+
Horriditriletes unicus	...			+
Apiculatisporis levis	+	...	+	+
Indotriradites sparsus				+
Parasaccites korbaensis				+
P. diffusus	...	...	...	+
Plicatipollenites gondwanensis				...
P. indicus				...
Virkkipollenites triangularis				+
V. orientalis				+
Potonieisporites sp.				...
Strotersporites indicus				...

+, Well represented; ..., Scanty; Blank, Not found.

they are too meagre in specific representation to qualify the miospore group. Thus we see (Table 1) that almost all the species of *Rhizomaspora* and *Primuspollenites* have been recorded from the first three samples. In the fourth they are found to be less in number as well as in kind.

The non-striate disaccate genus *Ibisporites* gen. nov. is present in all the four samples, but in the Sample No. 4, it is very meagre. Similarly, *Sulcatisporites* although present everywhere, tends to qualify the Sample Nos. 1, 2 and 3. Among other genera, *Cuneatisporites* and *Platysaccus* have been found only in Sample Nos. 1, 2 and 3. In spite of the fact that these are the rare forms, their partially restricted distribution is suggestive of a disaccate richness for the samples where they are found.

Thus, the qualitative distribution has suggested that there are two different miospore assemblages. (I) It is characterized by the eminent representation of *Brijrajisporites, Rhizomaspora, Primuspollenites, Lahirites, Ibisporites, Sulcatisporites, Cuneatisporites* and *Platysaccus* along with other constituents of the flora. These genera have been considered important to qualify the miospore groups found in the Sample Nos. 1, 2 and 3. (II) It is characterized by the significant rarity or absence of the miospores given above, and by the notable representation of *Punctatisporites, Horriditriletes, Apiculatisporis, Indotriradites, Parasaccites, Plicatipollenites, Potonieisporites, Virkkipollenites, Strotersporites* along with other constituents of the flora. These genera have been considered important to qualify the miospore groups found in the Sample No. 4.

That the Assemblage — I is different from Assemblage — II by virtue of its

qualifying elements such as disaccate with reticuloid striations and without any striations in general, is very evident. Assemblage — II further differentiates itself in the prevalence of trilete spores and monosaccate pollen grains which determine its quality.

Stratigraphy — Among the above derived two assemblages, Assemblage — II is older in age than Assemblage — I as clearly indicated by their qualitative composition. When compared on the basis of this data, Assemblage — I shows a trend of similarity with the miospore assemblages described from the Barakar coals of Korba coalfield (particularly KB — *see* TIWARI 1965, Histo: I) West Bokaro Coalfield (WB — TIWARI 1965) and Karanpura Coalfield (BHARADWAJ & TIWARI 1966). The Assemblage — II shows a qualitative resemblance with the miospore assemblages of Korba Coalfield (KA — *see* TIWARI, 1965), Sohagpur Coalfield (NAVALE & TIWARI, 1967) and Talchir Coalfield (NAVALE & TIWARI, 1966).

Notwithstanding the fact that such comparisons are of only qualitative value, Assemblage – I is closely related to the Upper Barakar miofloras and Assemblage – II to the Lower Barakar miofloras.

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EXPLANATION OF PLATES

(All Figures are × 500)

PLATE 1

1. *Leiotriletes* sp., slide nol 2756.
2, 3. *Punctatisporites gretensis* Balme & Henn., slide no. 2763, 2769.
4, 5. *Punctatisporites uniformis* sp. nov., slide no. 2764, 2731
6-8. *Punctatisporites indicus* sp. nov., sl. nos. 2767, 2767, 2777.
9. *Hennellysporites indicus* Tiwari, sl. no. 2747.
10, 11 Cf. *Horriditriletes unicus* Tiwari, sl. nos. 2765, 2726.
12-16. *Apiculatisporis levis* (B. & H.) emend., sl. nos. 2775, 2769, 2766, 2747, 2731.
17. *Horriditriletes rampurensis* sp. nov., sl. no. 2757 A.
18. *Lophotriletes* sp., sl. no. 2753.
19. *Horriditriletes* sp., sl. no. 2744.
20. *Cyclobaculisporites minutus* Bharad. & Salujha, sl. no. 2745.
21, 22. *Microfoveolatispora directa* (B. & H.) Bharad., sl. nos. 2747, 2768.
24. *Indotriradites sparsus* Tiwari, sl. nos. 2772, 2771.
23, 25. *Brijrajisporites distinctus* gen. et sp. nov., sl. nos. 2729, 2728.
26, 27. *Brijrajisporites fusus* sp. nov., sl. nos. 2745, 2753.

PLATE 2

28-29. *Latosporites colliensis* (B. & H.) Bharad., sl. nos. 2742, 2731.
30. *Parasaccites korbaensis* Bharad. & Tiwari, sl. no. 2774.
31. *Parasaccites diffusus* Tiwari, sl. no. 2758.
32. *Parastriapollenites* sp., sl. no. 2742.
33, 34. *Parasaccites bilateralis* Tiwari, sl. nos. 2763, 2764.
35. *Parasaccites invasus* sp. nov., sl. no. 2743.
36. *Plicatipollenites gondwanensis* (B. &. H.) Lele, sl. no. 2766.

PLATE 3

37. *Virkkipollenites triangularis* (Mehta) Lele, sl. no. 2766.
38-40. *Virkkipollenites orientalis* sp. nov., sl. nos. 2765, 2768, 2768.
41. *Potonieisporites* sp., sl. no. 2769.
42. *Rhizomaspora indica* Tiwari, sl. no. 2726.
43-45. *Rhizomaspora monosulcata* sp. nov., sl. nos., 2751, 2740, 2751.

PLATE 4

46. *Rhizomaspora monosulcata* sp. nov., sl. no. 2730.
47, 48. *Primuspollenites levis* Tiwari, sl. nos. 2755, 2744.
49-52. *Primuspollenites obscurus* Tiwari, sl. nos. 2740, 2750, 2745, 2739.
53. *Primuspollenites linterus* Tiwari, sl. no. 2749.

PLATE 5

54-56. *Lahirites levicorpus* sp. nov., sl. nos. 2740, 2725, 2747.
57 *Lunatisporites fuscus* Bharad., sl. no. 2728.
58, 59. *Striatopodocarpites magnificus* Bharad. & Salujha, sl. nos. 2728, 2751.
60. *Striatites* sp., sl. no. 2768.
61. *Strotersporites indicus* Tiwari, sl. no. 2759.
62. *Faunipollenites parvus* Tiwari, sl. no. 2744.
63. *Faunipollenites varius* Bharad., sl. no., 2743.
64-66. *Illinites delasaucei* (Pot. & Kl.) Grebe & Schweit., sl. nos. 2757, 2766, 2766.

PLATE 6

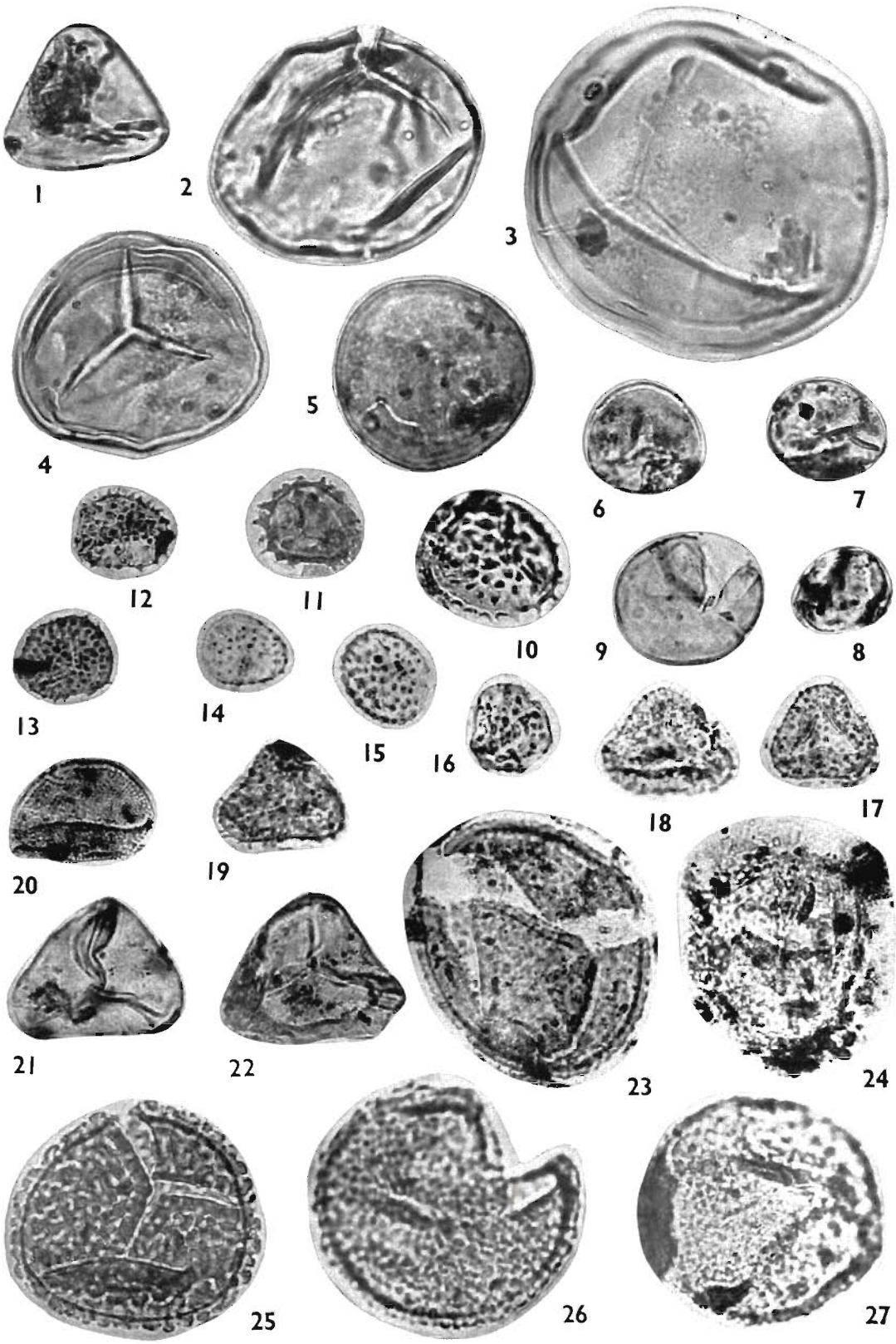
67-74. *Ibisporites diplosaccus* gen. et sp. nov. (Figures 68, 69 and 74 showing laterally flattened specimens), sl. nos. 2723, 2741, 2745, 2739, 2744, 2754, 2744, 2743.

PLATE 7

75. *Sulcatisporites maximus* (Hart) Singh, sl. no. 2752.
76, 77. *Sulcatisporites barakarensis* Tiwari, sl. nos. 2744, 2751.
78, 79. *Sulcatisporites maximus* (Hart) Singh, sl. nos. 2723, 2750.
80. *Densipollenites indicus* Bharad., sl. no. 2741.
81-83. *Sulcatisporites tentulus* sp. nov., sl. nos. 2744, 2755, 2757.

PLATE 8

84. *Cuneatisporites* sp., sl. no. 2726.
85, 86. *Platysaccus brevizonatus* sp. nov., sl. nos. 2726, 2723.
87. *Platysaccus hingirensis* sp. nov., sl. no. 2750.
88-90. *Vittatina verrucosa* sp. nov., sl. nos. 2725, 2730, 2744.
91. *Ginkgocycadophytus* sp., sl. no. 2768.
92. *Tiwariasporis gondwanensis* (Tiwari), Maheshw. & Kar., sl. no. 2766.
93-94. *Decussatisporites obscurus* sp. nov., sl. nos. 2756, 2733.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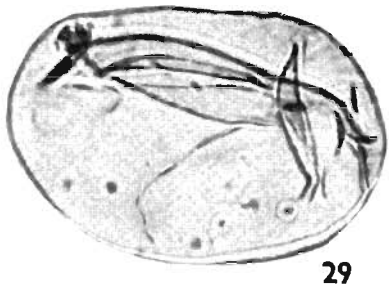
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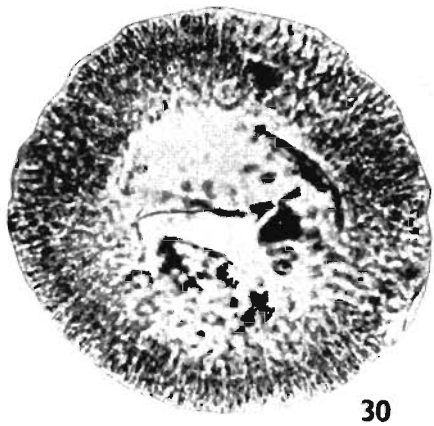
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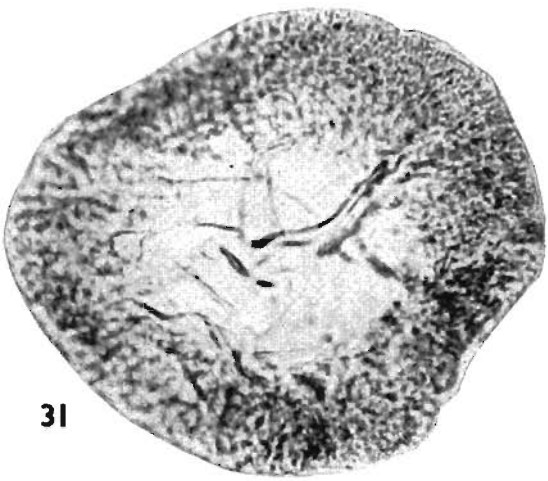
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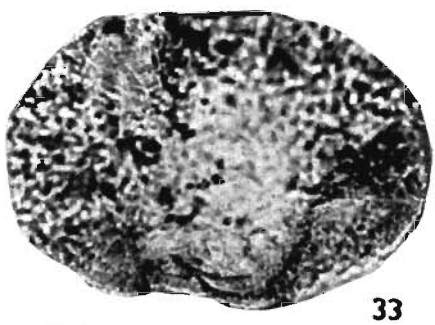
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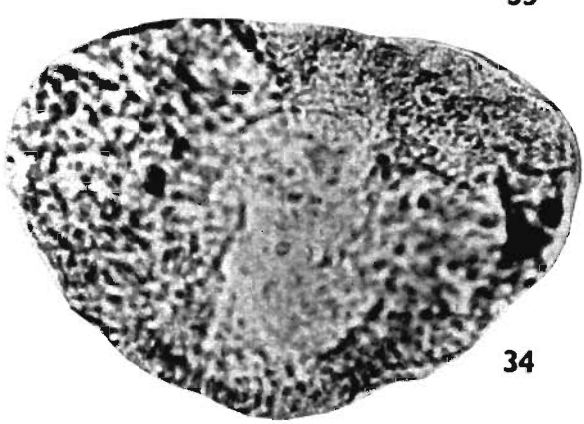
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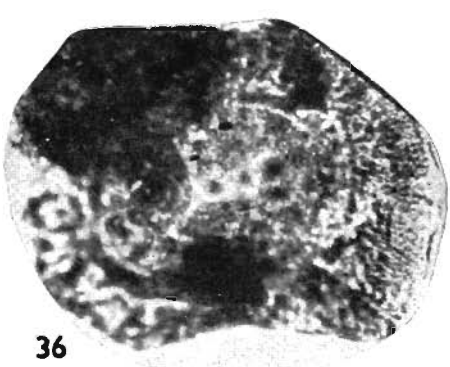
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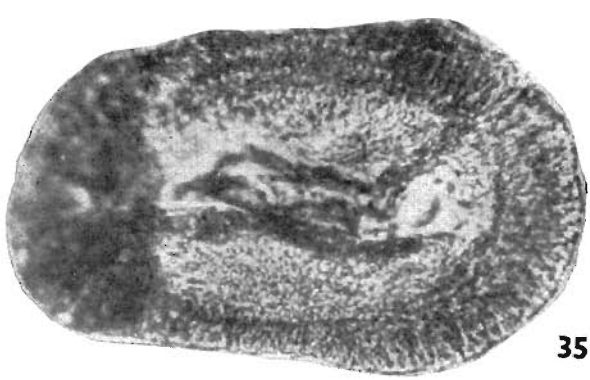
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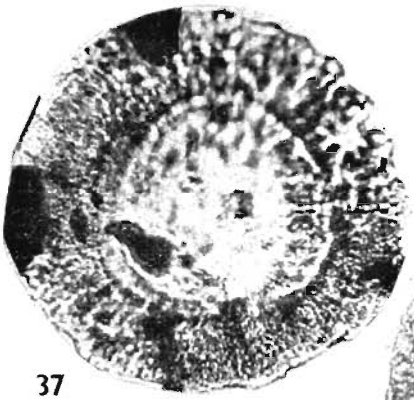

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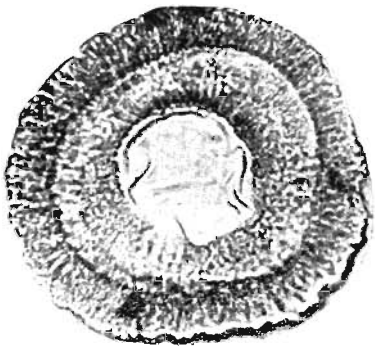

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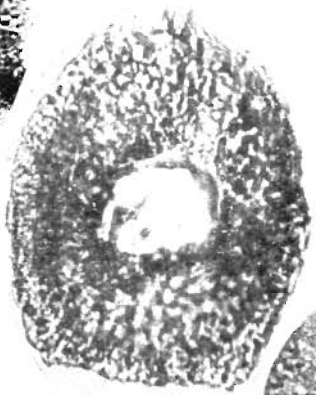

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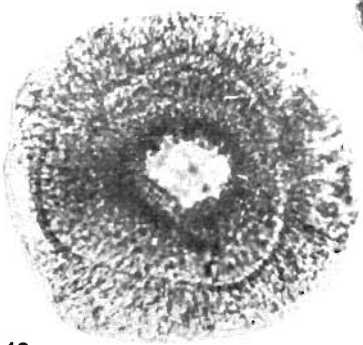

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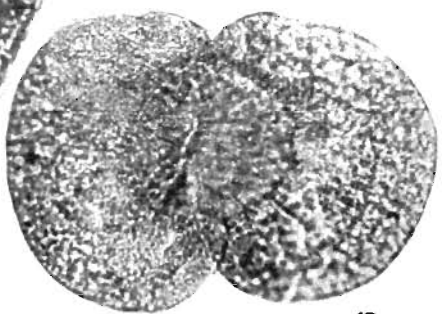

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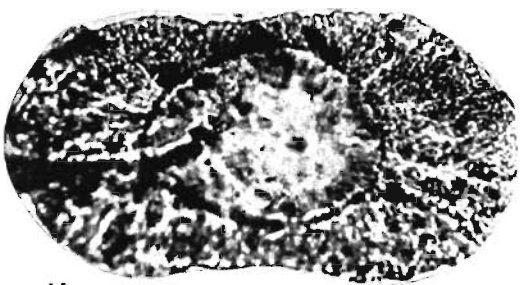

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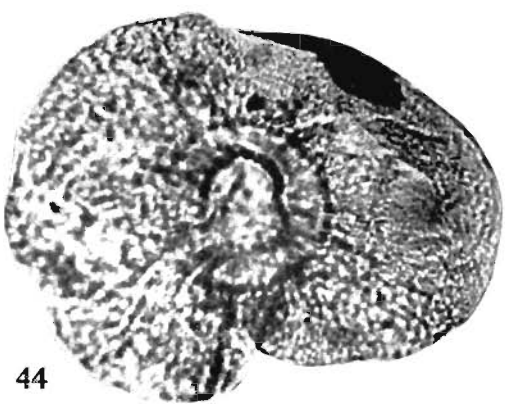

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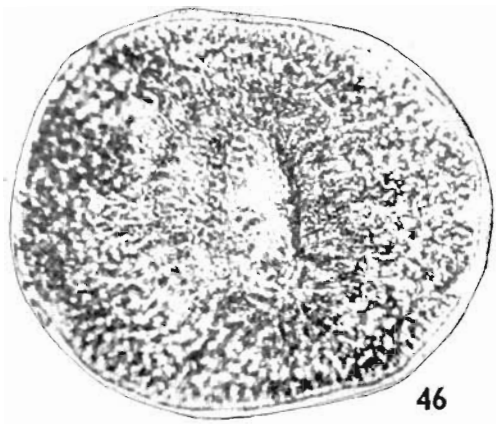
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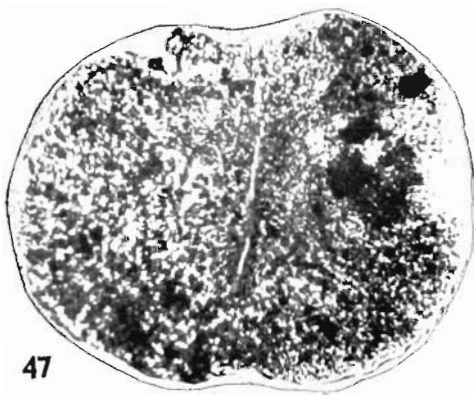
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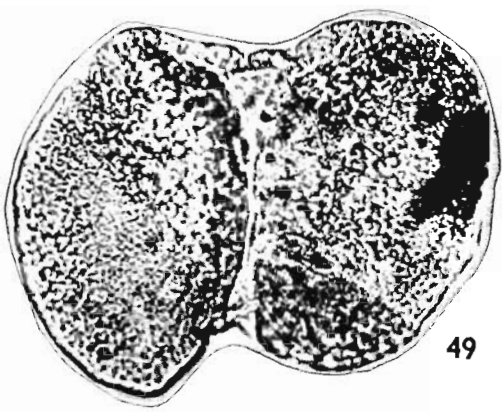
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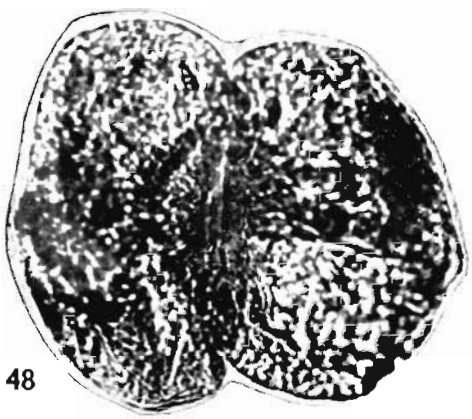
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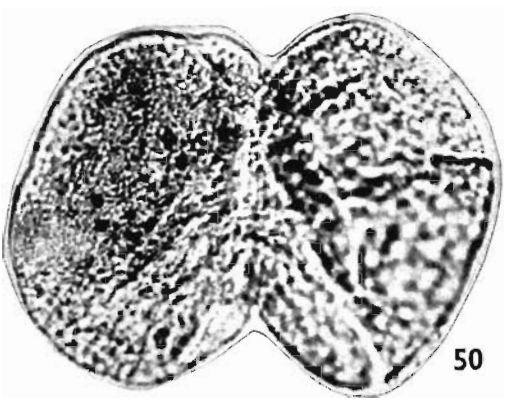
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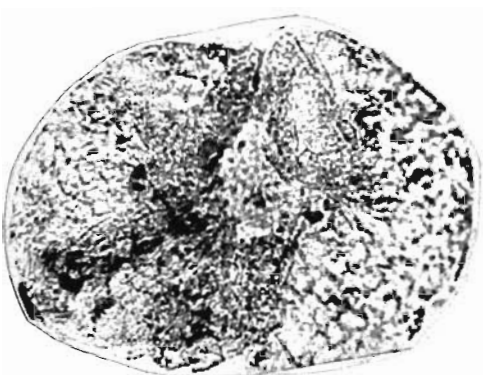
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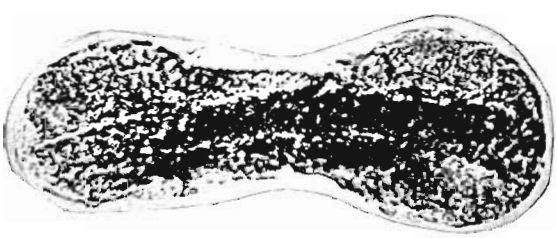
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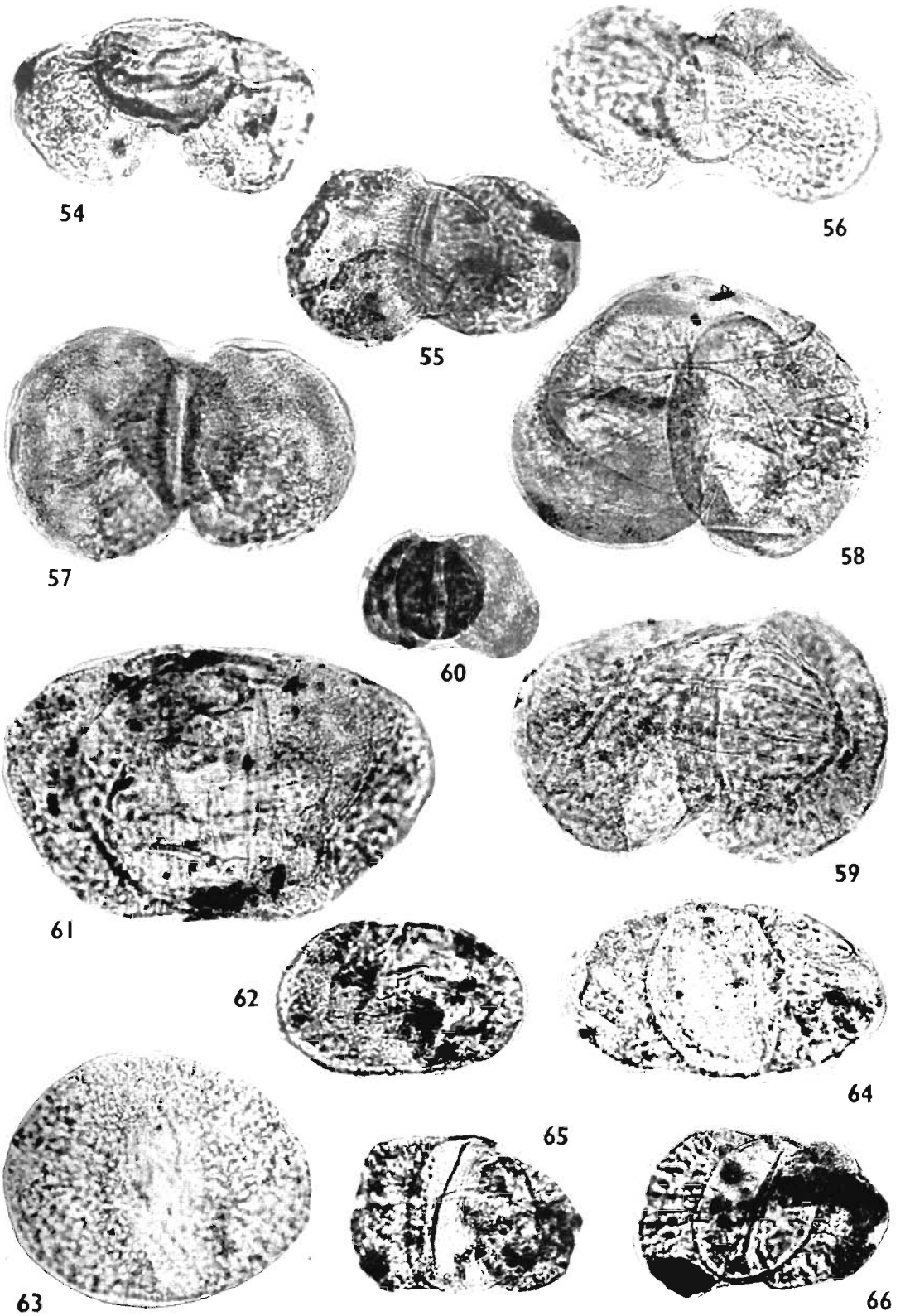
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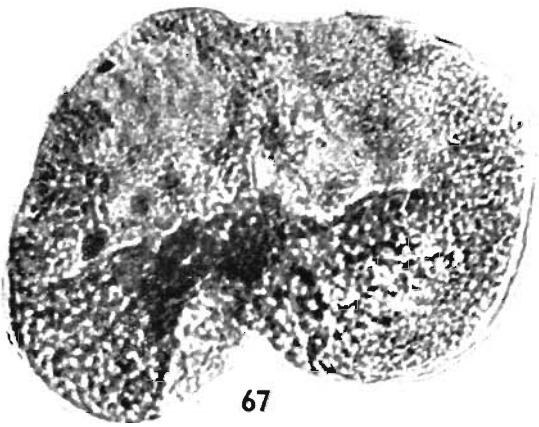

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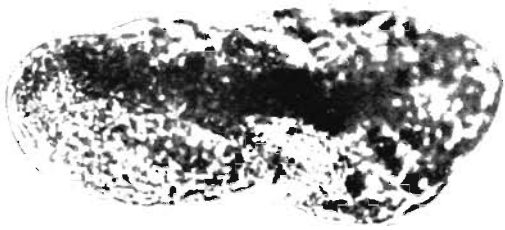

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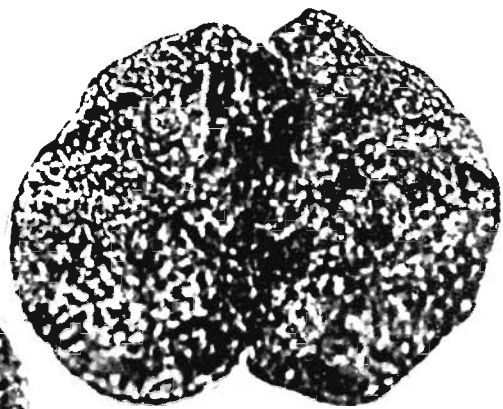

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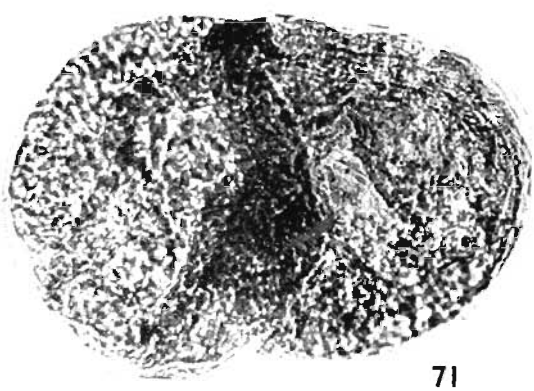

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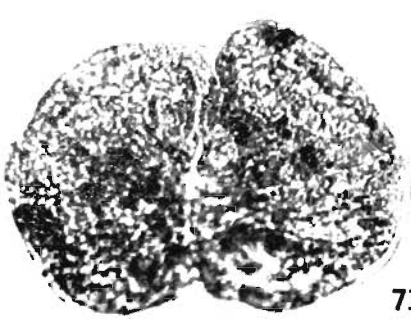

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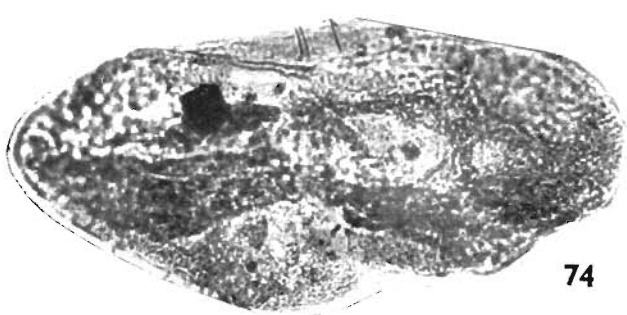

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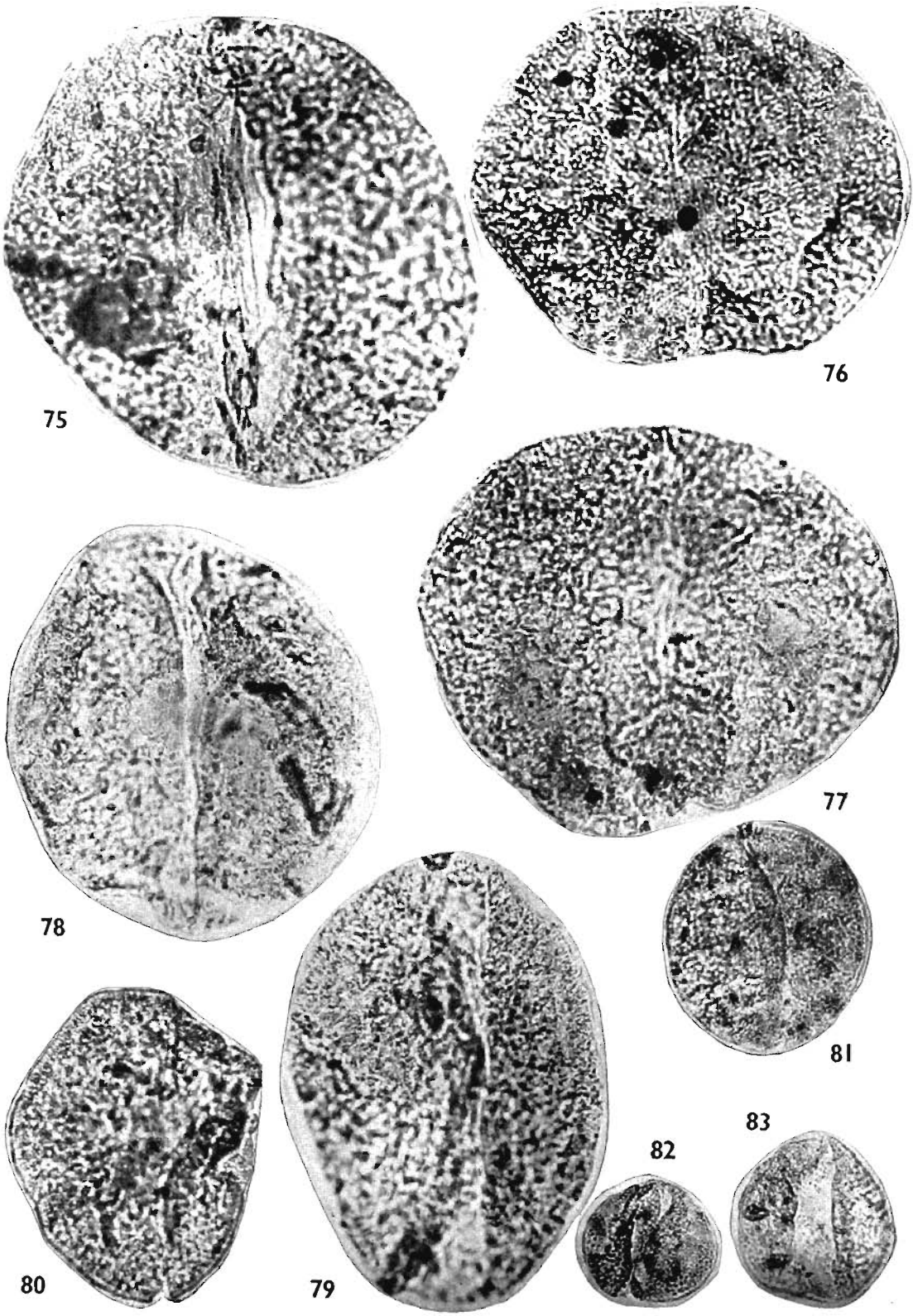
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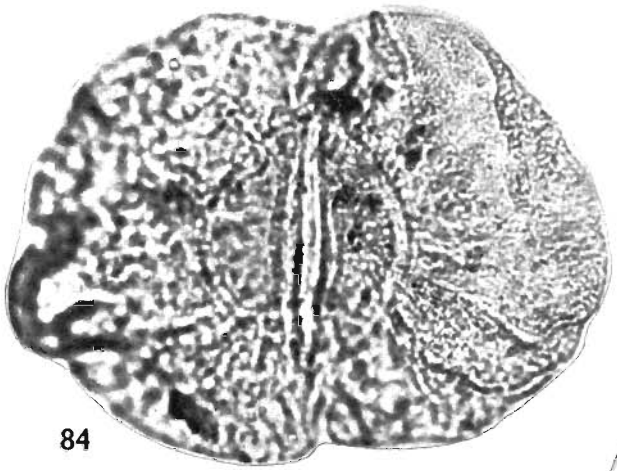
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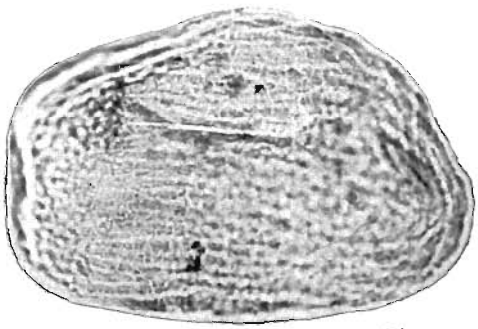
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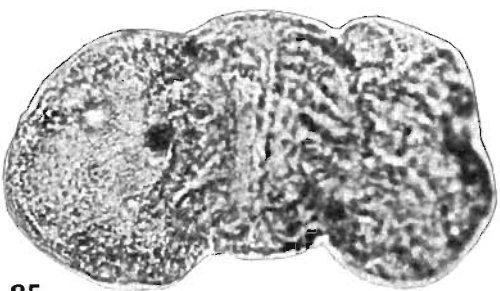
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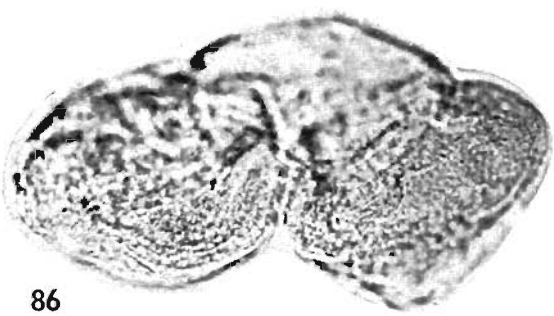
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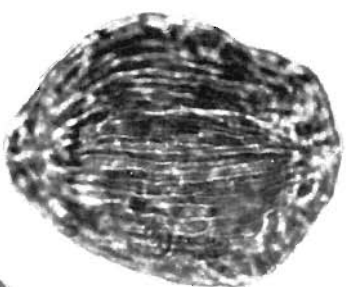
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