# STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA– 27. SPORAE DISPERSAE FROM THE KARHARBARI BEDS IN THE GIRIDIH COALFIELD, BIHAR

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## ABSTRACT

The miospore assemblage of the Karharbari beds in the Giridih Coalfield is described. The assemblage consists of 42 species belonging to 27 genera, out of which 15 species are new. This assemblage shows a close resemblance with the underlying miospore assemblage of the Talchir Stage.

## INTRODUCTION

DURING last two decades considerable amount of investigations have been done on the 'Sporae dispersae' of the Lower Gondwana sediments of India. Virkki (1937) first described the disaccate grains and later in (1939) the monosaccate grains. Sen (1944) has given an preliminary account of the micro-flora from Satpuria, Ghusick and associated coal seams of West Raniganj Coalfield. Mehta (1944) described some microfossils from the carbonaceous beds of South Rewa Gondwana basin. Virkki (1944) described a large number of spore types from the Lower Gondwana sediments of India, viz., the Talchir Stage of Salt range, Barakar stage of Daltongunj Coalfield and the Pali beds, Rewa. Ghosh, Chandiok & Sen (1947) listed 8 spore types from the only coal seam of Chope Coalfield. Ghosh & Sen (1948) published an account of 52 spore types from the Raniganj Coalfield. Trivedi (1950) published few megaspores from the Singrauli Coalfield, it was followed later by a detailed paper in 1953. Tripathi (1952) reported few megaspores from the Barakar Stage of Umaria Coalfield. Goswami (1951, 1952) recorded some microspores from Budha nalla and Dhanpuri (Burhar) and in 1956 some megaspores. Surange *et. al.* (1953) published their results of investigations on few Barakar seams of West Bokaro Coalfield. It was later followed by a paper of megaspores (SRIVASTAVA, 1955). Surange & Lele (1957) recorded few miospores from the Talchir Needle Shale of the Gridih Coalfield. Datta (1957) published an account of the miospores from the Talchirs and Barakars of Jhakrakhand area, Madhya Pradesh. Das (1958) published few miospores from the Barakars and Bhattacharya, B. (1939) from the Auranga Coalfield and Ganguly (1959) from the Pondri Colliery, Chirmiri. However, in most of the above mentioned studies the present prevalent binomial system of taxonomic nomenclature have not been followed.

It was first in 1960 that Potonié & Lele published a systematic description of the miospore assemblage of the Talchirs in the South Rewa Gondwana Basin. Bharadwaj (1962) published a detailed account of miospore genera in the coals of Raniganj stage (Upper Permian). It was later followed by a detailed account of miospore assemblage of this stage by Bharadwaj & Salujha (1964). Thiergart & Frantz (1962) recorded miospores from the Gondwanas of Hyderabad district. Pant & Srivastava (1962) recorded some megaspores from the Barakars of Talchir Coalfield. In recent years Lele (1964) from the Talchir stage, and Bharadwaj and Tiwari (1964) and Tiwari (1964) from the Barakar stage have contributed few new miospore genera.

In comparison to the above records of miospore assemblage from the different Lower Gondwana formations, the knowledge of the miospores from the Karharbari Stage is very meagre. Sen (1953) published an account of the miospore assemblage of the coals of Karharbari stage from the Giridih Coalfield, however, in this the present prevalent binominal system has not been followed. Recently Lele & Maithy (1964) have published a new miospore genus from the Karharbari stage of the Giridih Coalfield. In view of the scanty knowledge, the study was undertaken to investigate in detail the miospore assemblage of the Karharbari stage in the Giridih Coalfield.

## MATERIAL AND METHODS

For the investigation of the miospore assemblage shale samples were collected from different collieries and stream cuttings of the Karharbari stage in the Giridih Coalfield.

For the isolation of microfossils, the maceration technique applied by Bharadwaj (1962) has been followed. Shale samples from the stream outcrops and collieries yielded negative results except for the shales of the Central pit, Srirampur Colliery, which yielded a rich miospore assemblage.

The miospores have been classified according to the artificial system proposed by Potonié (1958) and later elaborated by Bharadwaj (1962). Recently Hart (1964) proposed a classification for the series *Striatiti* on basis of quantative analysis. An application of Hart's system shows that under one genus widely different type of grains come together, resulting the genus to become unwieldy. Thus, the system proposed by Bhardwaj (*l.c.*) has been followed.

## TAXONOMIC DESCRIPTION

SUPER DIVISION — **Sporites** H. Pot.
DIVISION — **Triletes** (Re.) Pot. & Kr.
SUB-DIVISION — **Azonotriletes** Luber
SERIES — **Laevigati** (B. & K.) Pot. & Kr.

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

*Leiotriletes* sp.
Pl. 1, Fig. 1

Size range 40-60 $\mu$; outline $\pm$ triangular with three ends convex, Y-mark distinct, rays attaining to the equator; exine smooth to internally granulate. This is scantly represented in the spore flora, therefore, a detailed comparison is not possible.

### Genus *Eupunctisporites* Bharadwaj

*Eupunctisporites* sp.
Pl. 1, Fig. 2

Size range 45-65 $\mu$; equator $\pm$ circular or circular-oval, Y-mark distinct, rays $\pm$ equal in size, 10-15 $\mu$ long, exine thick bearing distinct, minute roundish or elliptical puncta closely placed. Only few forms in the assemblage.

SERIES — **Apiculati** (Benn. & Kids.) Pot.

### Genus *Cyclogranisporites* Pot. & Kr.

*Cyclogranisporites* sp.
Pl. 3, Figs. 3-4

Size range 96-112 $\mu$; outline $\pm$ circular, Y-mark distinct, rays attaining nearly to half of the radius, exine bears closely spaced grana all over the spore surface. The genus is rather scantly represented in the flora.

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

*Lophotriletes* sp.
Pl. 1, Fig. 5

Size range 45-55 $\mu$; outline $\pm$ triangular with convex ends, Y-mark distinct, rays $\pm$ equal, attaining to the equator; exine covered all over by coni, almost as high as broad at the base; 6-9 coni from ray to ray on equator. The genus is poorly represented in the spore assemblage.

SUPER DIVISION — **Pollenites** R. Pot.
DIVISION — **Saccites** Erdt.
SUB-DIVISION — **Monosaccites** (Chit.) Pot. & Kr.
SERIES — **Apertacorpiti** Lele

### Genus *Plicatipollenites* Lele

*Pilicatipollenites indicus* Lele
Pl. 1, Figs. 6, 7

*Description* — Size range 80-180 $\mu$; outline circular to subcircular (ovalish); occasionally a roundly triangular shape may be stimulated. Body distinct and has a contour corresponding to the overall outline of the grain. Body ornamentation intramicroreticulate, muri is not regular. Sometimes due to bad preservation the body ornamentation is distorted and appears to be microverrucose or granulate. Y-mark $\pm$ weakly developed, occasionally invisible. The rays extend nearly 1/3-2/3 body radius, and sometimes approach nearly to the body equator. The rays show a noticeable tendency of becoming asymmetrical in their length and angles. Usually one of the ray is much longer in length than the other two. The saccus is attached equatorially on the proximal face and sub-equatorially on the distal face, distal overlap usually less than 1/3 body radius. The distal zone of sac attachment is associated with a

well developed body infold system. The body infold system is typically circular and nearly confirms to the body outline and is situated close apart from or in contact with the body periphery. Sac relatively narrow in comparison to the body radius (about 1/3-1/2 body radius). Saccus is 20-30 $\mu$ wide, finely intrareticulate. The sac surface is nearly flat and the outline is typically more or less smooth.

*Comparison and Remarks* — The spores agree in organization with *P. indicus* Lele (1964, PL. 1, FIGS. 6-10), from the Talchirs, of South Rewa Gondwana basin. However, the size range is comparatively more than the Talchir one. Pant & Mehra (1963) described similar grains under *Endosporites* from the Bacchus Marsh Tillite of Australia.

*Stratigraphical Remarks* — *Plicatipollenites indicus* has been recorded from the Permo-Carboniferous and Permian localities in India (LELE, *l.c.*). It forms the bulk of the Talchir flora and is dominant in Karharbaris, as evidenced from present material. The species persists in the Barakars as well. It occurs in similar abundance in equivalent formations of Australia (VIRKII, 1946; BALME & HENNELLY, 1955), Madagascar (RAKOTOARIVELO, 1960) and Belgian Congo (PIERART, 1959). Recently Pant & Mehra (1963) have recorded from Bacchus Marsh Tillite of Australia.

### *Plicatipollenites gondwanensis* (Balme & Henn.) Lele

Pl. 1, Fig. 8

*Description* — Size range 120-250 $\mu$; outline $\pm$ circular, body $\pm$ circular and distinct and if favourably preserved shows intramicroreticulate structure. The trilete mark is weakly developed or invisible. The rays are more or less equal in length and they extend nearly 1/2 body radius. Saccus is relatively broader. It is usually greater than 1/2 body radius, in average about 2/3 body radius and may be as wide as body radius. Saccus intrareticulate, there is a tendency towards radial elongation of the muri. Saccus attachment subequatorial on distal face, distal overlap zone nearly 1/3 or more of the body radius. Body infold system is well developed, typically polygonal or tetragonal in contour, made up of 4-6 fold components. The ends of the fold components are $\pm$ tapering and they are connected together with a noticeable angularity and overlap. The infold system tends to lie well apart from the body periphery.

*Comparison and Remarks* — The spores are organizationally similar to those described by Lele (1964, PL. 2, FIG. 11) from the Talchirs of South Rewa Gondwana Basin and Balme & Hennelly (1956) from the Permian of Australia.

*Stratigraphical Remarks* — *Plicatipollenites gondwanensis* Lele is known from the Talchir Stage (VIRKKI, 1946; LELE, *l.c.*) and Barakar Stage (VIRKKI, *l.c.*) of India. Outside India it is known from the Permian of Australia (BALME & HENNELLY, 1956), Assie á Couches de houille, Luena, Katanga, Belgian Congo (PIEARART, 1959) and Groupe de la Sakoa, Madagascar (RAKOTOARIVELLO, 1960).

### *Plicatipollenites trigonalis* Lele

Pls. 1, 2, Figs. 9, 10

*Description* — Size range 120-240 $\mu$; outline $\pm$ circular to roundly triangular, body distinct, usually denser than the sac, outline triangular to roundly triangular, body exine intramicroreticulate, trilete mark is usually $\pm$ clear, rays equal or unequal in length, rays 1/2-3/4 body radius; saccus about 1/2 to equal body radius, distal overlap less than 3/4 body radius, body infold system is well developed, typically $\pm$ triangular, conforming to body outline, saccus structure fine intrareticulate.

*Comparison and Remarks* — The Karharbari spores agree well with those of Lele (1964, PL. 2, FIGS. 13-14) described from the Talchirs of South Rewa Gondwana Basin, however, the size range in the Karharbari spores is much greater.

*Stratigraphical Remarks* — *Plicatipollenites trigonalis* Lele has been earlier recorded from the Talchirs of South Rewa Gondwana basin (POTONIÉ & LELE, 1960) and Bacchus Marsh Tillite, Australia (VIRKKI, 1939).

### *Plicatipollenites diffusus* Lele

Pl. 2, Fig. 11

*Description* — Size range 120-180 $\mu$; outline $\pm$ circular, body outline $\pm$ circular, weakly defined, ornamentation finely intramicroreticulate, trilete mark $\pm$ clear, rays $\pm$ equal, $\pm$ 1/2 body radius; saccus circular in outline, fairly wide usually 1/2 body radius, range in saccus width 30-50 $\mu$, distal saccus overlap less than 1/3 body radius, body

infold system ± circular, ± subdued, situated closed apart or touching the body margin; sac structure fine intrareticulate, muri often radially disposed.

*Comparison* — The present spores agree well with those of *P. diffusus* Lele (1964, PL. 2, FIG. 12) described from the Talchirs of South Rewa Gondwana Basin.

**Genus *Virkkipollenites* Lele**

*Virkkipollenites triangularis* (Mehta) Lele
Pl. 2, Fig. 13

*Description* — Size range 110-120 μ; outline roundly triangular; body distinct, thin, ± circular, exine intrareticulate, known size range 110-140 μ, trilete mark faintly visible, rays 1/2-2/3 body radius, sometimes reaches the body margin, unequal in length; saccus roundly triangular in outline, width usually greater than 1/2 the body radius, distal zone of sac attachment distinct, overlap zone narrow, surface frilled, outline undulated.

*Comparison and Remarks* — The spores from the Karharbari beds agree well in their description and size with those described by Lele (1964) from the Talchir beds of South Rewa Gondwana Basin.

*Stratigraphical Remarks* — *V. triangularis* has been recorded earlier from the Talchirs of South Rewa Gondwana Basin (Mehta, 1944; POTONIÉ & LELE, *l.c.*; LELE, *l.c.*) and Talchir boulder bed, Kathwai, Salt Range (VIRKKI, 1939, 1946).

*Virkkipollenites mehtae* Lele
Pl. 2, Fig. 14

*Description* — Size range 100-130 μ; outline of spore distinctly circular. Body distinct, circular in outline conforming to the spore outline; thin and wrinkled with many microfolds, ornamentation intramicroreticulate, but in ill-preserved specimen appears to be microverrucose. Trilete mark mostly obscure, rays extend nearly ± 1/2 body radius. Saccus width ± more than 1/2 body radius or equal to 1/2 body radius, zone of distal attachment distinct, overlap zone narrow. Surface of saccus has microfolds. Outline of the saccus is undulated; muri of sac intrareticulam tend to be radially disposed.

*Comparison and Remarks—Virkkipollenites mehtae* Lele is known from the Talchirs of South Rewa Gondwana Basin (LELE, *l.c.*), Dhanpuri (Burhar) South Rewa (GOSWAMI, 1951-52) and Pali beds (VIRKKI, 1946). It is also known from Australia (BALME & HENNELLY, 1956) and Tanganyika (HART, 1960).

*Virkkipollenites obscurus* Lele
Pl. 2, Fig. 12

*Description* — Size range 130-180 μ; spores are circular in shape but often tend to be somewhat ovalish. Body ± circular or circular-oval in shape, outline of the body is mostly indiscernible, body exine thin, intramicroreticulate with minute wrinkles. The trilete mark is obscure to invisible. Arms of the Y-mark asymmetrical, rays extend up to 2/3 body radius; may be open to form a triangular rent. The saccus is denser and comparatively narrow in appearance in comparison to the body radius (± 1/2 the longer radius of body or less). The zone of distal sac attachment is ill-defined; its narrow overlap on the body may be sometime conjectured. The sac shows fine intrareticulum and there is no marked tendency towards radial frills.

*Comparison and Remarks* — The spores from the Karharbari beds agree well organizationally with those of Lele (1964) described from the Talchirs of South Rewa Gondwana Basin.

*Stratigraphical Remarks* — Similar looking spores have been described from the Talchir boulder bed, Kathwai (VIRKKI, 1946), Talchirs and Barakars of South Rewa Gondwana Basin (POTONIÉ & LELE, 1960; Goswami, 1951) in India. It has been also recorded from the Permian of Australia (BALME & HENNELLY, 1956), Tanganyika (HART, 1960) and Belgian Congo (HØEG & BOSE, 1960).

*Virkkipollenites densus* Lele
Pl. 2, Figs. 15, 16

*Description* — Size range 90-150 μ; outline ± circular or circular-triangular, body dense, outline circular, exine intramicroreticulate. Due to dense thick body the body exine is not very distinct. Trilete mark weakly developed, rays equal or unequal, extending 2/3 body radius, may be open to form a triangular rent. Saccus ± circular or the three ends convex; saccus width more than 1/2 body radius. Distal zone of saccus attachment subequatorial, saccus encroachment 1/6th body diameter,

saccus ornamentation finely reticulate, surface smooth or frilled.

*Comparison and Remarks* — The spores from the Karharbari beds agree organizationally to *V. densus* Lele (1964, PL. 2, FIGS. 19, 20) described from the Talchirs of the South Rewa Gondwana basin. The grains described by Pant & Mehra (1963) under *Potonieisporites novicus* from the Bacchus Marsh Tillite, Australia appears to be *Virkkipollenites densus*.

SERIES — **Amphisacciti** Lele

**Genus *Crucisaccites* Lele & Maithy**

*Crucisaccites monoletus* sp. nov.
Pl. 3, Figs. 17, 18

*Diagnosis* — Size range about 120-160 μ (along longer axis), outline ± oval to circular, body 110-130 μ (along longer axis), thin, distinct, circular or oval in outline, body ornamentation intramicroreticulate, saccus outside the body extremely narrow, more or less uniformly wide; zone of attachment nearly reaching to the body periphery, bilateral, cruciate with respect to each other on the two sides, saccus free areas of body ± wide, thinner, sulcus-like; body infolds absent; an undoubted monolete mark demonstrable, sometimes the body exine in the saccus-free area may often rupture to a broad horizontal slit; saccus structure fine intra-reticulate.

*Holotype* — Pl. 3, Fig. 18, Size 136×108 μ.

*Description* — This species is fairly common in the assemblage. A considerable large body is surrounded by a narrow saccus (15-25 μ wide). The saccus encroaches nearly 1/3-1/2 body radius. Zones of saccus attachment bilateral, concave, cruciate with respect to each other on the two sides. Body is more or less oval to circular. Exine ornamentation intramicroreticulate but in ill-preserved specimens it is distorted and appears to be microverrucose. Body infolds are absent. A definite monolete mark is perceptible. Occasionally the exine of the body along the mark ruptures to a broad horizontal slit.

*Comparison* — *Crucisaccites latisulcatus* Lele & Maithy (1964, PL. 1, FIGS. 1-6) differs from the present specimens by the presence of distinct thick body, body infolds and comparatively much wider saccus.

**Genus *Parsaccites* Bharadwaj & Tiwari**

*Parasaccites karharbarensis* sp. nov.
Pl. 3, Figs. 19, 20

*Diagnosis* — Size range 120-160 μ; outline ± circular or circular-oval, body ± thick, distinct, ± circular with intramicroreticulate ornamentation, Y-mark distinct, rays extend more or less 2/3 body radius, saccus narrow, uniformly wide, ± 1/4 body radius, zones of attachment distinct, subequatorial both proximal and distal side of body leaving a ± circular saccus free area; saccus finely intrareticulate, surface of the saccus frilled.

*Holotype* — Pl. 3, Fig. 19, Size 130×110 μ.

*Description* — Spores are circular or subcircular in outline. Body is comparatively as thick as saccus. Outline of body is distinct, ± conforming to spore outline. Body ornamentation is intramicroreticulate, but in ill-preserved specimens it is distorted and appears to be microverrucose. Trilete mark distinct, rays ± symmetrical and extend ± 2/3 body radius. Saccus uniformly wide, narrow ± 1/4 body radius, zones of saccus attachment subequatorial both on the proximal and distal side, zone of attachment well defined, saccus overlap is ± 1/4 body radius. Surface of the saccus is frilled. Saccus ornamentation finely intrareticulate, muri and lumina are of ± equal size.

*Comparison* — *Parasaccites karharbarensis* sp. nov. is distinguished from *P. korbaensis* Bharadwaj and Tiwari (1964) by its distinct ± thick body, comparatively narrow saccus, distinct zones of saccus attachment, surface of saccus with fine radial folds and distinct Y-mark.

*Parasaccites radiplicatus* sp. nov.
Pl. 3, Fig. 21

*Diagnosis* — Size range 160-210 μ; outline ± oval to circular-oval, body distinct, thick, outline ± circular, body ornamentation intramicroreticulate, no definite mark is perceptible, exine on the proximal side ruptures into a wide fissure; saccus uniformly broad, ± 2/3 body radius, attachment zone distinct, subequatorial both on the proximal and distal side, saccus covers ± 1/3 of the peripheral area of body, ornamentation intrareticulate, surface of saccus has prominent radial folds, which emerge from the zone of saccus attachment; outline of saccus undulated.

*Holotype* — Pl. 3, Fig. 21; Size 190-150 μ.

*Description* — Spores golden yellow in colour, outline of the spores are ± circular-oval. Body thick, dark brown in colour, outline ± circular, ornamentation of the body is subdued due to thick dark body, but in well preserved grains it is distinctly intramicroreticulate structure. No definite mark is perceptible, but generally the exine ruptures into a wide fissure. Saccus uniformly wide, surface has prominent radial folds which emerge out from the zone of saccus attachment. This results an undulation of saccus outline and sometimes to the extent that the saccus gets lobed. Saccus ornamentation intrareticulate, lumina is three times bigger than the muri.

*Comparison* — The present species is distinguished from *P. korbaensis* Bharadwaj & Tiwari (*l.c.*) and *P. karharbarensis* sp. nov. by its distinct body and the presence of prominent saccus folds. The spores recorded by Høeg & Bose (1960, Pl. 23, Figs. 1, 3, 5) from Assie a couches de houille of Belgian Congo seems to be organizationally similar to the present spores.

**Genus *Vesicaspora* (Schem.) Wilson & Venkatachala**

*Vesicaspora ovata* (Balme & Hennelly) Wilson & Venkatachala

*Synonymy* — 1955 *Florinites ovatus* Balme & Hennelly.

1961 — *Sulcatisporites ovatus* Bharadwaj

*Description* — Size range 80-120 μ, spores ± oval in outline, body indistinct, vertically oval, ornamentation microverrucose, saccus attached subequatorially both on proximal and distal side of the body leaving a ± biconvex saccus free area. Saccus ornamentation intrareticulate, muri and lumina are of equal width.

*Comparison and Remarks* — The spores agree well in organization with those of Balme & Hennelly (1955, Pl. 5, Figs. 49-52) described from Australia.

*Stratigraphical Remarks* — *Vesicaspora ovata* has been recorded from the Raniganj stage (Bharadwaj, 1961), the Barakar (Bharadwaj & Tiwari, 1964) and the Talchir stage (Lele, 1959, Pl. 3, Figs. 76, 77) of India. It has also been recorded by Balme & Hennelly (1955) from Australia and Hart (1960) from the Permian Coal formations of Tanganyika.

Series — **Trieletesacciti** Leschik

**Genus *Barakarites* Bharadwaj & Tiwari**

*Barakarites gondwanensis* sp. nov.

Pl. 4, Fig. 23

*Diagnosis* — Size range 100-140 μ; outline ± circular or subcircular; body outline obscure, ± circular conforming to the spore outline; exine intrapunctate and divided into polygonal or irregular areas, 5-20 μ wide, by narrow grooves. Trilete mark obscure. Saccus uniformly wide, less than 1/2 body radius, attachment equatorial proximal and subequatorial distal; exine finely intrareticulate, frills uncommon.

*Holotype* — Pl. 4, Fig. 23, Size 116 × 100 μ.

*Description* — The spores are circular or circular oval in outline. Body is thin, outline generally obscure; body exine intra, punctate and divided into several polygonal, hexagonal or irregular areas of 5-20 μ wide, by narrow grooves. Trilete mark generally unmarked, in some cases it is visible. Rays are short and asymmetrical. Saccus narrow, less than 1/2 body radius. Attachment of saccus distally subequatorial and proximally equatorial. Saccus exine intrareticulate, muri and lumina are of nearly of equal size. Margin of the saccus is ± entire.

*Comparison* — *Barakarites indicus* Bharadwaj & Tiwari (1964) differs by the presence of distinct thick body, inner body and the areas of ± uniform size on the body. *Barakarites rotatus* (Balme & Hennelly) Bharadwaj and Tiwari (*l.c.*) has ± equal polygonal areas on body, whereas in *B. gondwanensis* it is of unequal size. It will be also worthwhile to mention here that cf. *Nuskoisporites reticulatus* Bharadwaj & Salujha (1964) is a *Barakarites*.

Series — **Vesiculomonoradites** (Pant) Bhard.

**Genus *Potonieisporites* Bharadwaj**

*Potonieisporites* cf. *novicus*

Pl. 4, Fig. 24

*Description* — Size range 120-140 μ, monosaccate with a circular outline, central body ± circular, thick, intramicroreticulate, a monolete mark or bent mark is perceptible running parallel to long axis. Two series of body infolds are present; one series is near the periphery parallel to the long axis

and other series near the centre at right angles to the first series. Saccus attachment subequatorial on the distal side and equatorial on the proximal side. Saccus ornamentation intrareticulate.

*Comparison and Remarks* — The spores agree organizationally with *Potonieisporites novicus* Bharadwaj (1955), but so far the relationship between the floras of Northern and Southern hemisphere is not well established, therefore, it is placed here under *P.* cf. *novicus*.

*Potonieisporites neglectus* Potonié & Lele
Pl. 4, Figs. 25, 26

*Description* — Size range 120-180 μ, monosaccate, ± oval in outline, body distinct, ± thick, outline ± oval, circular-oval or trapezoid, exine intramicroreticulate; a monolete mark or a bent monolete or sometimes a reduced trilete mark is present in the median region of the body. Saccus encircles the body, attachment equatorial on the proximal side and subequatorial on the distal side. Saccus narrow along the vertical axis and broad along the horizontal axis. Body infold well developed, ± tetragonal in shape. The horizontal infolds are placed near the periphery of body while the vertical ones are more towards centre. The vertical infolds are more conspicuous than the horizontal ones. Saccus ornamentation intrareticulate, muri and lumina are of equal thickness.

*Comparison and Remarks* — The spores are organizationally similar to *P. neglectus* Potonié & Lele (1960) described from the Talchirs of the South Rewa Gondwana basin.

***Sahnites* Pant**

*Sahnites gondwanensis* (Mehta) Pant
Pl. 4, Figs. 27-29

*Synonymy* — 1944 *Pitysporites gondwanensis* Mehta

*Description* — Size range 110-170 μ, outline elongate oval; body distinct, thin, ± circular-oval or hexagonal in outline, body exine intramicroreticulate. A distinct monolete mark is generally present on the body; saccus attached subequatorially distally and equatorially proximally. The distal saccus free area is ± rectangular. Saccus wider along the horizontal axis but extremely narrow along the vertical axis and it nearly touches the body outline. Two distinct semilunar vertical infolds are present, (Pl. 4, Fig. 28, 29) but in some grains faint horizontal infolds are marked (Pl. 4, Fig. 27).

*Comparison & Remarks* — The spores are organizationally similar to the spores described by Mehta (1944) from the Pali beds of the South Rewa Gondwana basin.

***Vestigisporites* (Balme & Henn.) Hart**

*Vestigisporites diffusus* sp. nov.
Pl. 5. Figs. 30, 31

*Diagnosis* — Size range 130-160 μ, outline ± oval, body thin, ± diffused, ± circular, exine intramicroreticulate, monolete mark is perciptible in the centre of the body; saccus attachment equatorial on the proximal, and subequatorial on the distal side of body leaving a ± circular saccus free area, saccus wider along the longer axis, ornamentation intrareticulate, body infolds absent.

*Holotype* — Pl. 5, Fig. 30; Size 140×84 μ.

*Description* — Spores are oval in outline, body is thin and diffused. Outline of the body is ± circular or circular-oval. Body exine is well preserved grains shows distinct intramicroreticulate structure, but in ill preserved grains, it is subdued and appears to be microverrucose. A distinct monolete mark or bent mark is noticed in well preserved forms. Saccus is more wider along the horizontal axis (equal to body radius or less) and is comparatively much narrower along the vertical axis (1/3 of the body radius).

*Comparison* — *Vestigisporites ruidis* Balme & Hennelly (1955) is distinguished by the presence of distinct body and saccus with microradial folds. V. *balmeii* Hart (1960) and *V. disectus* Hart (1960) differs by the presence of distinct body and comparatively much smaller size. The above mentioned species of Hart (1960) seems to organizationally similar and allied. The only difference between them seems to be that in one case saccus is comparatively little wider near the lateral region.

Sub-Divison — **Disaccites** Cookson
Series — **Striatiti** Pant

***Striatites* Pant emend. Bharadwaj**

*Striatites karharbarensis* sp. nov.
Pl. 5, Fig. 32

*Diagnosis* — Known size range 140-170 μ ×80-110μ diploxylonoid; body thin, outline

distinct, rhomboidal or vertically oval, 70 to 80 μ in diameter, exine microverrucose, with horizontal striations (7-9) with few vertical connections; sacci ± hemispherical, distal attachment straight, full length associated with body folds, leaving a narrow saccus free area on the body; ornamentation intrareticulate.

*Holotype* — Pl. 5, Fig. 32; Size 150×90 μ.

*Description* — Spores golden yellow in colour with pale yellow to dark brown central body. Body is thin but the outline is well marked. Saccus is ± 1½ of the body. Saccus attachment is associated with body folds. Laterally the saccus come closer leaving a narrow saccus free area on the body; ± 1/10 of the body diameter. Saccus ornamentation intrareticulate, lumina twice bigger than muri.

*Comparison* — *Striatites notus* Bharadwaj and Salujha (1964), *S. subtilis* Bhard. & Salu. (*l.c.*) *S. obtusus* Bhard. & Salu. (*l.c.*) have dark brown central body and have number of vertical partitions whereas in the Karharbari specimen it is few. *S. solitus* and *S. communis* Bhard. & Salu. (*l.c.*) is distinguished by the absence of vertical striations. *S. rhombicus* Bharadwaj & Salujha (*l.c.*) compares in the shape of body, but differs by the convex saccus attachment.

*Striatites densus* sp. nov.
Pl. 5, Fig. 33

*Diagnosis* — Size range 130-150 μ×90-100 μ; diploxylonoid, body distinct, thick, circular, 40-50 μ in diameter; exine microverrucose; with 6-10 horizontal striations; sacci subspherical, usually much bigger than body; attachment full length, straight, laterally the saccus comes very near leaving a very narrow vertical gap, exine intrareticulate.

*Holotype* — Pl. 5, Fig. 33; Size 116×92 μ.

*Description* — Spores golden yellow in colour with thick dark brown body having a rough outline. Both the sacci are well dilated out laterally and are nearly three times bigger than body. Saccus exine intrareticulate, lumina twice bigger than muri. Spores are orientated mostly with their distal side up.

*Comparison and Remarks* — Due to absence of vertical striations the present specimens are comparable to *S. solitus* Bhardwaj & Salujha (1964) and *S. communis* (*l.c.*), but both of them possess thin body whereas the present specimens have dark thick body.

*Striatites incirus* sp. nov.
Pl. 5, Fig. 34

*Diagnosis* — Size range 100-150 μ; spore are ± oval or circular-oval in outline; body distinct, ± circular or circular-oval, exine microverrucose with 7-10 horizontal striations with few vertical connecting striations. Sacci sub-spherical, laterally fused on one side and widely separated on the other side, distal saccus attachment ± convex, distal saccus free body area is narrow and ± biconvex, exine intrareticulate.

*Holotype* — Pl. 5, Fig. 34; Size 110×80 μ.

*Description*—Imperfectly disaccate spores, ± haploxylonoid. Outline of spores mostly oval with dense thick dark brown body, exine microverrucose with 7-10 horizontal striations with occasional vertical connections. Sacci distally attached, fused laterally on one side and widely separated on the other side. Sacci is vertically fairly dilated along the fused side of the sacci. Owing to this the body appears to be placed eccentric. Ornamentation intrareticulate, muri and lumina are of equal size.

*Comparison and Remarks* — Uptill now a good number of *Striatites* species have been described from the Lower Gondwanas of Southern hemisphere but the present species is distinguished from all of them by its imperfect disaccate nature of the spore, eccentric body and sacci fused laterally on one side and free on the other side.

***Lahirites* Bharadwaj**

*Lahirites rhombicus* sp. nov.
Pl. 5, Fig. 35

*Diagnosis*—Size range 120-160 μ×90-106 μ, diploxylonoid, body distinct, ± thick, ± rhomboidal, 50-60 μ×65-80 μ, usually bearing proximally 7-9 striations, the exine ornamentation laevigate and intrapunctate structured. Sacci subspherical, attachment straight, extending full length, narrowly separated from each other, folds associated with saccus attachment; ornamentation intrareticulate.

*Holotype* — Pl. 5, Fig. 35; Size 150×100 μ.

*Description* — Pollen grains almost bilateral and disaccate, central body rhomboidal, dark brown in colour, margin even, central body has 7-9 striations, vertical connections

absent. Sacci 2-3 times bigger than body, fairly dilated out laterally, distal sulcus narrow nearly 1/10 of the body diameter. Saccus ornamentation intrareticulate, lumina twice bigger than muri.

*Comparison and Remarks* — *Lahirites raniganjensis* Bharadwaj (1962) differs by the presence of distinct circular body and the presence of vertical connecting striations. *Lahirites notus* Bharadwaj & Salujha (1964) differs by the presence of distinct marginal ridge all round. The other species of *Lahirites* described differs by the presence of vertical connecting body striations.

**_Lunatisporites_ (Leschik) Bharadwaj**

*Lunatisporites amplus* (Bal. & Henn.) Potonié

Pl. 5, Fig. 36

1964 — *Protohaploxypinus amplus* Hart

*Description* — Size range 120-150 $\mu \times$ 80-100 $\mu$, $\pm$ haploxylonoid, body $\pm$ oval, distinct, exine fairly thin, intramicroreticulate with 7-10 horizontal striations with few vertical connections; sacci symmetrical, greater than 1/2 of the saccus outside the body, attached full length, straight, mostly associated with prominent body folds; distal zone of saccus free body area 8-12 $\mu$ wide, 1/6-1/8 of the body breadth, saccus finely intrareticulate, muri and lumina are of equal width.

*Comparison and Remarks* — According to the emended diagnosis of Bharadwaj (1960: 93) *Lunatisporites* has a biconvex distal zone of saccus attachment with arcuate body folds. The Giridih spores confirms with the generic diagnosis of Bharadwaj except for the saccus attachment, i.e. $\pm$ straight.

The spores from the Giridih Coalfield agree well with the spores described under *Lunatisporites amplus* Balme & Hennelly (1955; PL. 3, FIG. 24) and the other specimens recorded by Potonié and Lele (1960, PL. 3, FIG. 69) from the Talchir stage of the South Rewa Gondwana Basin.

*Lunatisporites* cf. *amplus* (Balm. & Henn.) Potonié

Pl. 5, Fig. 37

*Description* — Size range 120-140 $\times$ 90-100 $\mu$; $\pm$ oval in outline, haploxylonoid; body distinct roundly oval, exine thin intramicroreticulate, with 8-10 branched horizontal striations; sacci symmetrical, nearly equal to the size of body, distally attached full length, straight, saccus free body area (14-16 $\mu$), 1/4-3/4 of the body diameter. Roots of saccus attachment associated with distinct vertical body folds; saccus exine intramicroreticulate, lumina and muri are of equal width.

*Remarks* — These spores are similar in organization to *L. amplus* Balme & Hennelly, however, they differ in the fact that the part of sacci outside of the body is nearly 1/2 of total saccus breadth. It is greater than half in *L. amplus* Balme & Hennelly and less than half in *L. globosus* sp. nov. Thus, the present spores occupy an intermediate position between *L. amplus* and *L. globosus* but seem to be more comparable with the former, hence they are described here as *L.* cf. *amplus*.

*Lunatisporites globosus* sp. nov.

Pl. 6, Fig. 38

*Diagnosis* — Size range 120-136 $\mu$; outline of spore $\pm$ circular, haploxylonoid; body $\pm$ circular, distinct, exine thin, intramicroreticulate with 8-10 horizontal striations; sacci symmetrical, part of the sacci outside the body less than 1/2 total saccus width, saccus attachment distal, $\pm$ straight and associated with prominent body folds; distal saccus free body area is $\pm$ 1/10 of the body diameter; saccus exine intrareticulate, muri and lumina are of equal width.

*Holotype* — Pl. 6, Fig. 38; Size 120 $\times$ 90 $\mu$.

*Description* — Spores are golden yellow in colour. Outline of spore distinctly circular. Body thick, distinct, dark brown in colour. Body exine finely intramicroreticulate, but in ill-preserved grains it is distorted and appears to be microverrucose. Striations 8-10 in number. Saccus narrow, distal sac attachment straight and associated with prominent body folds.

*Comparison and Remarks* — So far a good number of species of *Lunatisporites* are known from the Lower Gondwanas of India, but the present species differs from all of them by its distinct circular configuration of the body and the spore.

Potonié & Lele (1960) described a species *Lunatisporites goraiensis* from Talchirs. Under this spores both with obscure body (PL. 3, FIGS. 70, 71) and with a distinct body andf olds are present. With the result the speeics has become a heterogenous

group containing spores of two genera, i.e. *Lunatisporites* and *Faunipollenites*. Therefore, in the present study only those grains with distinct body are retained under *Lunatisporites* and those with obscure body are transferred to *Faunipollenites*.

***Faunipollenites* Bharadwaj**

*Faunipollenites varius* Bharadwaj

Pl. 6, Fig. 39

*Description* — Size range 120-150 $\mu \times 80$-90 $\mu$; haploxylonoid, oval in outline, body diffused and its outline is marked only by the ends of striations, exine thin intramicroreticulate, traversed by 7-9 horizontal striations; sacci hemispherical, distal zone of attachment not discernible, distal zone of saccus free area $\pm$ straight and narrow.

*Comparison and Remarks* — The spores agree organizationally with *Faunipollenites varius* Bharadwaj (1962), however, the Karharbari spores are comparatively bigger in size. The spores figured by Potonié & Lele (1960, Pl. 3, Figs. 68 & 71) under *Lunatisporites* has indistinct body and are, therefore, referable to *Faunipollenites* Bharadwaj, however, they are smaller in size.

*Faunipollenites goraiensis* (Potonié & Lele) n. comb.

Pl. 6, Fig. 40

1960 — *Lunatisporites goraiensis* Potonié & Lele.

1964 — *Protohaploxypinus goraiensis* Hart

*Emended Diagnosis* — Size range 120-140 $\mu$; outline $\pm$ cicrular, haploxylonoid, body outline indistinct and only marked by the ends of striations, exine thin intramicroreticulate with 8-11 horizontal striations, sometimes with few vertical connections. Saccus attachment obscure, distal saccus free body area $\pm$ straight, exine intrareticulate.

*Description* — Spores are golden yellow in colour, outline of spores distinctly circular. Body circular-oval in outline and is marked by the ends of striations. Body exine intramicroreticulate with 8-11 horizontal striations with few vertical connections. Sacci attachment zone ill-defined. Exine intrareticulate, muri and lumina are of equal width.

*Remarks* — Potonié & Lele (1960) described *Lunatisporites goraiensis* from the South Rewa Gondwana basin, India. A study of type specimen presents that the spore has a obscure body and indistinct sac attachment, which confirms with the diagnosis of *Faunipollenites*. Therefore, those spores with indistinct body are now transfered here under *Faunipollenites*.

SERIES — **Striareticuloiditi** Tiwari

**Genus *Rhizomaspora* Wilson**

*Rhizomaspora* sp.

Pl. 6, Fig. 41

Size range 110-136 $\mu$, central body, $\pm$ sub-circular, dense without any equatorial rim; polygonal areas distinct, 1-5 $\mu$ in size forming a reticuloid pattern, sacci encroaching upon the body proximally from all sides, attachment diffused, distal attachment zone ill-defined, close to each other forming a narrow, almost ill-defined sulcus, sacci laterally continuous, intrareticulation double.

Only few grains are in the assemblages, therefore, a detailed comparison is not possible.

SERIES — **Disaccitrileti** (Lesch.) Pot.

***Succinctisporites* Leschik**

*Succinctisporites* sp.

Pl. 6, Fig. 43

Size range 150-180 $\mu$, spores are mostly oval in outline, body $\pm$ circular or $\pm$ oval, distinct, dark brown in colour, exine externally smooth, internally intrapunctate, striations or mark absent. Saccus encircles all round the body, attachment distal bilateral, the distal zone of saccus free body area is $\pm$ biconvex. Saccus wider along the horizontal axis and sometimes notched along the vertical axis, exine intrareticulate, muri and lumina are of equal width.

The spores are organizationally similar to *Succinctisporites* Leschik (1959, Pl. 1, Fig. 16), however, in view of lack of number of specimens a detailed comparison is not possible. Comparable spores have been previously recorded by Virkki (1946, Pl. 14, Fig. 187) from the glacial tillite of Bacchus Marsh, Australia and by Potonié & Lele (1960, Pl. 3, Fig. 84) from the Talchirs of South Rewa Gondwana Basin.

SERIES — **Pinosacciti** (Erdt.) Pot.

***Alisporites*** **Daugherty**

*Alisporites oblongus* sp. nov.

Pl. 6, Fig. 44

*Diagnosis* — Size range 100-180 $\mu \times 70$-106 $\mu$, haploxylonoid, oblong, body $\pm$ circular, exine thin, laevigate, Y-mark or striations absent, sacci hemispherical, nearly same size of the body, attachment straight, distal saccus free body zone narrow, 1/12th of body diameter, accompanied by two distinct arcuate folds on the two sides of body, saccus exine intrareticulate.

*Holotype* — Pl. 6, Fig. 44; Size $114 \times 72$ $\mu$.

*Description* — The overall length of the grain is $\pm$ twice in breadth. The sacci are equal to body dimensions. The saccus free zone is narrow and accompanied by distinct folds.

*Comparison*—From the Lower Gondwanas of Southern hemisphere only two species of *Alisporites* are known. *Alisporites milvinus* Balme & Hennelly (1955b) differs by its small size and oval body. *Alisporites phaselosaccites* Lakhanpal *et. al.* (1958) is distinguished by its bean shaped sacci and distinct disaccate condition.

SERIES — **Podocarpoiditi** Pot., Thoms. & Thierg.

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

*Platysaccus ovatus* sp. nov.

Pl. 6, Fig. 42

*Diagnosis*—Size range 120-150 $\mu \times 70$-80 $\mu$, dipoloxylonoid. Body $60 \times 50$ $\mu$, $\pm$elliptical, dark coloured, Y-mark and striations absent, exine microverrucose, sacci twice bigger than body, subspherical, attachment straight, saccus free area narrow, ornamentation intrareticulate, muri thick.

*Holotype* — Pl. 6, Fig. 42; Size $140 \times 90$ $\mu$.

*Description* — Spores golden yellow in colour with dark brown thick body, exine microverrucose, elliptical in outline. The sacci are distally inclined. Muri twice thicker than lumina.

*Comparison and Remarks* — *Platysaccus ovatus* is distinguished from *P. papillonis* by its oval body and narrow zone of saccus free area. *Platysaccus leschikii* Hart (1960) differs by $\pm$ diffused, small central body.

SERIES — **Disacitrileti** (Lesch.) Pot.

***Limitisporites*** **Leschik**

cf. *Limitisporites* sp.

Pl. 7, Fig. 45

Size range 80-100 $\mu$, outline $\pm$ oval, body thin indistinct, $\pm$ circular, exine microverrucose sometimes a mark is perceptible; sacci attached subequatorially on distal side leaving a wide area. Two distinct body infolds are produced from the zone of sacci attachment. Sacci ornamentation intramicroreticulate. Only few grains are in the assemblage, therefore, a detailed comparison is not possible.

SUB-DIVISION — **Polysaccites** Cookson

**Genus *Crustaesporites* Leschik**

cf. *Crustaesporites* sp.

Pl. 7, Fig. 46

Size range 130-160 $\mu$, equator $\pm$ triangular, central body distinct, $\pm$ triangular, angles rounded or flat, ornamentation granulate; about seven striations present; apparently three sacci of uniform size encircling the body, zones of attachment on distal side along the three sides of the body and associated with folds, exine intrareticulate.

The present spore assemblage has only few specimens which appears like a trisaccate pollen. The three sacci are somewhat overlapping outside. The body, their distal attachment also somewhat masked due to the body folds. They resemble the genus *Crustaesporites* more than any other genera. It may be, however, be remarked that similar grains have been put by Balme & Hennelly (1956, PL 4, FIG. 44) under *Lueckisporites*.

**Genus *Tetrasaccus* (Pant) emend.**

*Generic Diagnosis* — Spores with four sacci attached distally subequatorially to the body. Body $\pm$ circular without any striations or mark, exine laevigate.

*Genotype* — *Tetrasaccus karharbarensis* sp. nov.

*Remarks* — The name *Tetrasaccus* was proposed by Pant (1954: 47) for tetrasaccate pollen grains but no type was designated. The generic name is now validated on the basis of present findings and an emended diagnosis is given. The species *T. karharbarensis* is here proposed to represent the genotype.

*Tetrasaccus karharbarensis* sp. nov.

Pl. 7, Fig. 47

*Diagnosis* — Spore 130-160 $\mu \times$ 120-140 $\mu$, body distinct 80-84 $\mu$, $\pm$ circular thin, laevigate (? intrapunctate), devoid of striations or mark; four sacci attached distally, 1/3 part overlapping body, saccus free zone $\pm$ cross-shaped; sacci unequal in size, subcircular, individual saccus smaller than body ornamentation intra-reticulate, muri as wide as lumina.

*Holotype* — Pl. 7, Fig. 47; Size 140 $\mu \times$ 140 $\mu$.

*Description* — The spores are characterized by a dark brown laevigate body attached to $\pm$ unequal sacci. The distal saccus free area is $\pm$ cross shaped. Striations or a mark absent.

DIVISION — **Polyplicates** Erdtman

**Genus *Welwitschiapites* Bolchowitina**

*Welwitschiapites magnus* sp. nov.

Pl. 7, Figs. 48, 49

*Diagnosis* — Size range 150-180 $\mu \times$ 94-120 $\mu$; outline $\pm$ oval to circular-oval, exine externally smooth, internally microverrucose, several longitudinal striations run parallel to long axis all round the body with several interconnections, exine $\pm$ 2 $\mu$ thick, outline of the spore is smooth.

*Holotype* — Pl. 7, Fig. 48; Size 150 $\times$ 96 $\mu$.

*Description* — The shape of the spores varies from oval to circular-oval. Generally their length breadth ratio is 1/4 or more. The intraverrucate exine is strongly developed. No marginal protuberance is marked.

*Comparison* — *Welwitschiapites tenuis* Bharadwaj & Salujha (1964) differs in having a much smaller number of striations and intrabaculate exine. *W. extansus* Bharadwaj & Salujha (*l.c.*) differs by its small size.

*Welwitschiapites minutus* sp. nov.

Pl. 7, Fig. 50

*Diagnosis* — Size range 60-80 $\mu$, outline $\pm$ oval, exine microverrucose, one face with several longitudinal striations connected by interconnections and on another face with several longitudinal striations with connections giving a reticuloid appearance. The two poles have small protuberances, outline $\pm$ smooth.

*Holotype* — Pl. 7, Fig. 50; Size 66 $\times$ 46 $\mu$.

*Description* — Spores are $\pm$ oval in outline or elliptical, exine microverrucose, one face has several longitudinal striations with interconnections and on the other face the striations are reticuloid. Two polar protuberances are present. The outline of body is smooth.

*Comparison* — *Welwitschiapites tenuis* Bharadwaj and Salujha (1964) is comparable in size but the present species is distinguished by the presence of polar protuberances and reticuloid striations on one face.

DIVISION — **Monocolpates** Iverson & Troels-Smith

SUB-DIVISION — **Intortes** (Naumova) Potonié

***Marsupipollenites* Balme & Hennelly**

*Marsupipollenites triradiatus* Balme & Hennelly

Pl. 7, Fig. 52

*Description* — Size range 40-70 $\mu$, equator $\pm$ oval or sub-circular with two folds at right angles to the plane of striations. Exine microverrucose bearing several transverse striations, irregularly connected by small vertical interconnections. A perceptible small trilete mark is present.

*Comparison* — The spores agree with *M. radiatus* Balme & Hennelly. *Marsupipollenites* and *Vittatina* Luber have similar organization, however, according to Bharadwaj (1962) the former possess a Y-mark.

***Ginkgocycadophytus* Samoilowitz**

*Ginkgocycadophytus cymbatus* (Balme & Henn.) Potonié & Lele

Pl. 7, Fig. 51

*Description* — Size range 42-70 $\mu$, outline boat to spindle shaped, ends rounded or tapering to a point, exine infragranulate, a distinct median colpus is present, which is little open on one pole.

*Comparison* — The spores from the Karharbari beds agree organizationally with those of Potonié & Lele (1959).

*Stratigraphical Remarks* — *Ginkgocycadophytus cymbatus* is known in India from the Talchir stage of South Rewa Gondwana basin. In Australia it has been recorded by Balme & Hennelly from the Permian deposits. Høeg & Bose (1960) has recorded from the Assise à Couches de houille of Belgian Congo.

## DISCUSSION

### General Remarks on the Organization of the Karharbari spores

The miospore assemblage of the Karharbari stage consists of trilete, saccate and plicate grains. The plicate and trilete are similar in organization to those of contemporaneous strata of Europe. The saccate grains which constitutes the bulk of the spore assemblage revealed a number of distinctive spore organizations which point marked differences from the contemporaneous strata of Northern hemisphere. The saccate grains from the Karharbari stage throw the following significant light on their organization.

A. *General Outline of Saccus* — Among the saccate grains we find distinctly monosaccate and disaccate grains, but there are large number of grains showing intermediate type in between the mon- and disaccates. These miospores are haploxylonoid, oval in outline, saccus bilaterally expanded and the saccus is constricted along the vertical axis, sometimes the saccus is greatly reduced that it leaves only a rudimentary saccus region along the body, (*Potonieisporites, Vestigisporites* etc.).

B. *Saccus Attachment* — The saccus attachment among the monosaccate grains exhibits certain remarkable featuresa nd on this basis they are divisible into two sects:

(i) The attachment of saccus is equatorially proximal and subequatorially distal (*Plicatipollenites, Potonieisporites* etc.).

(ii) The attachment of saccus subequatorial both on the proximal and distal side, i.e. the amphilateral condition of saccus attachment. The saccus attachment is either superposed to one another on both the surfaces leaving a $\pm$ circular (*Parasaccites*) to oval (*Vesicaspora*) saccus free area on both the surfaces or the zone of saccus attachment crossed to each other (*Crucisaccites*). Spores with these organizational manifestations fall within the Series ' Amphisacciti ' recently introduced by Lele (1965).

C. *Fold Components* — In large number of miospore assemblage the fold components on the body is well developed and their characteristic presence forms a distinct basis for generic delimitation. The formation style of the fold component is dependant on saccus attachment. In *Plicatipollenites* Lele all the fold components are complete and well developed, whereas in *Potonieisporites* Bhard. which is circular to bilateral, it is found that the vertical fold components are more developed than the lateral ones. Even in some cases the lateral ones are diffused. In disaccates only two vertical folds are developed they are either straight or semilunar. In some spores the saccus has radial folds, and an undulated outline.

D. *Striations* — Striations of various types have been observed among Karharbari miospores. They can be classified as follows:

(i) Horizontal striations without any interconnections.
(ii) Horizontal striations with vertical short interconnections.
(iii) Reticuloid type of striations. This may be of regular to irregular form.

E. *Mark* — The monosaccate pollen grains have generally a Y-mark. But it has a range of variations. The rays may be all equal in size or two of the rays bigger and one ray reduced or all the rays of unequal size or two of the rays reduced and the extent of reduction is so great that it gives rise to nearly a monolete mark.

On the other side the bilateral monosaccate pollen grains a distinct monolete, or a bent monolete mark, but occasionally another short ray is seen at right angles just to the bent mark, thus, resulting a reduced assymetric trilete mark.

### The miospore assemblage of the Karharbari stage and its comparison with the Talchir and the Barakar stage

The miospore assemblage of the Karharbari stage as evidenced here is rich and diversified. The assemblage consists of 42 species belonging to 27 genera. The whole flora shows a predominance of saccate grains. The trilete and nonsaccate grains are rare and poor in representation except for the genus *Welwitschiapites*. Among the saccate grains monosaccates are more common in occurrence in comparison to disaccates. The following genera are dominant.

Monosaccates:

*Plicatipollenites*
*Virkkipollenites*
*Crucisaccites*
*Potonieisporites*
*Parasaccites*
*Vestigisporites*

Disaccate:

*Striatites*
*Lunatisporites*
*Faunipollenites*
*Sahnites*

Plicates:

*Welwitschiapites*

The following genera are poorly represented:

Monosaccate:

*Barakarites*
*Vesicaspora*

Disaccate:

*Lahirites*
*Limitisporites*
*Succinctisporites*
*Platysaccus*

Plicates:

*Ginkgocycadophytus*

The following genera are rare in the assemblage:

Trilete:

*Leiotriletes*
*Eupunctisporites*
*Cyclogranisporites*
*Lophotriletes*

Saccate:

*Alisporites*
*Rhizomaspora*
cf. *Crustaesporites*
*Tetrasaccus*

Plicates:

*Marsupipollenites*

The Karharbari stage lies in between the underlain Talchir stage of Talchir series and overlain by the Barakar stage of the Damuda series. The miospore assemblage of both the stages are now well known.

The miospore assemblage of the Talchir stage has been published in detailed in recent years by Potonié & Lele (1960) and Lele (1964). A comparison of the miospore assemblage from both formations show the following common occurrences:

Trilete:

*Leiotriletes*
*Cyclogranisporites*
*Lophotriletes*

Saccate:

*Plicatipollenites*
*Virkkipollenites*
*Potonieisporites*
*Vestigisporites*
*Lunatisporites*
*Faunipollenites*
*Alisporites*
*Vesicaspora*
*Succinctisporites*

Plicates:

*Ginkgocycadophytus*

The following genera which are present in the Karharbari assemblage are absent in the Talchirs:

Trilete:

*Eupunctisporites*

Saccate:

*Parasaccites*
*Crucisaccites*
*Barakarites*
*Striatites*
*Lahrites*
*Rhizomaspora*
*Limitisporites*
*Platysaccus*
cf. *Crustaesporites*
*Tetrasaccus*

Colpate:

*Welwitschiapites*
*Marsupipollenites*

The following Talchir genus are absent in the Karharbari assemblage:

Trilete:

*Punctatisporites*
*Granulatisporites*
*Acanthotriletes*

Alete:

*Quadrisporites*

Thus, from this comparison it becomes increasingly clear that the Karharbari assemblage is nearly represented by all the forms of Talchirs and the dominant constituents of Talchirs viz., *Plicatipollenites*, *Virkkipollenites* and *Potonieisporites* are also dominant in Karharbaris, still it is relatively more diversified and retains the individuality by the presence or absence of certain genera.

The miospore assemblage of the Barkar stage has been recently described in detail by Bharadwaj & Tiwari (1964). A comparison of the two miospore assemblage show the following common occurrences.

Trilete:

*Leiotriletes*
*Eupunctisporites*
*Cyclogranisporites*
*Lophotriletes*

Monosaccate:

*Plicatipollenites*
*Virkkipollenites*
*Potonieisporites*
*Parasaccites*
*Barakarites*
*Vesicaspora*

*Sahnites*
*Vestigisporites*

Disaccate:

*Platysaccus*
*Striatites*
*Lahrites*
*Lunatisporites*
*Faunipollenites*
*Rhizomaspora*

Plicates:

*Welwitschiapites*
*Ginkgocycadophytus*

Even among these common genera, the trilete are poorly represented in comparison to the Barakars. The disaccates are also comparatively less common.

The following Karharbari genera are absent in the Barakars:

Saccates:

*Crucisaccites*
*Alisporites*
*Succinctisporites*
cf. *Crustaesporites*
*Tetrasaccus*

Plicate:

*Marsupipollenites*

There are a large number of miospore genera in the Barkars which are absent in the Karharbaris. The genera are as follows:

Trilete:

*Punctatisporites*
*Retusotriletes*
*Verrucosisporites*
*Cyclobaculisporites*
*Microfovelatispora*
*Indospora*
*Cirratriradites*
*Indotriradites*
*Dentatispora*

Monosaccates:

*Densipollenites*
*Striomonosaccites*
*Distriomonosaccites*

Disaccates:

*Verticipollenites*
*Fimbriaesporites*
*Korbapollenites*
*Primuspollenites*
*Direticuloidispora*
*Hindipollenites*
*Striapollenites*

Alete:

*Pilasporites*
*Maculatasporites*

Plicates:

*Vittatina*

Therefore, it becomes evident from the above comparison of the miospore assemblages that the Barakar miospore assemblage resembles to a certain extent with that of the Karharbari stage. However, the former is much diversified and is quite distinguishable from Karharbari in having much larger number of genera of trilete, zonate, and disaccate miospores.

Thus, from the above comparisons of miospore assemblage, it becomes increasingly clear that the miospore assemblage of the Karharbari occupies an intermediate position in between the two floras, viz. the Talchirs and the Barakars. The Talchir elements are well represented and form the dominant constituents, whereas at the same time incoming of Barakar elements is also noted together with the presence of characteristic miospore types of the Karharbari stage.

## ACKNOWLEDGEMENT

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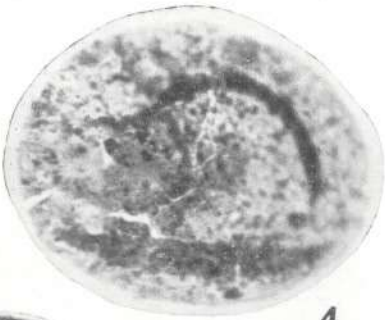
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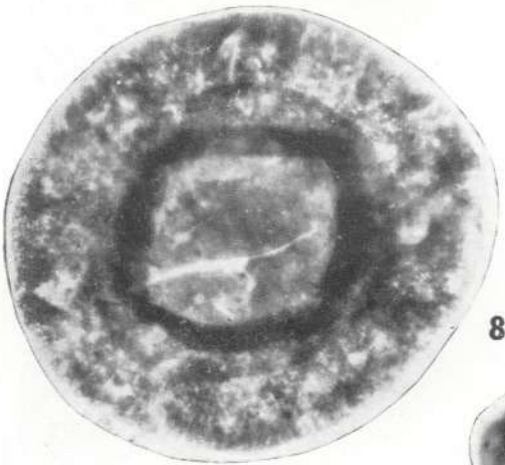
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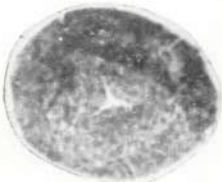
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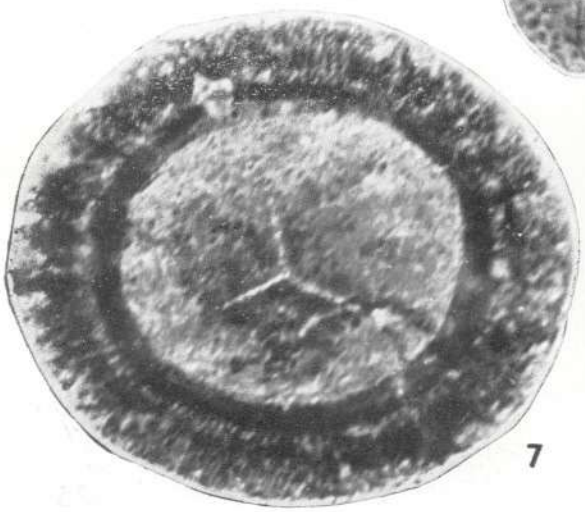
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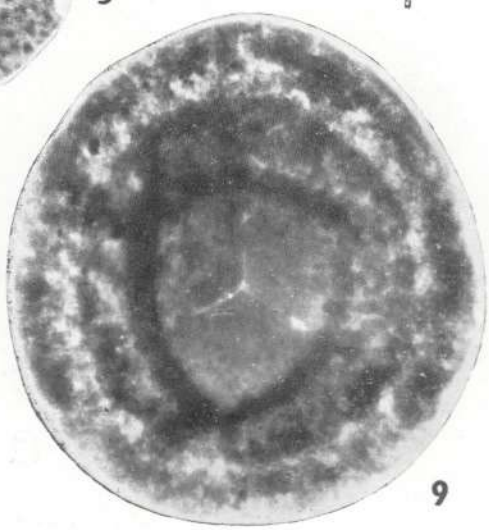
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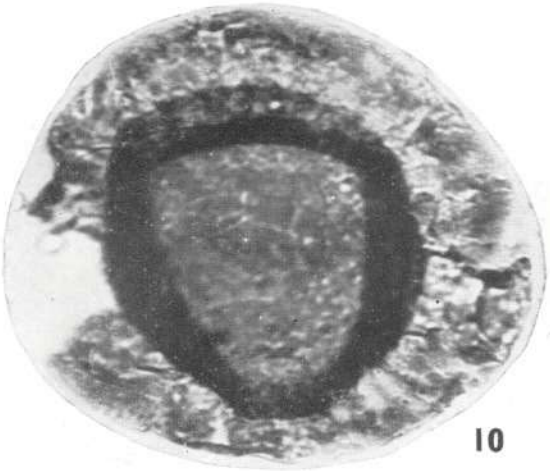

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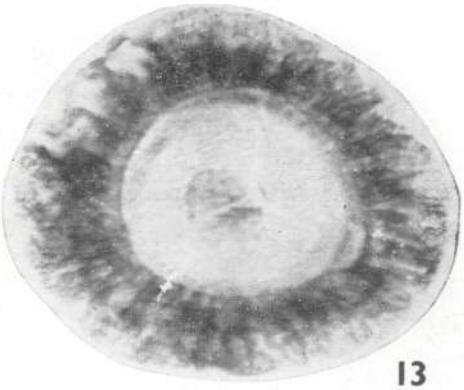

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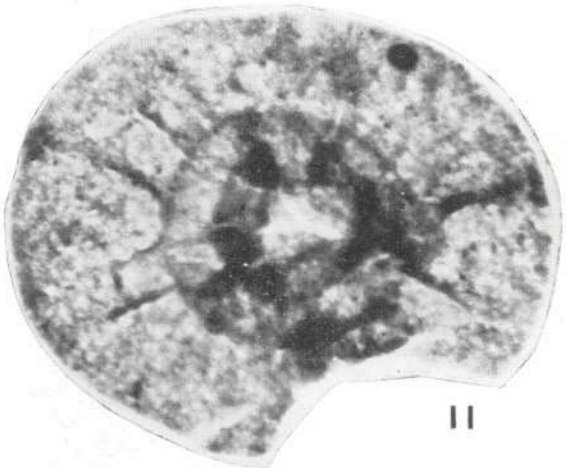

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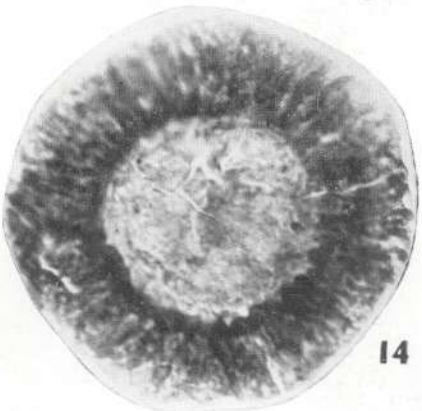

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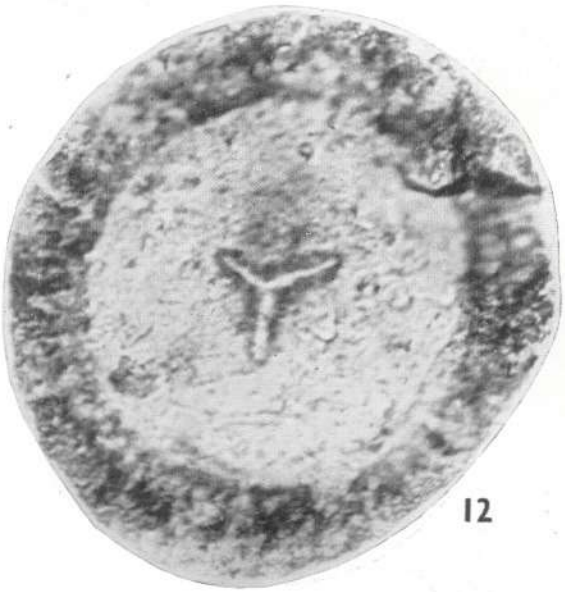

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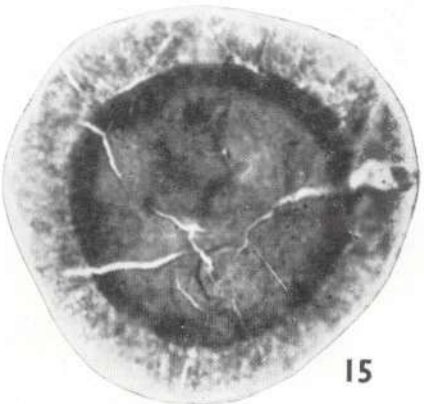

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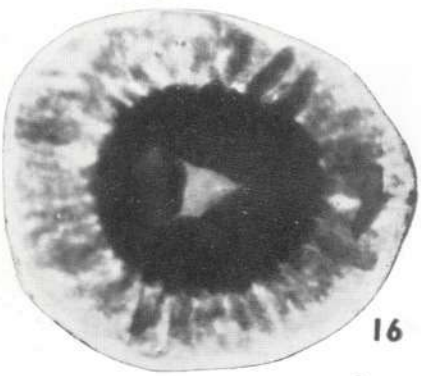

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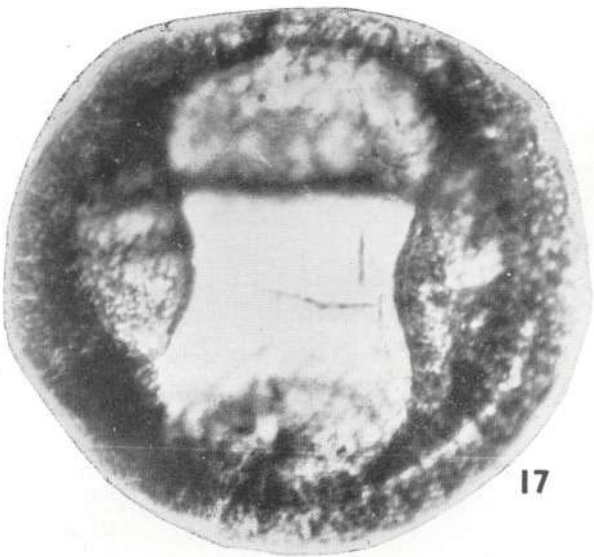
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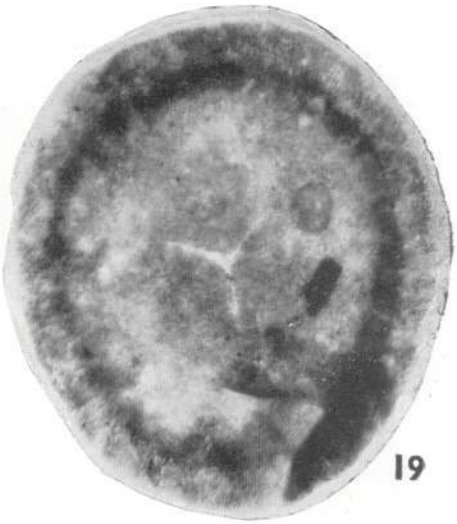
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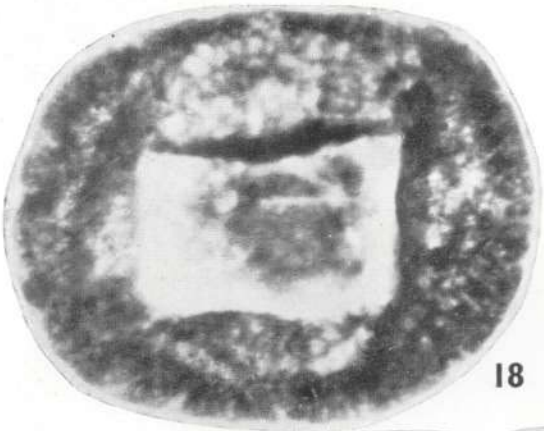
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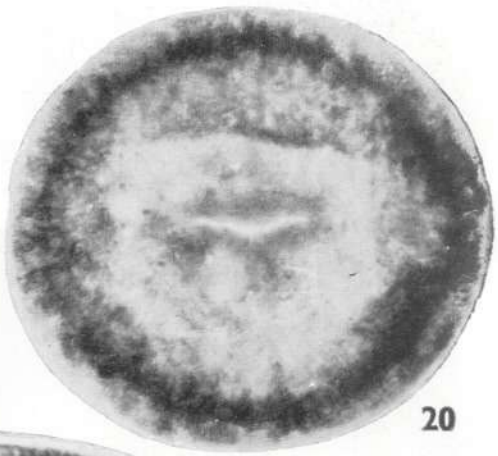
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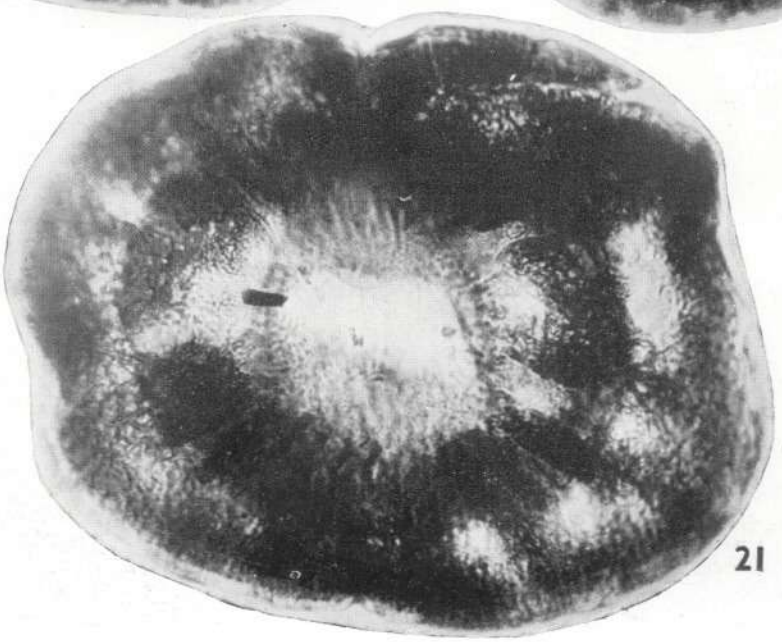
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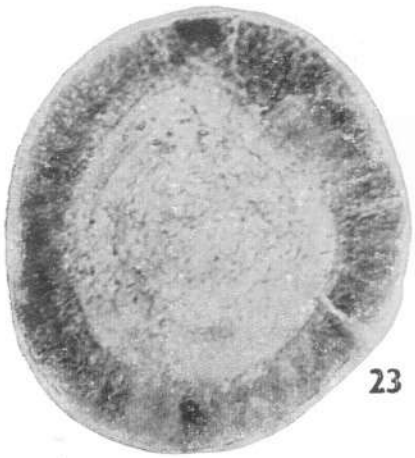

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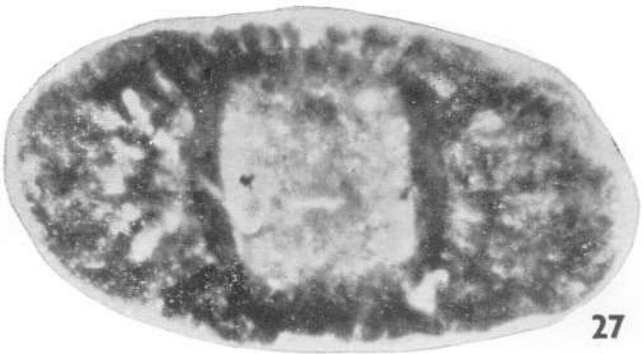

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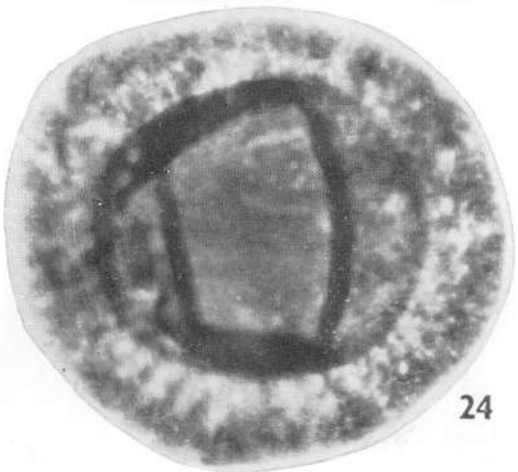

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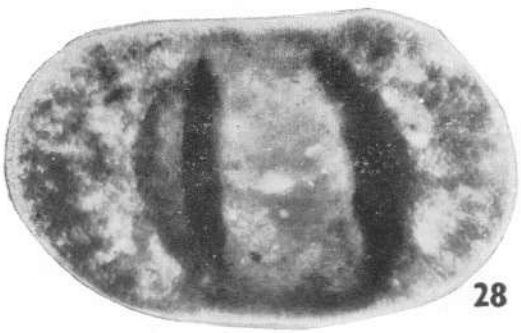

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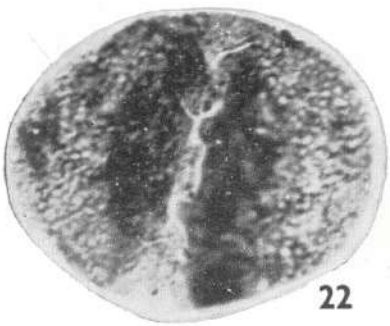

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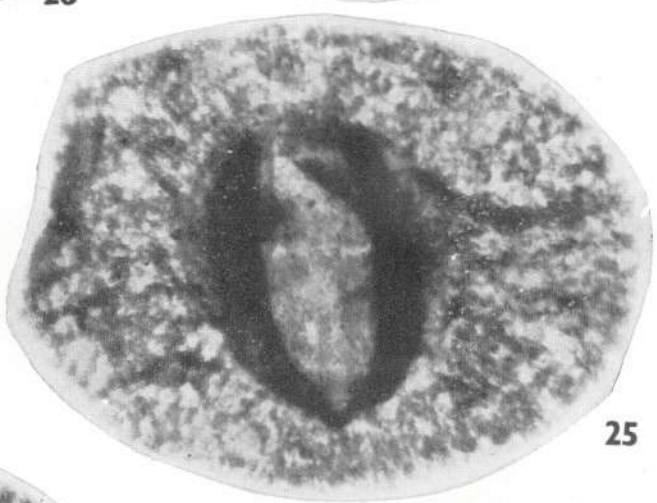

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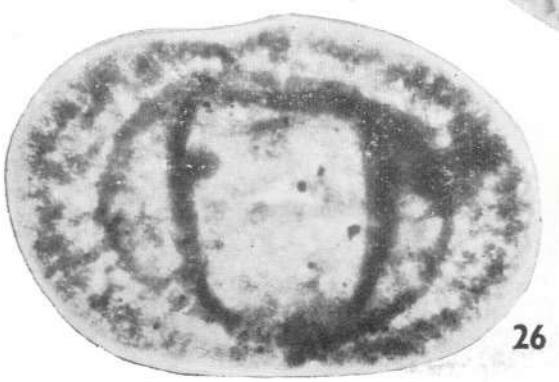

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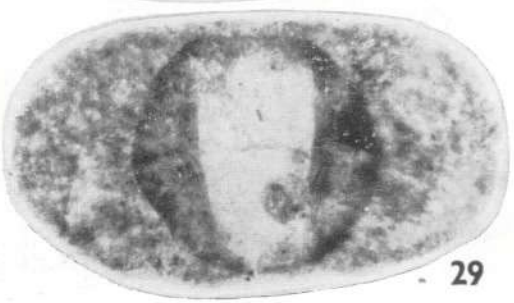

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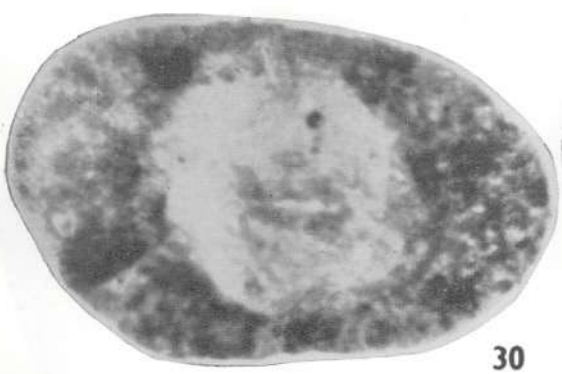

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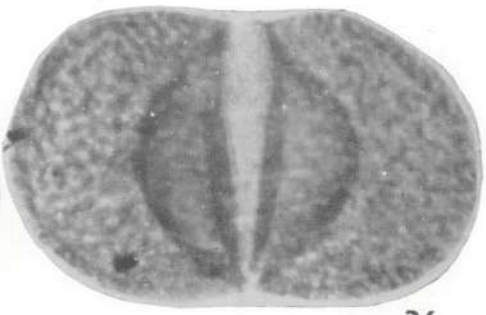

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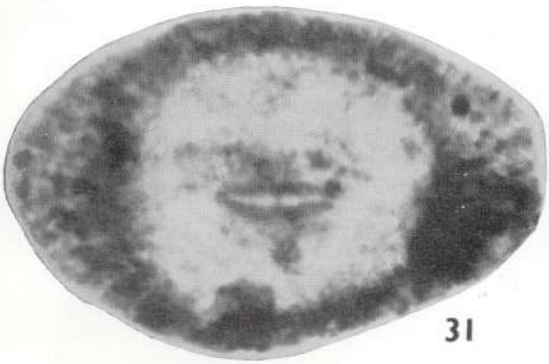

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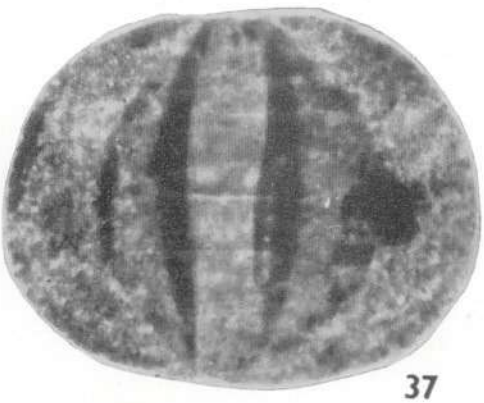

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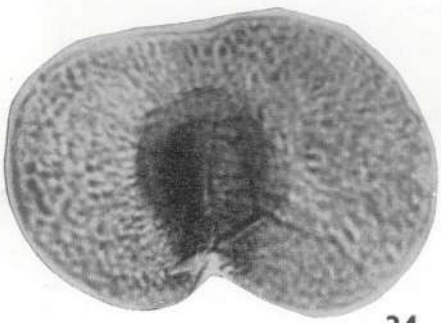

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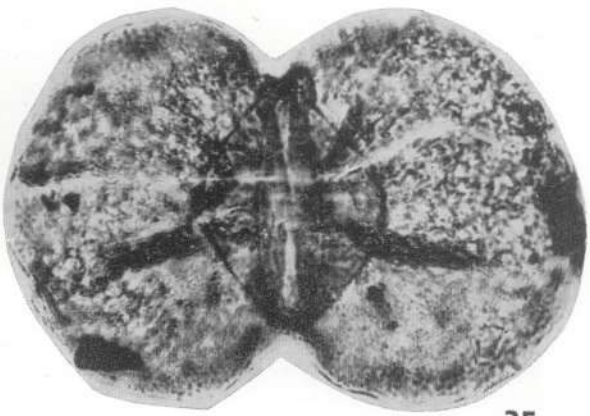

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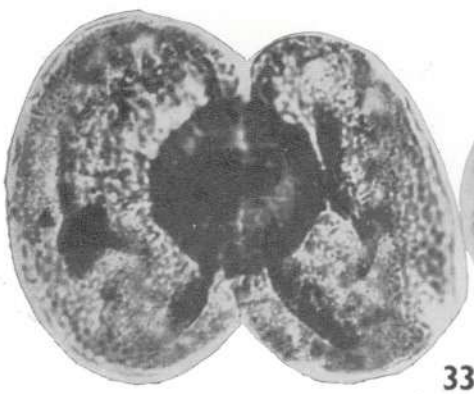

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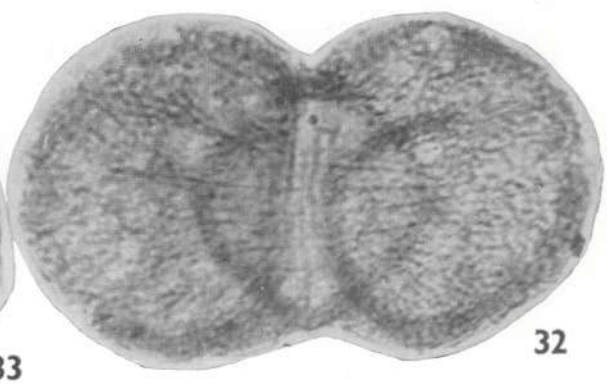

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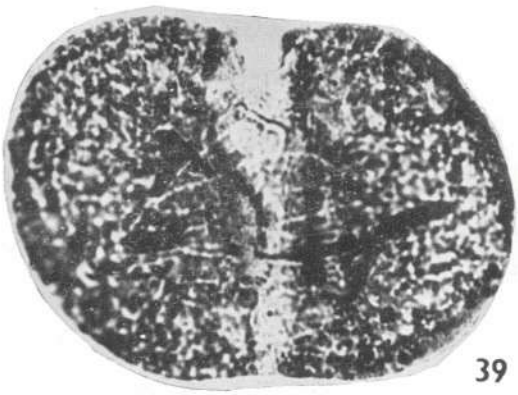

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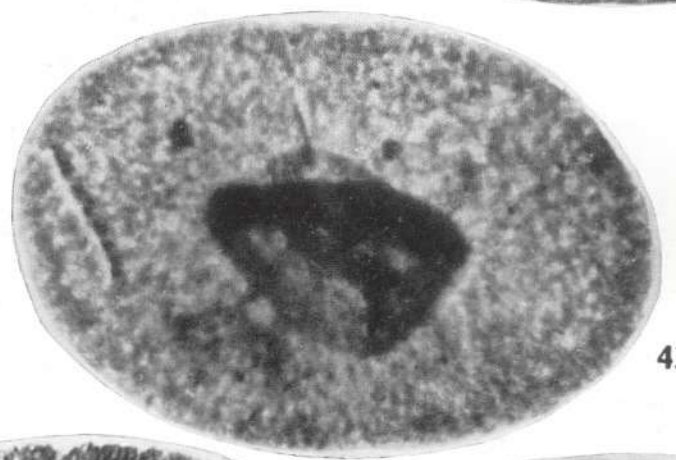

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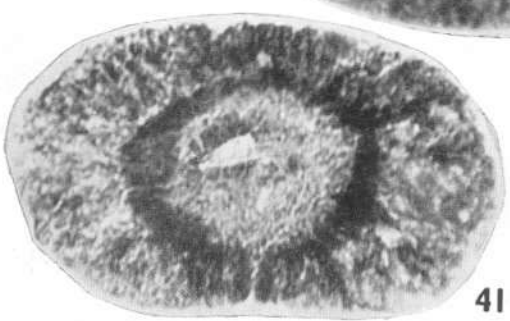

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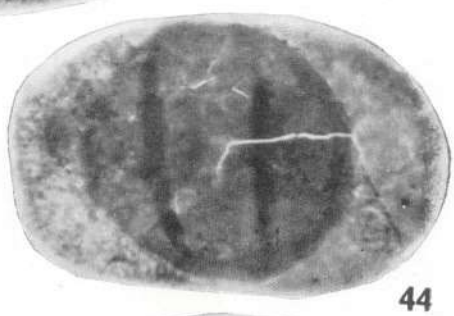

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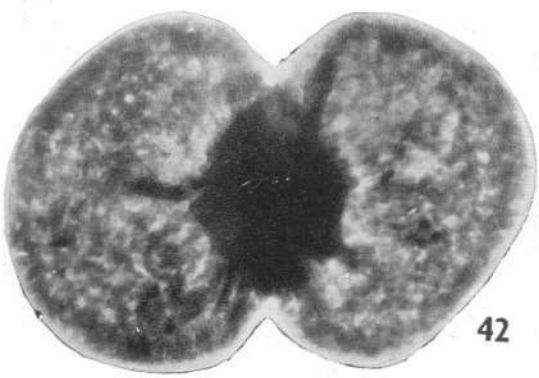

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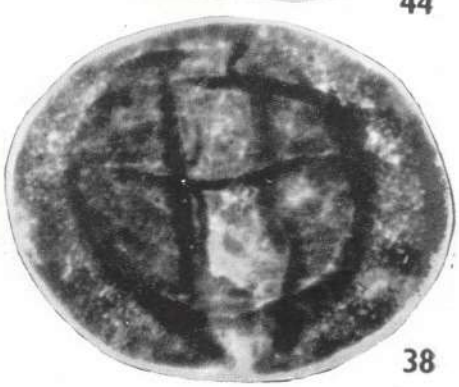

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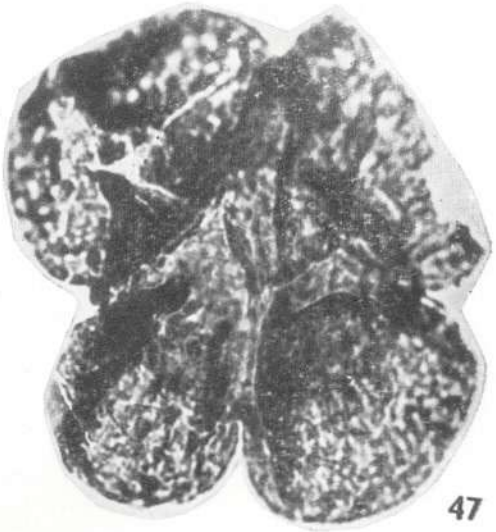
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## EXPLANATION OF PLATES

(*All photomicrographs are* × 500 *magnification*)

### PLATE 1

1. *Leiotriletes* sp. Slide no. 1977.
2. *Eupunctisporites* sp. Slide No. 1977.
3-4. *Cyclogranisporites* sp. Slide No. 1978, 1977.
5. *Lophotriletes* sp. Slide No. 1977.
6-7. *Plicatipollenites indicus* Lele, Slide No. 1979, 1980.
8. *Plicatipollenites gondwanensis* Lele, Slide No. 1981.
9. *Plicatipollenites trigonalis* Lele, Slide No. 1982.

### PLATE 2

10. *Plicatipollenites trigonalis* Lele, Slide No. 1983.
11. *Plicatipollenites diffusus* Lele, Slide No. 1984.
12. *Virkkipollenites obscurus* Lele, Slide No. 1980.
13. *Virkkipollenites triangularis* Lele, Slide No. 1979.
14. *Virkkipollenites mehtae* Lele, Slide No. 1983.
15-16. *Virkkipollenites densus* Lele, Slide No. 1977, 1978.

### PLATE 3

17-18. *Crucisaccites monoletus* sp. nov., Slide No. 1984, 1983.
19-20. *Parasaccites karharbarensis* sp. nov. Slide No. 1985.
21. *Parasaccites radiplicatus* sp. nov., Slide No. 1986.

### PLATE 4

22. *Vesicaspora ovata* (B. & H.) Wilson & Venkatachala, Slide No. 1977.
23. *Barakarites gondwanensis* sp. nov., Slide No. 1983.
24. *Potonieisporites* cf. *novicus* Bharadwaj, Slide No. 1989.
25, 26. *Potonieisporites neglectus* Potonié & Lele, Slide No. 1989, 1985.
27-29. *Sahnites gondwanensis* Pant, Slide No. 1990, 1985, 1991.

### PLATE 5

30, 31. *Vestigisporites diffusus* sp. nov., Slide No. 2052.
32. *Striatites karharbarensis* sp. nov., Slide No. 1983.
33. *Striatites densus* sp. nov., Slide No. 1977.
34. *Striatites incirus* sp. nov., Slide No. 1980.
35. *Lahirites rhombicus* sp. nov., Slide No. 1992.
36. *Lunatisporites amplus* Potonié, Slide No. 1978.
37. *Lunatisporites* cf. *amplus*, Slide No. 1985.

### PLATE 6

38. *Lunatisporites globosus* sp. nov., Slide No. 1984.
39. *Faunipollenites varius* Bharadwaj, Slide No. 1992.
40. *Faunipollenites goraiensis* n. comb., Slide No. 1985.
41. *Rhizomaspora* sp., Slide No. 1980.
42. *Platysaccus ovatus* sp. nov., Slide No. 1989.
43. *Succinctisporites* sp., Slide No. 1990.
44. *Alisporites oblongus* sp. nov., Slide No. 1977.

### PLATE 7

45. Cf. *Limitisporites* sp., Slide No. 1991.
46. Cf. *Crustaesporites* sp., Slide No. 1992.
47. *Tetrasaccus karharbarensis* sp. nov., Slide No. 1992.
48, 49. *Welwitschiapites magnus* sp. nov., Slide No. 1984, 1980.
50. *Welwitschiapites minutus* sp. nov., Slide No. 1984.
51. *Ginkgocycadophytus cymbatus* Potonié & Lele, Slide No. 1979.
52. *Marsupipollenites triradiatus* Balme & Hennelly, Slide No. 2053.