

MIOSPORE ASSEMBLAGE OF THE GANJRA NALLA BEDS, SOUTH REWA GONDWANA BASIN, WITH SOME REMARKS ON THE AGE OF THE BEDS

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ABSTRACT

A miopore assemblage containing 23 genera and 42 species from the Ganjra Nalla Beds of the Johilla Coalfield, Madhya Pradesh is described. The genera *Rugasaccites*, *Pachysaccus*, *Gondwanopollis* and *Rimospora* are newly instituted. The stratigraphical position of the Ganjra Nalla Beds is briefly discussed in the light of the plant micro- and macrofossil evidences.

INTRODUCTION

THE Ganjra Nalla beds represent a succession of carbonaceous shales and sandstones exposed in the Ganjra Nalla, a small stream feeding the Johilla river in the vicinity of Birsinghpur railway station in Madhya Pradesh. The sequences terminates upwards in coals, which is being worked out in the small Johilla Coalfield at some places. These strata, particularly the coal were formerly held to be of Barakar age, but recently independent evidence based upon physical and chemical analysis of coals has been put forth by Basu (1964) which indicates a Karharbari age to the coal bed. No systematic palynological work relevant to the question was so far carried out although spores from the Ganjra Nalla beds were earlier described by Mehta (1944) and Virkki (1946).

The material for the present study comes from the beds of finegrained carbonaceous-micaceous shales intercalated with coals and sandstones of variable thickness, exposed in the Ganjra Nalla at its junction with the Johilla river. Its location is about 1½ miles South-West of Birsinghpur Railway station.

For the isolation of miospores the shale samples were treated with in Hydrochloric acid (\pm boiling, 20 min.) followed with Nitric acid (\pm boiling, 30 min.). After removing all traces of acid by thorough washing in water (centrifuge or decantation), the residue was treated with a 5 per cent solution of Potassium hydroxide and warmed for ten minutes. The alkali was

removed by gradually washing in water. Slides were prepared with the help of Poly-venyl alcohol in canada balsam. All the slides studied are preserved at the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

MIOSPORE ASSEMBLAGE

The miospore assemblage described from the Ganjra Nalla beds comprises 23 genera and 42 species. Only new species and genera (marked by asterisk) and few others are described and compared in detail in the following description.

- **Punctatisporites ganjrensis* sp. nov.
- Didecitriletes horridus* Venkat. & Kar, 1965
- D. unicanthus* (Bal. & Henn.) Venkat. & Kar, 1965
- **D. spinosus* sp. nov.
- Dentatispora indica* Tiwari, 1964
- Plicatipollenites indicus* Lele, 1964
- P. diffusus* Lele, 1964
- P. trigonalis* Lele, 1964
- P. gondwanensis* (Bal. & Henn.) Lele, 1964
- **Virkipollenites triangularis* (Mehta) Lele, 1964
- V. mehtae* Lele, 1964
- V. obscurus* Lele, 1964
- V. densus* Lele, 1964
- **Rugasaccites polyplacatus* gen. et sp. nov.
- **R. orbiculatus* sp. nov.
- **R. obscurus* sp. nov.
- Parasaccites karharbarensis* Maithy, 1965
- P. korbaensis* Bharad. & Tiwari, 1964
- **P. radialis* sp. nov.
- **Pachysaccus solaris* gen. et sp. nov.
- Stellapollenites talchirensis* Lele, 1965
- Crucisaccites latisulcatus* Lele & Maithy, 1964
- Crucisaccites monoletus* Maithy, 1965
- **Crucisaccites medius* sp. nov.
- Caheniasaccites elongatus* Bose & Kar, 1968
- **C. diffusus* sp. nov.
- **Gondwanopollis ganjrensis* gen. et sp. nov.
- **G. indicus* sp. nov.

Potonieisporites neglectus Pot. & Lele, 1959
Vestigisporites diffusus Maithy, 1965
V. densus Singh, 1964
 **Rhizomaspora reticulata* sp. nov.
 **Rimospora rimosa* gen. et sp. nov.
Striatites densus Maithy, 1965
Lunatisporites amplus (Bal. & Henn.)
 Pot. & Lele
L. globosus
Faunipollenites varius Bhard. 1962
F. goraiensis (Pot. & Lele) Maithy, 1968
Illinites unicanus Kosanke, 1950
Welwitschiapites magnus Maithy, 1965
Ginkgocycadophytus cymbatus (Bal. & Henn.) Pot. & Lele
Vittatina scuta (Bal. & Henn.) Bharad. 1962

TAXONOMIC DESCRIPTION

Anteturma — *Sporites* H. Potonié
 Turma — *Triletes* (Rein.) Pot. & Kr.
 Subturma — *Azonotriletes* Luber
 Infraturma — *Laveigati* (B. & K.) Pot. & Kr.

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

Punctatisporites ganjrensis sp. nov.

Pl. 1, Figs. 1-4

Diagnosis — Size range 50-90 μ , outline circular or circular-triangular, exine smooth, moderately thick ($\pm 4 \mu$), intramicropunctate, trilete mark distinct, rays almost reaching up to the equator of body.

Holotype — Pl. 1, Fig. 2; size 60 μ , Slide No. 2824, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana basin, Madhya Pradesh.

Description — The grains are dark-brown or yellowish brown in colour. Commonly they are circular in outline, but occasionally they derive a roundly triangular shape. The body exine is externally smooth but has an intramicropunctate structure. It is moderately thick as is revealed in some examples figured here. The trilete mark is commonly distinct. The rays of the trilete mark are mostly equal in size and reach body equator.

Comparison — *Punctatisporites ganjrensis* differs from *P. gretensis* Balme & Hennelly (1956), *P. punctatus* Ibr. (see POTONIÉ & LELE, 1961), *P. minutus* Kos. (see POTONIÉ & LELE, 1961) and *P. nervatus* Alpern (1959)

in having circular to circular-triangular outline and marginal thickenings. *P. perminutus* Alpern (*l.c.*) is comparatively smaller in size and triangular in outline.

Infraturma — *Apiculati* (B. & K.)
 Pot. & Kr.

Subinfraturma — *Varitrileti* Venkat. & Kar

Genus — *Didecitriletes* Venkat. & Kar

Didecitriletes spinosus sp. nov.

Pl. 1, Figs. 5, 6

Diagnosis — Spores \pm triangular in outline, 25-40 μ , Trilete mark distinct, reaching equator, proximal surface smooth, distal surface covered with sparsely arranged spines.

Holotype — Pl. 1, Fig. 7; Size 26 μ ; Slide No. 2825, Birbal Sahni Institute of Palaeobotany.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana basin, Madhya Pradesh.

Horizon — Karharbari Stage

Description — Spores are uncommon in the assemblage, yellowish brown in colour. The outline is triangular, the sides being \pm convex and the angles rounded. The trilete mark is distinct, occasionally thick, and the rays are \pm equal size, reaching the body margin. Proximal surface of the spore is smooth while the distal surface is covered with sparsely arranged spines.

Comparison — *Didecitriletes spinosus* sp. nov. differs from *D. horridus* Venkatachala & Kar (1965), *D. ericianus* (B. & H.) Venkatachala & Kar (*l.c.*) *D. dentatus* (B. & H.) Venkatachala & Kar (*l.c.*) and *D. unciatus* (B. & H.) Venkatachala & Kar (*l.c.*) by the presence of broad-based, blunt and sparsely arranged spines.

Anteturma — *Pollenites* Pot.
 Turma — *Saccites* Erdtm.
 Subturma — *Monosaccites* (Chit.)
 Pot. & Kr.
 Infraturma — *Apertacorpi* Lele

Genus — *Virkkipollenites* Lele

Virkkipollenites triangularis (Mehta) Lele

Pl. 1, Fig. 12

Remarks — Lele (1964) selected the figured specimen of *Hymenozonotriletes triangularis*

Mehta (1945, Pl. 1, FIG. 1) from the Ganjra Nalla Beds as the holotype of the species. Since the slides of Mehta are not traceable, therefore, according to the International Code of Botanical Nomenclature, Art. 7/3, a neotype is designated for it from the present material.

Neotype — Pl. 1, Fig. 14; Size 104 μ ; Slide No. 2818, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coal-field, South Rewa Gondwana Basin, Madhya Pradesh.

Genus — *Rugasaccites* gen. nov.

Diagnosis — Monosaccate grains; circular, circular-oval or oval in outline; body distinct to indistinct, exine almost structureless or faintly intramicropunctate, both proximal and distal sides of body covered by vermiculate sculpture; vermiculae occasionally coalesce to form an irregular reticuloid pattern; mark trilete with a tendency to become reduced to a bilette or monolette, distinct to indistinct; saccus attachment proximally equatorial and distally subequatorial; distal attachment associated with a body infold system of variable pattern.

Genotype — *Rugasaccites polyplacatus* sp. nov.

Organization — The grains are circular, circular-oval, triangular or oval in outline. The body outline is distinct to indistinct and varies in shape from circular, circular-oval to vertically oval. The exine of the body is either smooth or intramicropunctate. The proximal as well as the distal side of the body bears vermiculate to rugose sculptural elements. These elements may be rather small-sized in some cases, giving merely a rough appearance to the body as seen under low optics. In other cases the vermiculae may be conspicuous enough to show their irregular anastomosis and the resultant reticuloid pattern. Evidently, specimens with finer sculpture warrant careful observation under higher magnification. Measurements of different specimens indicate that the areas enclosed by the reticuloid vermiculae may be up to 20 μ wide.

The trilete mark is distinct to indistinct. In circular grains the mark is distinctly trilete and the three rays are more or less

equal in size, whereas in oval grains one of the rays is extremely reduced and the mark shows a tendency to become bilette or monolette. A kind of gradual transition in the reduction of the trilete mark is observed from circular to circular-oval or oval grains.

The saccus is \pm uniformly wide or dilated horizontally and constricted at the two vertical ends. Saccus surface may have microfolds. The exine is intrareticulate with lumina and muri of variable size.

The attachment of the saccus is equatorial on the proximal side and subequatorial on the distal side. The distal saccus free area is \pm circular, circular-oval or vertically oval.

The distal saccus attachment is associated with body infolds which may be distinct to obscure. The components of the infold system are usually connected to form a circular, polygonal, oval or triangular pattern but occasionally there may be only two unconnected \pm vertical infolds.

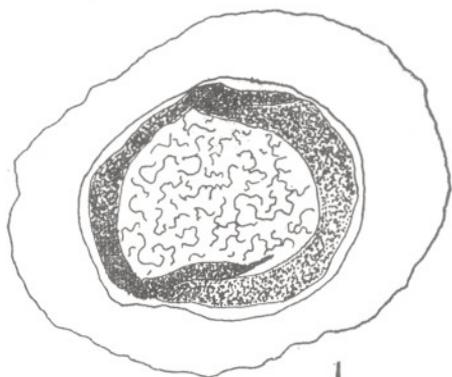
Comparison — Among the members of 'Apertacorpi' Lele (1964) *Rugasaccites* shows the nearest approach to *Plicatipollenites* Lele (1964). Both these genera have a body infold system associated with the distal saccus attachment and exhibit similar trends in the reduction of trilete mark and in the tendency to attain bilateral overall symmetry. The important distinction between *Rugasaccites* and *Plicatipollenites* is that the former genus has a sculptured body (rugate or vermiculate) while the latter has no sculpture.

The genera *Barakarites* Bharadwaj & Tiwari (1964), *Schizopollis* Venkatachala & Kar (1964) and *Parastriopollenites* Maheshwari (1967) possess a reticuloid pattern on the body of the grain but this pattern is due to the presence of gooves which intervene the polygonal areas. In contrast to this, the reticuloid pattern in *Rugasaccites* is entirely due to the branching and coalescence of the vermiculate elements which form the sculpture of the body on both sides. Besides this primary difference, there are other important differences between the above genera and *Rugasaccites*. For instance, the genus *Barakarites* differs in the presence of an inner body and the absence of body infolds. *Parastriopollenites* distinguishes itself by the para-condition of saccus attachment. The genus *Schizopollis* is mono- to polysaccate.

Rugasaccites polyplacatus sp. nov.

Pl. 1, Figs. 7-10; Text-fig. 1

Diagnosis — Grains oval in outline or circular-oval, 100-180 μ , body distinct, circular, exine smooth to intramicropunctate both proximal and distal surfaces of the body exine covered by vermiculate or convoluted rugose sculpture; sculptured elements often branched or coalescent giving rise to irregular and imperfect reticuloid pattern on the body surface. Y-mark indistinct, rays short, less than $\frac{1}{2}$ body radius. Saccus attachment proximally equatorial and distally subequatorial, distal overlap $\pm 1/3$ body radius, distal body infolds distinct, polygonal, composed of 4-6 components; saccus exine intrareticulate, muri and lumina are of equal size.



TEXT-FIG. 1 — *Rugasaccites polyplacatus* gen. et sp. nov. $\times 375$.

Holotype — Pl. 1, Fig. 9; Size 158 μ ; Slide No. 2819, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — Grains are commonly circular in outline. Body transversely oval, more or less conforming to overall outline, thin 60-100 μ in size. Surface of the body irregularly vermiculate, elements branched or coalescent, producing a reticuloid pattern. Vermiculae 1-2.5 μ wide and the areas surrounded by vermiculae are 5-20 μ in size. Y-mark obscure. Rays \pm equal and short $\pm \frac{1}{2}$ body radius. Saccus uniformly wide \pm equal to $\frac{1}{2}$ body radius. Exine intrareticulate, muri and lumina

are of equal width. There is a tendency for the radial elongation of the muri. Distally body infold system may be touching body periphery or somewhat displaced away, composed of 4-6 components; components may be of varying size and the ends of the components are \pm angular.

Rugasaccites orbiculatus sp. nov.

Pls. 1, 2, Figs. 11, 13, 14

Diagnosis — Size range 90-120 μ , circular-triangular in outline body thick, distinctly circular, exine smooth to intramicropunctate both the surfaces with irregular vermiculate sculpture, Y-mark distinct, rays \pm equal; length of rays equal to body radius; saccus narrow $\pm \frac{1}{2}$ body radius or even less, exine finely intrareticulate; surface frilled, body infold system distinctly circular.

Holotype — Pl. 2, Fig. 10; Size 100 μ ; Slide No. 2818, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds; Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — Grains are circular-triangular in outline. The body is moderately thick and distinctly circular in outline, body size 50-80 μ . The enclosed area by vermiculae are 2-4 μ in size. Saccus is narrow, 16-22 μ wide. Muri and lumina are of equal size. Surface of the saccus has microfolds. Body infold components is nearly touching to body periphery and circular in outline.

Comparison — From *Rugasaccites polyplacatus* sp. nov. the grains differ in having distinctly circular body infold component and narrow saccus.

Rugasaccites obscurus sp. nov.

Pl. 2, Figs. 15-17

Diagnosis — Grains distinctly circular or circular-oval in outline, measuring 90-130 μ in size; body thin; outline well marked, circular exine smooth to intramicropunctate; surface of body with vermiculate sculpture; Y-mark obscure; saccus narrow, equal to $\pm \frac{1}{2}$ body radius; exine finely intrareticulate, surface frilled, fold components, circular thin and obscure.

Holotype — Pl. 2, Fig. 14; Size 130 μ ; Slide No. 2817, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin; Madhya Pradesh.

Horizon — Karharbari Stage.

Description — The grains are circular or circular-oval in outline. The body exine is thin and obscure, however, the outline is well marked. Y-mark generally obscure. Rays \pm unequal in size sometimes reaching body equator. Saccus width is narrow 12-20 μ in size. Surface of the body has microradial folds. The body infold components are diffused and nearly touch the body periphery.

Comparison — It compares with *R. orbiculatus* sp. nov. but differs in having a thin body, diffused infold system and narrow saccus.

Infraturma — *Parasacciti* Maheshwari

Genus — *Parasaccites* Bharad. & Tiw.

Parasaccites radialis sp. nov.

Pl. 2, Figs. 18-19

Diagnosis — Size range 120-190 μ ; outline \pm circular, body distinct, 70-90 μ , exine thick, intramicroreticulate, Y-mark mostly obscure, saccus wide 35-60 μ , \pm 2/3 to equal body diameter, surface of saccus has radial folds, exine microreticulate, muri and lumina of equal width, saccus overlap on both sides of body \pm 1/3 of body radius.

Holotype — Pl. 1, Fig. 13; Size 110 μ ; Slide No. 2816, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Description — The grains are circular, the outline being somewhat undulated due to the preservation. The body is thick, intramicroreticulate and distinctly circular. Body exine is mostly obscure. Rays of the trilete mark are mostly obscure, \pm equal in length, extending up to 1/3 of body radius. The saccus is fairly wide, 2/3 body diameter and has prominent radial folds. The saccus exine is finely intrareticulate, having muri and lumina of equal width. The saccus free areas on both the sides of body are \pm circular and the saccus overlap is \pm 1/3 of body radius.

Comparison — In its organization the grains are comparable to *Parasaccites radiplicatus* Maithy (1965) recorded from the

Karharbari Stage of the Giridih Coalfield. However, the present grains differ in their comparatively smaller size, smaller body and wider saccus.

Genus — *Pachysaccus* gen. nov.

Diagnosis — Monosaccoid grains, circular to roundly triangular; outline irregularly undulated, body distinct to indistinct, circular, exine intramicroreticulate; trilete mark variable in prominence, saccus (or psuedosaccus) fleshy and with several pronounced, \pm overlapping radial folds, surface glossy with irregular fine puncta, attachment in para-condition.

Genotype — *Pachysaccus rotatus* sp. nov.

Description — The miospores are \pm radially symmetrical, well preserved grains show a fine intrareticulate central body, but the reticulum is usually imperfect. The trilete mark is simple with equal to unequal rays. The prominence of the mark is variable. The bladder does not show an intrareticulate structure, so typical of the gymnospermous pollen. The attachment is in paracondition i.e. subequatorial (radial) on both sides of body. The roots of attachment may be thickened. The whole appearance of bladder is rather fleshy and thick. The surface appears glossy. Fine irregular puncta could be detected on the bladder. Several conspicuous \pm overlapping folds radiate out from the zone of attachment which often give a characteristic wheel like appearance to the grains and produce an undulated overall outline.

Comparison — *Parasaccites* Bharadwaj & Tiwari (1964) is the nearest comparable genus, but it has a distinct intramicroreticulate saccus in which the muri of the intrareticulum tend to be radially arranged. The saccus is not fleshy or thick and the surface is \pm flat. Radial folds may be occasionally found but the intrareticulum cannot be missed. The present material incidently contains *Parasaccites* in good number and its species can be easily distinguished from the grains of *Pachysaccus* on the basis of above difference.

Remarks — The genus *Pachysaccus* is not typically saccate in as much as it lacks the intrareticulate structure in the saccus (?). The general fleshy and thick appearance of the saccus (?) is accentuated by the presence of heavy radial folds. The surface appears glossy and shows fine irregularly

placed puncta. A similar kind of saccus (?) is known in *Schizopollis* Venkatachala & Kar (1964). It may be that spores possessing a fleshy, non-intrareticulate saccus represent a distinct plexus.

Pachysaccus rotatus sp. nov.

Pl. 2, Figs. 20-24; Text-fig. 2A, B

Diagnosis — Size range 50-120 μ , outline circular or circular-triangular, body 40-50 μ , exine intramicroreticulate; Y-mark \pm distinct, rays \pm equal, about $\frac{3}{4}$ body radius or longer saccus (?) thick and glossy; $\pm \frac{1}{4}$ of body radius with pronounced folds, radially disposed, \pm overlapping, saccus, roots \pm thickened, exine with irregular fine puncta, margin undulated.

Holotype — Pl. 2, Fig. 22; Size 64 μ ; Slide No. 2818, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — The grains are fairly common in the assemblage. Body outline is thin but distinct. Rays may occasionally reach body equator. Lips may be present. Bladder is narrow with several heavy irregular radial folds. The exine is irregularly punctate, the puncta being better seen in between the radial folds or towards the margin. The saccus (?) appears to be generally thicker nearer the body and the roots may develop thickenings. The appearance of the saccus is fleshy and the surface is rather glossy.

Infraturma — *Amphisacciti* Lele

Genus — *Crucisaccites* Lele & Maithy

Crucisaccites medius sp. nov.

Pl. 3, Figs. 25-26

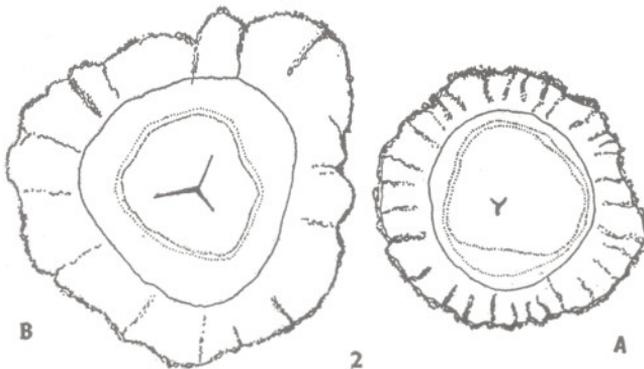
Diagnosis — Size range 200-250 μ ; outline \pm circular to oval, body 80-120 μ ; \pm circular, mediumly thick; exine intramicroreticulate; mark obscure; saccus fairly wide outside body, wider along horizontal axis, saccus attachment amphilateral, crosswise, one of the zones may be somewhat tilted laterally; saccus free area more or less oval, zones of attachment associated with body folds, saccus structure intrareticulate.

Holotype — Pl. 3, Fig. 25; Size 174 μ ; Slide No. 2819, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — The occurrence of these grains is very common in the assemblage. The grains are circular or circular-oval in outline. Body is mediumly-thick and the outline is well marked, \pm circular or circular-oval. The body exine is finely intramicroreticulate. The mark is generally obscure, occasionally a monolete mark is perceptible. Commonly the zones of saccus attachment are at right angles to each other, however, in some cases the attachment zones are somewhat obliquely crossed to one another (at 70°). Attachment zones are associated with body folds. Additio-



TEXT-FIGS. 2A, B — *Pachysaccus rotatus* gen. et sp. nov. $\times 500$.

nally irregular folds may be present on the body. Saccus fairly wide, 15-50 μ , horizontally more expanded. Saccus exine intrareticulate. Muri and lumina of equal size.

Comparison — The grains are comparable to *Crucisaccites latisulcatus* Lele & Maithy (1964) but differ by the presence of a wider saccus and the occasionally obliquely crossed zones of saccus attachment. Besides, in *C. latisulcatus* the saccus is uniformly wide, whereas in the present species it is wider along the horizontal axis.

Infraturma — *Caheniasacciti* Bose & Kar, 1966

Genus — *Caheniasaccites* Bose & Kar

Caheniasaccites diffusus sp. nov.

Pl. 3, Fig. 27

Diagnosis — Size range 120-180 μ , grains oval in outline, body thin, outline circular to circular-oval, well marked, exine intramicroreticulate, mark not perceptible; attachment of saccus amphilateral, proximally circular and distally oval. Saccus expanded horizontally, constricted at two vertical ends and nearly touching the body margin.

Holotype — Pl. 3, Fig. 27; Size 104 μ ; Slide No. 2822, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — Grains are oval in outline. The body is very thin, however, the outline is decipherable. Saccus is dilated along the horizontal axis and constricted to various extent at two vertical ends.

Comparison — *Caheniasaccites ovatus* Bose & Kar (1966) compares with the present grains but differs in the presence of radial folds on the saccus.

Genus — *Gondwanopollis* gen. nov.

Diagnosis — Pollen grains monosaccate, bilateral. Central body distinct, rhomboidal, subcircular, horizontally oval, exine intramicroreticulate. Monolete mark perceptible. Attachment of saccus to central body showing amphilateral condition. Saccus well developed, constricted laterally, mostly with well developed lateral ridges; exine intra-

reticulate; zones of attachment associated with body infolds or thickenings of variable pattern.

Genotype — *Gondwanopollis ganjrensis* sp. nov.

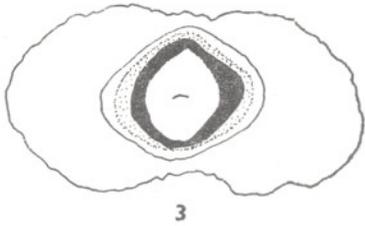
Organization — The pollen grains have an oval or elliptical overall outline. The central body is distinct, the exine may be sometime thick and generally finely intramicroreticulate. In ill-preserved grains occasionally the body structure is distorted so as to appear microverrucose. The monolete mark of the body is distinct to indistinct bent or straight occupying 2/3 length of the body diameter. The saccus shows amphilateral condition of attachment. The proximal attachment is subequatorial, and \pm circular while the distal attachment tends to be bilateral. Body infolds or thickenings of variable pattern are associated with both zones of saccus attachment. The infold components may form a continuous ring (circular, polygonal or vertically oval) or there may be only two separate, distinct, semilunar vertical infolds. The latter tendency seems to accompany those forms which are more distinctly bilateral. The saccus is bilateral, being wider along the horizontal axis and constricted along the vertical axis and often forming lateral ridges. The saccus exine is intrareticulate having muri and lumina of equal size.

Comparison — Among the amphisaccate genera the present grains are comparable to *Caheniasaccites* Bose & Kar (1966). However, *Gondwanopollis* is distinguished by the presence of distinct body infolds or thickenings associated with saccus attachment as well as the presence of a monolete mark. *Parasaccites* Bharadwaj & Tiwari (1964) differs in possessing radial symmetry and trilete mark. In *Crucisaccites* Lele & Maithy (1964) the amphilateral zones of saccus attachment are mutually crosswise whereas in *Stellapollenites* Lele (1965) they are reversed.

Gondwanopollis ganjrensis sp. nov.

Pl. 3, Figs. 28-29; Text-fig. 3

Diagnosis — Size range 120-180 μ , grains oval in outline; body distinct, moderately thick, rhomboidal in outline; exine finely intramicroreticulate, monolete mark obscure, body infold system \pm polygonal in outline, proximal attachment circular and distal attachment vertically oval; both attach-



TEXT-FIG. 3 — *Gondwanapollis ganjrensis* gen. et sp. nov. $\times 375$.

ment zones associated with body infolds or thickening, distal infolds relatively better developed, saccus dilated laterally and constricted along the vertical ends, exine intrareticulate, muri and lumina of equal size.

Holotype — Pl. 3, Fig. 28; Size 130 μ ; Slide No. 2818, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — The grains are distinctly oval in outline. The body is moderately thick and rhomboidal in outline. The body exine is intramicroreticulate but due to ill preservation and distortion it appears to be microverrucose. Monolete mark is slightly bent and occupies $2/3$ of body length. Commonly it is obscure. Proximal body infold system is subcircular to polygonal. Distal body infolds relatively better developed forming vertically oval bilateral pattern. The vertical ends of the infold may nearly touch body periphery. Saccus attachment amphilateral.

Gondwanapollis concavus sp. nov.

Pl. 3, Figs. 30, 31

Diagnosis — Size range 120-230 μ ; grains oval in outline; body thin, distinct, circular, exine intramicroreticulate; monolete mark perceptible; body infold system comprises of two vertical fold components, saccus attachment amphilateral, proximal circular and distal oval; saccus exine intrareticulate, muri and lumina of equal size.

Holotype — Pl. 3, Fig. 30; Size 120 μ ; Slide No. 2819, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — Grains are oval in outline. Body thin distinctly circular in outline. Exine intramicroreticulate but due to ill preservation it may be distorted. The monolete mark occupies $2/3$ length of body diameter and may have prominent lips. The body infold system consists of two distinct vertical concave folds. The attachment is amphilateral. It is circular on the proximal and vertically oval on the distal side. Saccus dilated horizontally and constricted at the two vertical ends. Saccus exine is intrareticulate having muri and lumina of equal width.

Comparison — *Gondwanapollis ganjrensis* differs in the presence of hexagonal body infold system, marginal thickening of body and rhomboidal body outline. The grain figured by Mehta (1945, TEXT-FIG. 2) from the Ganjra Nalla Beds appears from the diagram to be organizationally similar to the present species.

Subturma — *Disaccites* Cooks.

Infraturma — *Striareticuloiditi* Tiwari

Genus — *Rhizomaspora* Wils.

Rhizomaspora reticulata sp. nov.

Pl. 3, Fig. 34

Diagnosis — Size range 100-150 μ , central body distinct, \pm circular, dark 50-100 μ , exine finely intramicroreticulate; proximal surface of body has irregular polygonal areas bounded by grooves forming a mud-crack like pattern ('reticuloid striations'), polygonal areas, 10-18 μ , distal attachment zone obscure, sacci placed fairly apart from one another, sacci exine intrareticulate, muri and lumina of equal size.

Holotype — Pl. 3, Fig. 34; Size 110 μ ; Slide No. 2818, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla Beds, Johilla Coalfield, South Rewa Gondwana Basin, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — The grains are distinctly diploxylo-noid in outline. The body is dark brown in colour and circular or circular-oval in outline. The proximal side of body is covered by irregularly arranged polygonal areas, 10-18 μ in size. The sacci are hemispherical in shape. The attachment zones are obscure. Distal sulcus is very

wide. Sacci exine is intrareticulate. Muri and lumina are of equal size.

Comparison — Among the known species of *Rhizomaspora*, *R. divarisaccata* Wilson (1962) and *R. fimbriata* Tiwari (1965) resembles the present species in the presence of laterally separated sacci. *R. fimbriata* differs in having a thick equatorial rim of the body and faint polygonal reticulations. *R. divarisaccata* differs in the presence of hemispherical sacci and polygonal reticulation of body.

Genus — *Rimospora* gen. nov.

Diagnosis — Monosaccoid bilateral grains, body distinct, circular, exine intramicroreticulate, proximal and distal surfaces possess a mud-crack like pattern consisting of polygonal areas, bounded by narrow grooves; mark \pm visible, monolete or bilette; saccus attachment proximally equatorial and distally subequatorial; distal saccus free area more or less circular, distal zone of saccus attachment associated with body infolds, saccus exine intrareticulate.

Genotype — *Rimospora rimosa* sp. nov.

Organization — The grains are monosaccate and bilateral oval in outline. Body outline distinct or indistinct, thick or thin and intramicroreticulate. The areas bound by grooves are either polygonal, rectangular or oval in outline and of varying size. The mud-crack-like pattern generally keeps clear of the monolete mark. Secondly, it is also noticed that in some examples the polygonal areas are arranged in more or less parallel horizontal rows due to which the grooves become more prominent along the horizontal direction. The mark is monolete or bilette, \pm distinct and situated in the middle portion of the body. The lips may have thickenings. Body infold system may be distinct or diffused; circular, oval or polygonal in outline. Saccus expanded along horizontal axis and narrow or constricted along vertical axis of grains. Saccus may have radial frills.

Comparison — *Rimospora* compares to *Direticuloidispora* Tiwari (1964) in the presence of reticuloid pattern on both the surfaces of body, but differs in the strictly monosaccoid construction, distinct body infolds and the presence of a monolete mark. Besides, the body exine in *Rimospora* is intramicroreticulate whereas in *Direticuloidispora* it is intrapunctate.

Rimospora rimosa sp. nov.

Pl. 3, Figs. 35, 36; Text-fig. 4

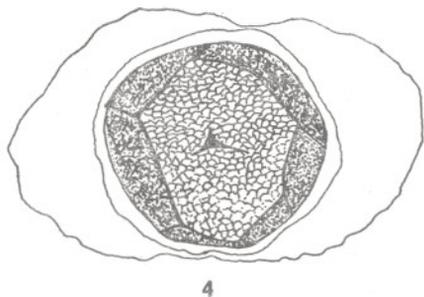
Diagnosis — Size range 150-200 μ , \pm oval in outline; body thick, distinct, oval to circular-oval, proximal and distal surface with reticuloid areas bounded by grooves, areas elongate-polygonal, 4-10 μ ; body infold system rhomboidal; mark reduced, bilette or monolete; saccus attachment proximally equatorial and distally subequatorial, saccus more expanded along horizontal axis and constricted along vertical axis of grains; saccus exine intrareticulate, muri and lumina of equal size, surface of saccus with micro-radial folds.

Holotype — Pl. 3, Fig. 35; Size 106 μ ; Slide No. 2826; Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Ganjra Nalla beds Johilla Coalfield, Madhya Pradesh.

Horizon — Karharbari Stage.

Description — Grains are bilateral in shape. The body outline is very distinct. The exine is intramicroreticulate. The reticuloid areas are elongate rectangular to polygonal in shape. Mark is commonly indistinct. It is either a monolete or may be bent to appear like a bilette mark. Body infold system is rhomboidal and shows considerable amount of angularity. The saccus is expanded along the horizontal axis and is constricted along vertical axis. Occasionally the saccus is very narrow along the vertical axis and nearly touches the body margin simulating a disaccate condition. Saccus surface has microradial folds. Folds may reach body margin.



TEXT-FIG. 4 — *Rimospora rimosa* gen. et sp. nov. \times 500.

DISCUSSION

The miospore assemblage of the Ganjra Nalla beds comprises 42 species belonging to 23 genera. Of these 4 genera and 12 species are new to our knowledge. Quantitatively the following genera are important in view of their dominant occurrence in the assemblage, viz. *Parasaccites*, *Virkipollenites*, *Crucisaccites*, *Plicatipollenites*, *Rugasaccites*, *Gondwanapollis*, *Caheniasaccites* and *Vestigisporites*. The following genera are also present but they are uncommon in the assemblage, viz. *Punctatisporites*, *Stellapollenites*, *Potoniisporites*, *Rhizomaspota*, *Striatites*, *Faunipollenites* and *Lunatisporites*. *Didictrilites*, *Gondisporites*, *Welwitschiapites*, *Vittatina* and *Ginkgocycadophytus* are rare in the assemblage. Thus, quantitatively the miospore assemblage shows predominance of monosaccate genera. Disaccates occur frequently, where as trilete, alete and plicates are rarely present.

The question whether the Ganjra Nalla beds belong to the Karharbari Stage or the Barakar Stage has remained somewhat controversial. These beds lie conformably over the beds of the Talchir Stage and are overlain by the lowest coal seams which was considered to be Barakar in age (HUGHES, 1884; FOX, 1932). Feistmantel (1884) and Pascoe (1958, p. 1047) have opined that the Ganjra Nalla beds are Karharbari in age. Saksena (1952, p. 10) also seems to be inclined to this view. He has rightly pointed out that the Ganjra Nalla beds have erroneously been included under the name 'Pali beds' by Virkki (1946) and Mehta (1945). The 'Pali beds' represent a horizon much younger than the Ganjra Nalla beds. The chemical and physical studies of the Ganjra Nalla Coals have led Basu (1964) to indicate a Karharbari age to the beds. The palaeobotanical evidences seem to fully support the viewpoint.

The miospore assemblage of the Barakars has been described in recent years in detail by Bharadwaj and Tiwari (1964) and Tiwari (1965). A comparison of the miospore assemblage of the Ganjra Nalla Beds with that of Barakar Stage shows that most of

trilete and zonate grains of the Barakars are absent from the Ganjra Nalla assemblage. Besides, the striate grains are not so common. On the other hand *Rugasaccites*, *Crucisaccites*, *Pachysaccus* and *Gondwanapollis* which are common elements of the Ganjra Nalla Beds are not known from Barakars.

The miospore assemblage of the Karharbari Stage is described in detail by Maithy (1965). The spore assemblage of the Karharbari Stage shows the dominance of monosaccates and imperfectly disaccate grains. The occurrence of amphisaccate spores is quite common. Trilete grains are rare and zonate ones are not known. The spore flora of Ganjra Nalla Beds compares with that of the Karharbari Stage in dominance of monosaccates and imperfectly disaccate grains. The trilete grains are also rare as in the Karharbari mioflora. The occurrence of *Dentatispora* Tiwari and *Stellapollenites* Lele is somewhat exceptional, but the precise range of these genera is yet to be known.

The evidence of megafossils also supports the contention that the Ganjra Nalla Beds are homotaxial to the Karharbari Stage of the Giridih Coalfield. Plant fossils have been described by Feistmantel (1884), Hughes (1884), Saksena (1952, 1963), Puri (see KRISHNAN 1954, p. 224), Lele and Maithy (1964) and Maithy (1968). These records are as follows:

Phyllothea sahnii Saksena, *Gangamopteris cyclopteroides* Feistmantel, *Gangamopteris srivastavae* Maithy, *Gangamopteris* sp., *Glossopteris communis* Feistm., *Glossopteris indica* Schimper, *Glossopteris browniana* Feistm., *Noeggerathiopsis gondwanensis* Lele & Maithy, *Noeggerathiopsis hislopi* Feistm., *Noeggerathiopsis indica* Lele & Maithy, *Samaropsis ganjrensis* Saksena, *Alotacarpus johillensis* (Saksena), *Buriadea* sp. and *Palamatophyllites debilis* Maithy.

These elements especially *Gangamopteris* and *Noeggerathiopsis* are among the dominant constituents of the Karharbari flora of the Giridih Coalfield. Lastly the record of *Buriadia* from the Ganjra Nalla Beds is highly significant as the genus is rather peculiar to the Karharbari Stage.

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EXPLANATION OF PLATES

(All photomicrographs are magnified $\times 500$, unless mentioned specifically).

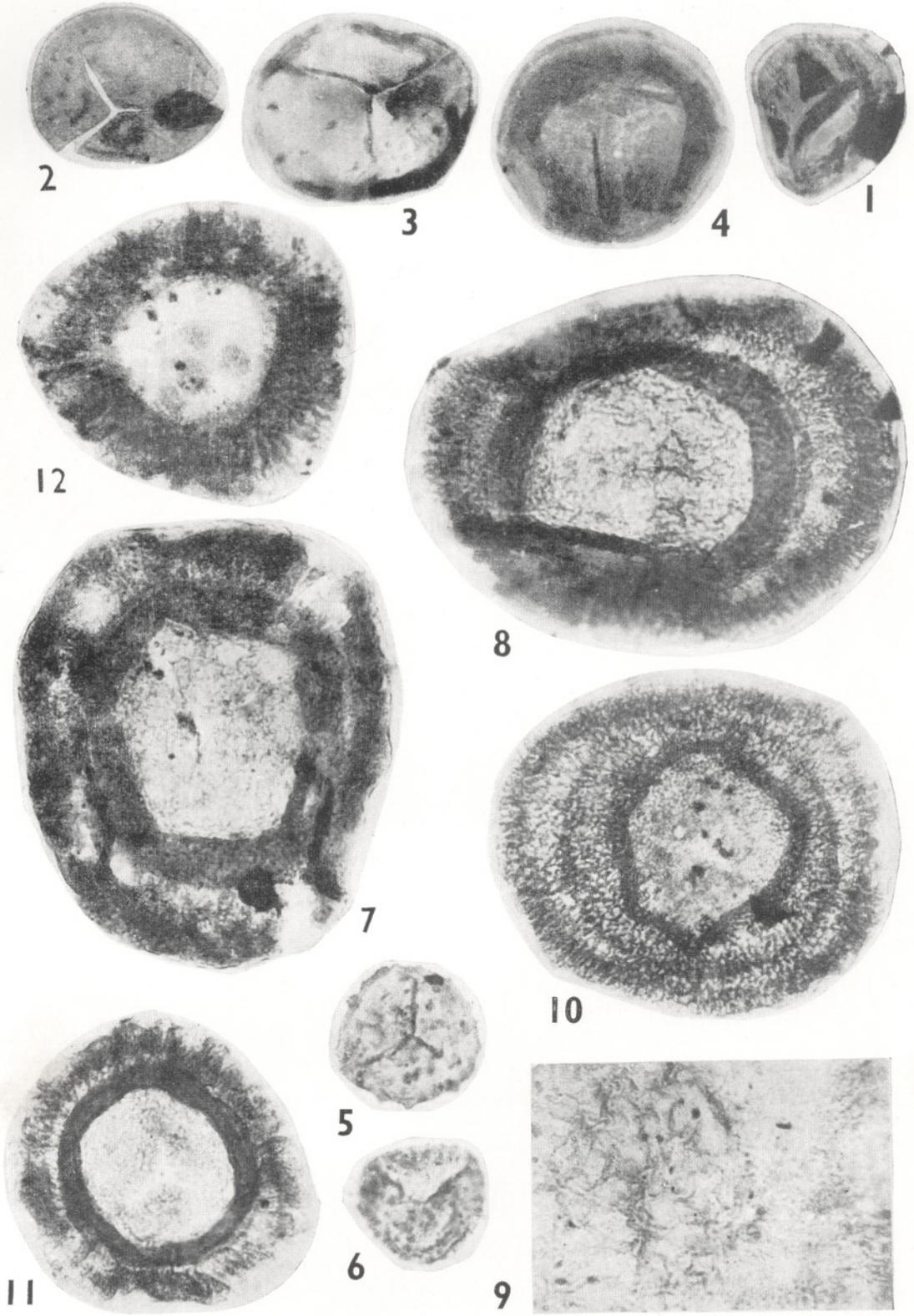
PLATE 1

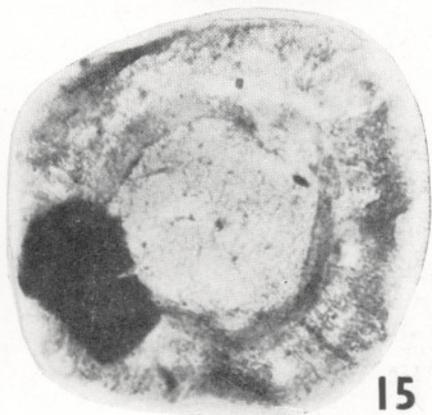
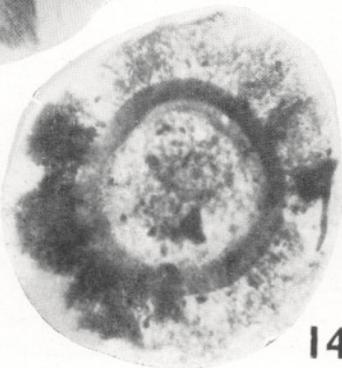
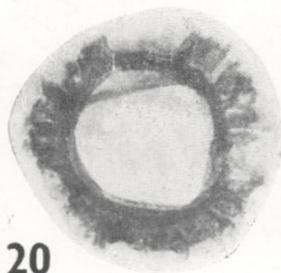
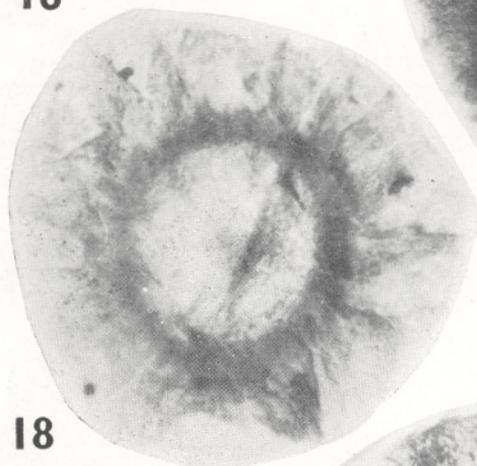
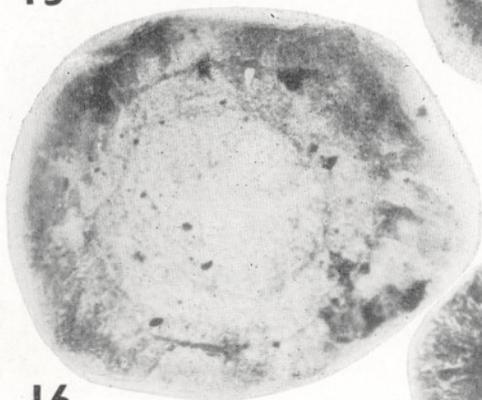
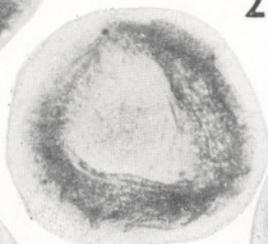
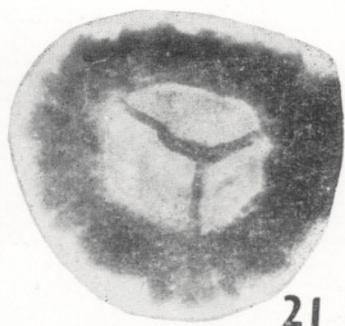
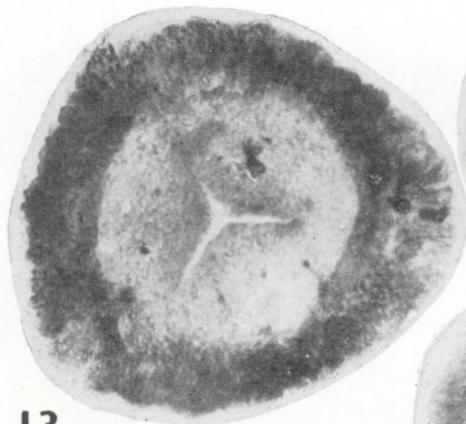
1. *Punctatisporites ganjrensis* sp. nov., a triangular grain. Slide No. 2821.
2. *Punctatisporites ganjrensis* sp. nov., a triangular grain with convex ends. Slide No. 2824.
3. *Punctatisporites ganjrensis* sp. nov., a circular-triangular grain, trilete mark reaching equator. Slide No. 2819.
4. *Punctatisporites ganjrensis* sp. nov., a circular grain. Slide No. 2821.
- 5-6. *Didectritetes spinosus* sp. nov. Slide Nos. 2825 and 2824. $\times 1000$.
7. *Rugasaccites polyplacatus* gen. et sp. nov. (Holotype). Slide No. 2819.
8. *Rugasaccites polyplacatus* gen. et sp. nov. Slide No. 2816.

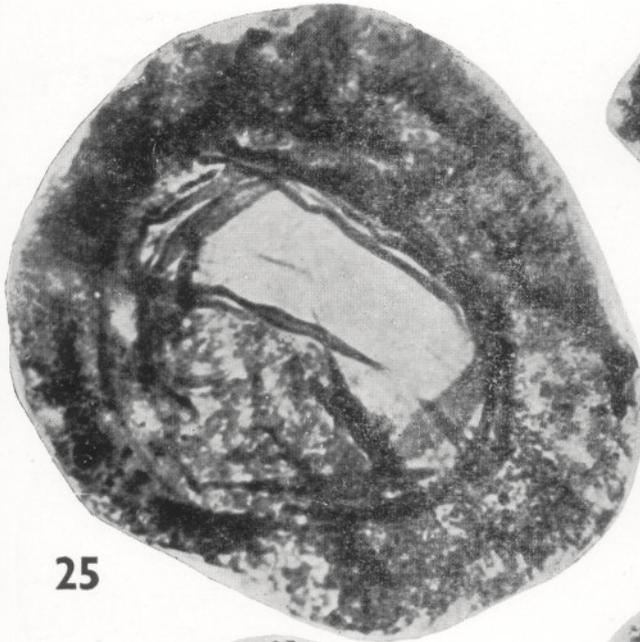
9. Body of *Rugasaccites* enlarged to show the exine pattern. Slide No. 2818. $\times 1000$.
10. *Rugasaccites polyplacatus* gen. et sp. nov. Slide No. 2816. Grain showing hexagonal folds.
11. *Rugasaccites orbiculatus* sp. nov. (Holotype). Slide No. 2818.
12. *Virkkipollenites triangularis* Lele. Slide No. 2818.

PLATE 2

13. *Rugasaccites orbiculatus* sp. nov. Slide No. 2827.
14. *Rugasaccites orbiculatus* sp. nov. Slide No. 2818.







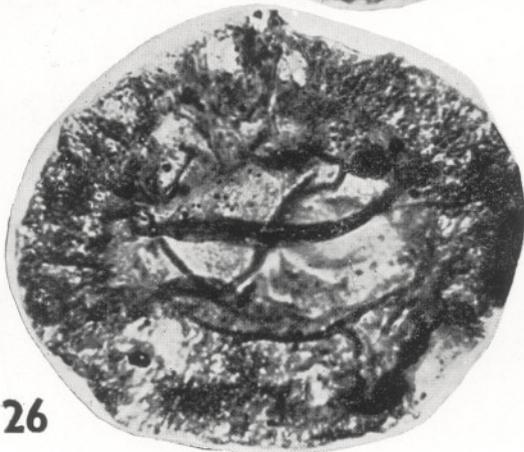
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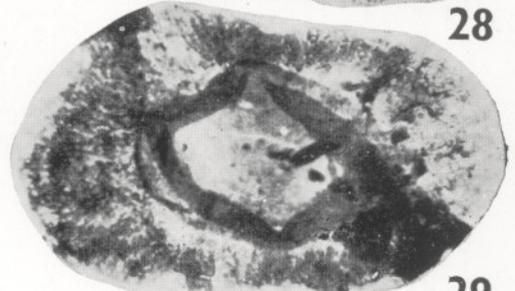
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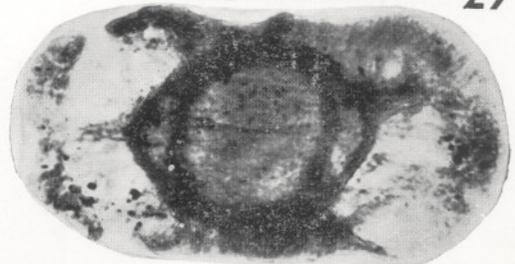
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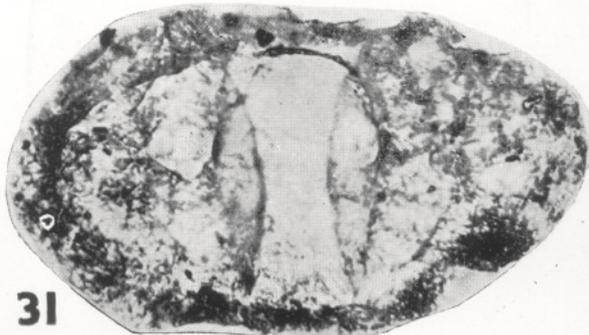
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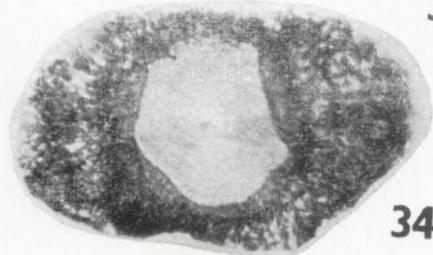
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PLATE 3

15. *Rugasaccites obscurus* sp. nov. Slide No. 2818.
16. *Rugasaccites obscurus* sp. nov. Slide No. 2817.
17. *Rugasaccites obscurus* sp. nov. Slide No. 2817.
- 18-19. *Parasaccites radialis* sp. nov. Slide Nos. 2816 and 2818.
20. *Pachysaccus rotatus* gen. et sp. nov. (Holotype). Slide No. 2816.
21. *Pachysaccus rotatus* gen. et sp. nov. Slide No. 2816.
22. *Pachysaccus rotatus* gen. et sp. nov. Slide No. 2819.
23. *Pachysaccus rotatus* gen. et sp. nov. Slide No. 2819.
24. *Pachysaccus rotatus* gen. et sp. nov. Slide No. 2816. Spore showing a wide pseudosaccate structure and open Y-mark.
- 25-26. *Crucisaccites medius* sp. nov. Slide Nos. 2816 and 2819.
27. *Caheniasaccites diffusus* sp. nov. Slide No. 2822.
28. *Gondwanapollis ganjrensis* gen. et sp. nov. (Holotype). Slide No. 2818.
29. *Gondwanapollis ganjrensis* gen. et sp. nov. Slide No. 2827.
30. *Gondwanapollis concavus* sp. nov. Slide No. 2819.
31. *Gondwanapollis concavus* sp. nov. Slide No. 2819.
32. *Rhizomaspora reticulata* sp. nov. Slide No. 2818.
33. *Rimospora rimosa* gen. et sp. nov. Slide No. 2817.
34. *Rimospora rimosa* gen. et sp. nov. Slide No. 2826.