PALYNOLOGY OF THE NORTH KARANPURA BASIN, BIHAR, INDIA — 5. PALYNOLOGICAL ASSEMBLAGE OF THE BORE-CORE NO. K_2, RANIGANJ STAGE (UPPER PERMIAN)

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ABSTRACT

The present paper deals with the palynological assemblage of the bore-core no. K_2, Raniganj Stage (Upper Permian), located in the top Raniganj — Kavendai area, North Karanpura coalfield (Sheet no. 13E/1), Bihar, India. 58 spores-pollen genera have been recovered. Some of the genera, viz. *Psilalacinites, Divarireticulates, Striasporis, Altimonoletes, Ghoshiasporites, Mammialetes, Raniganjiasaccites* and *Gondwanaeaplicates* are recorded and seems to be mostly confined to this particular Stage. The assemblage is dominated by the striate bisaccate and monosaccate pollen grains at the base of the core, but the percentage of the monosaccate dwindles down at the upper level and the trilete and the monolete spores take its place. The striate bisaccate is, however, dominant throughout the assemblage. Two palynological zones have been established according to the representation of the various spores-pollen in the count. The present palynological assemblage has also been compared with the other palynological assemblages of the same stage.

INTRODUCTION

PALYNOLOGICAL assemblage of the Raniganj Stage (Upper Permian) of the Lower Gondwanas of India is known mostly by the studies of Sen (1944), Ghosh and Sen (1948), Bhattacharya, Raychowdhury and Datta (1957), Bharadwaj (1962), Bharadwaj and Salujha (1964, 1965a, 1965b), Salujha (1965), Bharadwaj and Tiwari (1966) and Kar (1968). The present paper deals with the palynological assemblage recovered from the bore-core no. K_2 of the Raniganj Stage, located in the top Raniganj-Kavendai area, North Karanpura coalfield (Sheet no. 13E/1), Bihar, India. The bore-core was very kindly supplied by the Geological Survey of India. It consists of samples from RN 1 to RN 292 covering 12·37-366·07 metres of rock samples. The samples from RN 1 to RN. 265 belong to Raniganj Stage and the rest belong to Barren Measures. The samples comprising Raniganj Stage may be broadly categorized into five lithological units: grey shale, fine-coarse grained sandstone, sandstone with alternating shale bands, shale with coal bands and coal (TEXT-FIG. 1). The sandstone alternating with shale bands and the fine-coarse grained sandstone are dominant in the bore-core followed by grey shale. The shale is mostly sandy and hardly carbonaceous. The coal is meagre in representation and confined to the upper level.

MACERATION

The samples were taken from all lithological units approximately at an interval of 10 metres. When the samples did not yield, samples were generally macerated at closer intervals. The samples from the lower part of the bore-core yielded better than those at the upper ones. 10-15 grams of rock samples were kept in Nitric acid (40 per cent) for 5-10 days followed by a treatment of Potassium hydroxide solution (10 per cent) for 5 minutes. The material was dried on the cover glass with Polyvenyl alcohol and mounted in canada balsam. The rock samples and the slides have been deposited at the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow. Samples macerated from the bore-core no. K_2 are given in the following Table.

The spores-pollen recovered from the above samples have been grouped into 58 dispersed spores-pollen genera. They are as follows:

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

Genus — *Retusotriletes* Naum., 1953.

Genus— *Calamospora* Schopf, Wils. & Bent., 1944.

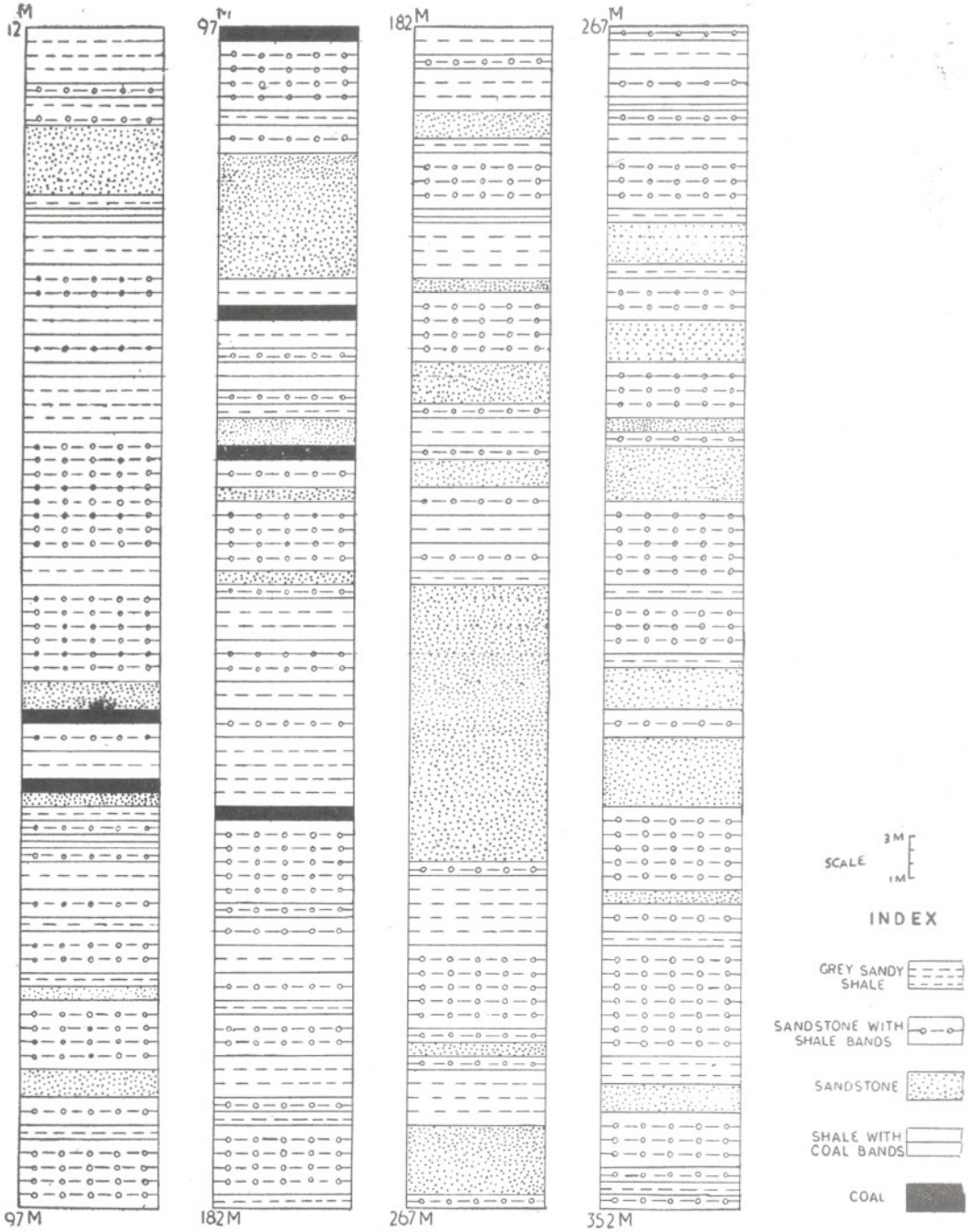
Genus — *Psilalacinites* gen. nov.

Genus — *Aulisporites* (Les.) Kl., 1960.

Genus — *Punctatisporites* Ibr., 1933.

Sample No.	Depth (in metres)	Lithology	Spores-pollen present or absent
RN 1	12·37- 12·47	Grey sandy shale	—
RN 4	15·57- 15·67	Grey sandy shale	—
RN 6	17·82- 17·92	Grey sandy shale	—
RN 14	26·62- 26·72	Shale with coal bands	+
RN 23	36·87- 36·97	Grey sandy shale	+
RN 26	40·47- 40·57	Grey sandy shale	—
RN 34	50·07- 50·17	Grey sandy shale	—
RN 43	61·09- 61·19	Shaly coal	+
RN 46	65·27- 65·37	Grey sandy shale	+
RN 47	66·47- 66·57	Coal	+
RN 55	76·07- 76·17	Grey sandy shale	—
RN 71	97·17- 97·27	Shaly coal	+
RN 74	101·37-101·47	Grey sandy shale with sandstone bands	—
RN 87	117·37-117·47	Coal	+
RN 92	124·47-125·57	Grey sandy shale	—
RN 95	127·67-127·77	Shaly coal	+
RN 109	144·87-144·97	Grey sandy shale	+
RN 114	153·67-153·77	Coal	+
RN 120	163·00-163·13	Grey sandy shale	+
RN 133	181·60-181·70	Grey sandy shale	—
RN 143	194·17-194·27	Fine grained sandstone with shale bands	—
RN 147	199·27-199·37	Grey sandy shale	+
RN 161	221·50-221·60	Fine grained sandstone with shale bands	—
RN 177	243·30-243·40	Grey sandy shale	+
RN 187	259·00-259·10	Grey sandy shale	+
RN 198	275·62-275·72	Grey sandy shale	+
RN 213	294·00-294·10	Alternate shale and sandstone bands	—
RN 225	308·37-308·47	Alternate shale and sandstone bands	+
RN 238	324·67-324·77	Medium-grained sandstone with shale streaks	+
RN 253	243·64-342·74	Grey sandy shale	+
RN 265	352·47-352·57	Alternate shale and sandstone bands	+

Genus — *Cyclogranisporites* Pot. & Kr., 1954.
Genus — *Apiculatisporis* Pot. & Kr., 1956.
Genus — *Cyclobaculisporites* Bhard., 1955.
Genus — *Lophotriletes* (Naum.) Pot. & Kr., 1954
Genus — *Acanthotriletes* (Naum.) Pot. & Kr., 1954.
Genus — *Neoraistrickia* Pot., 1956.
Genus — *Didecitriletes* Venkat. & Kar, 1965.
Genus — *Lacinitriletes* Venkat. & Kar, 1965.
Genus — *Microbaculispora* Bharad., 1962.
Genus — *Microfoveolatispora* Bharad., 1962.
Genus — *Indospora* Bharad., 1962.
Genus — *Divarireticulates* gen. nov.
Genus — *Striasporis* gen. nov.
Genus — *Laevigatosporites* Ibr., 1933.
Genus — *Altimonoletes*, gen. nov.
Genus — *Punctatosporites* Ibr., 1933.
Genus — *Ghoshiasporites* gen. nov.
Genus — *Mammialetes* gen. nov.
Genus — *Zonareticulatisporis* Kar, 1969
Genus — *Virkkipollenites* Lele, 1964.



TEXT-FIG. 1 — Showing the lithology of Raniganj Stage in the bore-hole no. K_2.

Genus — *Parasaccites* Bharad. & Tiw., 1964.
Genus — *Densipollenites* Bharad., 1962.
Genus — *Divarisaccus* Venkat. & Kar, 1966a.
Genus — *Striomonosaccites* Bharad., 1962.
Genus — *Platysaccus* Pot. & Kl., 1954.
Genus — *Cuneatisporites* Les., 1955.
Genus — *Raniganjiasaccites* gen. nov.
Genus — *Striatites* (Pant) Bharad., 1962.
Genus — *Verticipollenites* Bharad., 1962.
Genus — *Lahirites* Bharad., 1962.
Genus — *Hindipollenites* Bharad., 1962.
Genus — *Lunatisporites* (Les.) Bharad., 1962.
Genus — *Stroterisporites* Wils., 1962.
Genus — *Striatopiceites* (Zor. & Sed.) Sed., 1956.
Genus — *Rhizomaspora* Wils., 1962.
Genus — *Corisaccites* Venkat. & Kar, 1966b.
Genus — *Hamiapollenites* Wils., 1962.
Genus — *Vittatina* (Lub.) ex Samoil., Wils., 1962.
Genus — *Distriatites* Bharad., 1962.
Genus — *Sulcatisporites* (Les.) Bharad., 1962.
Genus — *Labiisporites* Les., 1956.
Genus — *Tumoripollenites* Bharad., 1962.
Genus — *Trochosporites* Wils., 1962.
Genus — *Crustaesporites* Les., 1956.
Genus — *Guttulapollenites* (Goub.) Venkat., Goub. & Kar, 1967.
Genus — *Gnetaceaepollenites* Thierg., 1938.
Genus — *Ephedripites* Bolkhov., 1953.
Genus — *Welwitschiapites* Bolkhov., 1953.
Genus — *Gondwanaeaplicates* gen. nov.
Genus — *Boutakoffites* Bose & Kar, 1966.
Genus — *Ginkgocycadophytus* Samoil. 1953.
Genus — *Decussatisporites* Les., 1955.

SYSTEMATIC PALYNOLOGY

Anteturma — *Sporites* H. Pot. 1893.
Turma — *Triletes* (Rein.) Pot. & Kr. 1954.
Subturma — *Azonotriletes* Lub. 1935.
Infraturma — *Laevigati* (Ben. & Kid.) Pot. 1956.

Genus — *Psilalacinites* gen. nov.

Type Species — *Psilalacinites triangulus* sp. nov.

Diagnosis — Spores triangular-subtriangular in polar view. Interapical margins ± straight-convex. Trilete, rays associated with regular, lacinate fold system. Exine mostly laevigate, rarely very slightly granulose, infrastructure generally absent, sometimes hardly perceptible.

Description — Spores generally triangular in polar view. Apices ± broadly rounded in most of the specimens, rarely acutely rounded. Interapical margins mostly slightly to markedly convex; specimens with ± straight margins are, however, also occasionally met with. Roundness of the apices is directly proportional to the convexity of the interapical margins. Trilete well developed, rays ± equal in length or one arm is slightly shorter than the two, extending two-thirds of radius to almost upto the margin. Rays always associated with folds, they are lacinate, generally accompanying throughout whole length of the rays; sometimes, however, one associated fold may be ill-developed or some part of it may be ill-developed than the rest. Exine upto 3 μ thick, translucent, laevigate in most of the specimens, in some rare cases very weakly developed granulose sculptural elements seems to be present. Infrastructure is not found in most of the specimens, when present they seem to be very weakly intrapunctate in some but mostly their nature is not discernible. Exine in addition to the regular, accompanying fold system with the trilete rays is also irregularly folded in most of the specimens producing various shapes.

Comparison — *Leiotriletes* (Naum.) Pot. & Kr. (1954) is comparable to the present species in its triangular-subtriangular shape in polar view, laevigate exine and extension of the trilete rays from two-thirds of radius to almost upto the equator. *Leiotriletes* can, however, be easily differentiated by its lack of regular, accompanying fold system along with the haptotypic mark. *Lacinitriletes* Venkat. & Kar (1965) resembles the present genus in its lacinate fold system and triangular-subtriangular shape but the former is distinguished by its granulose to microverrucose sculptural elements on the distal side. *Microbaculispora* Bharad. (1962) is baculate, while *Microfoveolatispora* Bharad. (1962) possesses microfoveola distally. *Pachytriletes* Bose & Kar (1966) approximates the present genus in its over all shape and extension of the trilete rays but the former is readily distinguished by its very thick exine and lack of regular fold system along with the trilete rays.

Deltoidospora (Miner) Pot. (1956), *Cyathidites* Coup. (1953), *Alsophilidites* (Cooks.) Pot. (1956) and *Gleicheniidites* (Ross) Delc. & Sprum. (1955) resemble the present genus in overall shape and laevigate exine but none of them has regular fold system along with the haptotypic mark. *Psilalacinites* proposed here is distinguished from all the known trilete genera by its triangular-subtriangular shape in polar view, mostly laevigate exine and association of regular, lacinate fold system along with the trilete rays.

Psilalacinites triangulus sp. nov.

Pl. 1, Figs. 1-4

Holotype — Pl. 1, Fig. 1. Size 74 μ. Slide no. 3325.

Type Locality — Bore-core no. K_2, depth 61·09-61·19M., North Karanpura coalfield, Raniganj Stage (Permian), India.

Diagnosis — Spore triangular – subtriangular shape in polar view. Apices rounded, interapical margins ± straight to convex. Trilete, rays extending upto three-fourths the radius, associated with regular, lacinate fold system. Exine laevigate, infrastructure generally absent.

Description — Spore mostly triangular in polar view. Size range 30-85×25-80 μ. Apices generally broadly rounded, interapical margins more or less straight to markedly convex. Trilete well developed, rays ± equal, always associated with flappy fold system. Fold system generally equally strongly developed in all the rays, sometimes, however, one arm may be ill-developed than the rest. Exine upto 3 μ thick, translucent, laevigate in most of the specimens, in rare cases, however, it may appear as slightly granulose. Infrastructure generally not found, very rarely it is perceptible and seems to be ± intrapunctate. Exine in addition to the regular fold system along with the trilete rays may also be folded irregularly causing various shapes.

Infraturma — *Murornati* Pot. & Kr. 1954.

Genus — *Varireticulates* gen. nov.

Type Species — *Varireticulates varius* sp. nov.

Diagnosis — Spores ± subcircular-circular in polar view. Trilete, rays associated with regular fold system. Exine proximally reticulate, distally laevigate, meshes irregular in size and shape.

Description — Spores mostly ± subcircular in polar view, rarely roundly triangular or subcircular forms are also met with. Trilete, rays well developed, extending mostly upto three-fourths the radius. Rays always associated with regular, lacinate fold system; folds may be equally well developed or sometimes one is ill-developed than the two. Exine thin, not more than 3μ thick, proximally reticulate, muri slightly raised, sometimes sinuous; meshes square – rectangular in size, mostly not uniform with the pattern of mesh and its size. Exine in between the muri translucent, ± laevigate or rarely slightly granulose. Distally exine is ± laevigate. Spores are mostly irregularly folded causing various shapes. Sometimes a long, more than a semilunar fold is found along the whole length covering commissural area. In other specimens, the folds are minor and haphazardly placed. When a major fold is formed placing the distal side on top it clearly shows that the exine is proximally reticulate and distally laevigate.

Comparison — *Lycopodiumsporites* Thierg. (1938) resembles the present species in its subcircular – roundly triangular forms and reticulate sculptural elements, the former can, however, be distinguished by its presence of reticulum on both surfaces. *Reticulatisporites* (Ibr.) Pot. & Kr. (1955) in the openion of Neves (1964) is subcircular – circular in shape, cingulate and possesses broad reticulation on both the surfaces. *Greinervillites* Bose & Kar (1967) has subcircular – circular shape but is alete and the broad, lacinate muri are present on both the surfaces. *Dictyotriletes* (Naum.) Pot. & Kr. (1954) is subtriangular – subcircular in overall shape, trilete rays are very well developed but not accompanying with regular fold system and reticulation is found only on distal side. *Maculatasporites* Tiw. (1964) is alete and reticulate on both the surfaces. *Undulatasporites* Les. (1955) is also alete and moreover, muri in most of the specimens do not form regular meshes. *Knoxisporites* Pot. & Kr. (1954) is very broadly reticulate. *Reticulatasporites* Pot. & Kr. (1954) is alete and seems to be a fungal spore genus. *Varireticulates* proposed here is differentiated from all the other known genera by its trilete rays associated with

regular fold system, proximally reticulate and distally laevigate exine.

Varireticulates varius sp. nov.

Pl. 1, Figs. 6-7

Holotype — Pl. 1, Figs. 6-7. Size 73×69 μ. Slide no. 3326.

Type Locality — Bore-core no. K_2, depth 61·09-61·19 M., North Karanpura coalfield, Raniganj Stage (Permian), India.

Diagnosis — Spores subtriangular–roundly triangular in polar view. Trilete, rays accompanied with regular, lacinate fold system. Exine proximally reticulate, distally laevigate, meshes variable in size and shape.

Description — Spores mostly subcircular in shape; fully flattened specimens are, however, rare due to irregular foldings of the exine in addition to the regular fold system along the trilete rays. Size range 50-85×40-80 μ. Trilete, rays well developed, extending upto three-fourths the radius, always associated with fold system. Exine upto 3 μ thick, proximally reticulate, muri slightly raised, straight, occasionally sinuous forming ± square to rectangular meshes. In some specimens meshes may be of various shapes and sizes. Exine in between muri translucent, laevigate or very slightly granulose. Distally exine is laevigate, in rare cases may be very slightly granulose.

Infraturma — *Striasporiti* infraturma nov.

Diagnosis — Spores azonate, triangular-circular in polar view. Trilete; exine striated on one or both surfaces.

Comparison — *Murornati* Pot. & Kr. (1954) possesses muri as sculptural elements. *Apiculati* (Ben. & Kids.) Pot. (1956) is apiculate and without any striations.

Genus — *Striasporis* gen. nov.

Type Species — *Striasporis striatus* sp.nov

Diagnosis — Spores subcircular–circular in polar view. Trilete, rays extending generally upto three-fourths the radius. Exine striated proximally, striations on each side of inter-radial area ± parallel to each other, interstriated exine microverrucose–granulose. Exine may be folded along the margin.

Description — Spores mostly subcircular in polar view, sometimes ± circular forms are also occasionally met with. Trilete, rays ± well developed, rays narrow, not elevated, ± equal in length, sometimes one may be shorter than the two, uniformly broad or slightly tapering at ends. Commissure well recognizable. Striations present on the proximal surface of the spores. Striations generally absent in contact area; they are ± parallel on each side of inter-radial area, sometimes inter-connection by smaller striations. Striations may join each other to provide ± triangular shape. In most of the specimens striations are easily recognisable but in some they are not very well developed. Exine thin, not more than 3 μ thick, mostly microverrucose, in some specimens some grana are also seem to be interspersed with them. Exine may be folded along the margin in circular fashion in some cases, mostly however, they are devoid of any major fold system.

Comparison — *Cicatricosisporites* Pot. & Gellet. (1933) is distinguished from the present genus by its triangular shape, extension of the trilete upto the equator and presence of raised muri parallel to each other. *Striatisporites* Les. (1955) is alete and has a well recognizable zona. *Striatriletes* (V. d. Ham.) Pot. (1956) is very big in size (180-400 μ), trilete rays are robustly built and the so-called striations are radially placed. *Contignisporites* Dettm. (1963) is characterized by a cingulum and distally it is sculptured with bifurcating and anastomosing muri. *Marsupipollenites* Balme & Henn. (1956) is monocolpate and both horizontal and vertical striations are present (*see* BHARADWAJ, 1962).

Remarks — *Striasporis* warrants some special attention for its presence of striations on the proximal surface of the spores. Trilete spores with true striations have not been recorded so far from the Palaeozoic sediments of India. During this period, striations are known to occur among the monosaccates (*e.g. Striomonosaccites* BHARADWAJ, 1962; *Mabuitasaccites* BOSE & KAR, 1966) and colpate pollen grains (*e.g. Fusacolpites* BOSE & KAR, 1966; *Striacolpites* VENKATACHALA & KAR, 1969). It seems that along with the dominant striated bisaccates, other major groups were also having a few of the striated forms. Mention may here be made that Hart (1965) opined that the striated monosaccates found in the Palaeozoic sediments of Gondwanaland are preternatural forms of the nonstriat-

ed ones. Kar and Bose (1967), however, thought them as normal ones. The presence of striated trilete spores perhaps points out that the striated forms were present during Permian in most of the major groups at least in the Lower Gondwanas.

Striasporis striatus sp. nov.

Pl. 1, Fig. 5

Holotype — Pl. 1, Fig. 5. Size 55×46 μ. Slide no. 3335.

Type Locality — Bore-core no. K_2, depth 342.64-342.74M., North Karanpura coalfield, Raniganj Stage (Permian), India.

Diagnosis — Spores subcircular–circular in polar view. Size range 45-65×40-55 μ. Trilete, rays extending upto three-fourths the radius. Exine striated proximally, striations on each side of the interradial areas ± parallel; exine mostly microverrucose, margin folded in circular fashion.

Description — Spores mostly subcircular in polar view. Trilete not very well developed, but easily recognizable, rays narrow, ± uniformly broad, not elevated. Commissure distinct. Striations absent in contact area, striations on each side of the interradial rays ± parallel to each other, occasionally interconnected by small striations and may join at ends to provide triangular shape. Exine not more than 3 μ thick, microverrucose, sometimes interspersed with grana. Exine generally folded along equatorial margin.

Turma — *Monoletes* Ibr. 1933.
Subturma — *Azonomonoletes* Lub. 1935.
Infraturma — *Psilamonoleti* V. d. Ham. 1955.

Genus — *Altimonoletes* gen. nov.

Type Species — *Altimonoletes flavatus* sp. nov.

Diagnosis— Spores oval-elliptical in shape. Monolete highly raised, well developed, extending from half to three-fourths the radius along longitudinal axis. Exine punctate, puncta small, uniformly or irregularly distributed.

Description — Spores mostly oval-elliptical in overall shape in polar view. Monolete markedly developed, seems to be raised upto 5 μ in original condition, lip ± uniformly broad, straight or very slightly curved in some specimens. In few cases a very small lip seems to be emerging in middle perpendicular to the major lip. Exine thin, not more than 3 μ thick, punctate, puncta ± ·5 μ in size, easily recognizable in most cases. Puncta are closely placed and evenly distributed in most of the specimens. Sometimes, however, they may be irregularly placed. Interpunctal exine laevigate.

Comparison — *Luenaites* Bose & Kar (1967) closely resembles the present genus in its overall shape and punctate exine, the latter can, however, be easily distinguished by its raised monolete. The monolete mark in *Luenaites* is ill-developed and while present is not elevated as in the present genus. *Laevigatosporites* (Ibr.) Schopf, Wils. & Bent. (1944) approximates the present genus in its shape but the exine is laevigate and the monolete mark is not raised. *Monolites* (Erdt.) Pot. (1956) is oval and laevigate. *Latosporites* Pot. & Kr. (1954) is circular to subcircular in shape and like *Laevigatosporites* possesses psilate exine. *Punctatoporites* Ibr. (1933) has granulose-microverrucose sculptural elements. *Thymospora* (Kos.) Wils. & Venkat. (1963) is verrucose.

Altimonoletes flavatus sp. nov.

Pl. 1, Figs. 8-9

Holotype — Pl. 1, Figs. 8-9. Size 53×38 μ. Slide no. 3326.

Type Locality — Bore-core no. K_2, depth 61·09-61·19M., North Karanpura coalfield, Raniganj Stage (Permian), India.

Diagnosis — Spores oval-elliptical in shape. Monolete well developed, raised, extending upto three-fourths along longitudinal axis. Exine punctate, puncta ± ·5 μ in size, ± closely placed, uniformly distributed.

Description — Spores mostly oval-elliptical in polar view. Size range 40-65×30-50 μ. Monolete highly developed, seems to be upto 5 μ elevated in original condition; lip narrow, ± uniformly broad, a vary minute lip seems to be emerging in middle region perpendicular to the main lip in some specimens. Exine punctate, interpunctal exine laevigate; puncta well recognizable in most of the specimens; sometimes they are ill-developed and not distinctly perceptible.

Infraturma — *Varimonoleti* infraturma nov.

Diagnosis — Spores monolete with differential ornamentational pattern on the surfaces (*see* VENKATACHALA & KAR, 1965).

Comparison — *Psilamonoleti* V. d. Ham. (1955) are psilate on both the surfaces. *Ornati* Pot. (1956) are equally ornamented on both the surfaces.

Genus — *Ghoshiasporites* gen. nov.

Type Species — *Ghoshiasporites didecus* sp. nov.

Diagnosis — Spores monolete, generally oval in shape. Monolete well or ill-developed. Exine proximally laevigate, distally mostly conied, sometimes interspersed with spines and verrucae.

Description — Spores mostly oval in overall shape; fully flattened specimens are, however, rare due to irregular foldings of the exine. Proximal surface of the spores seems to be lighter than the distal one and as a result most specimens do not show proximal surface fully. Monolete present but may also be absent in some specimens. Haptotypic mark is mostly uniformly broad and extends from half to three-fourths along the longitudinal axis; sometimes monolete is associated with fold. Exine 2-3·5 μ thick, proximally laevigate, distally sculptured mostly with coni, coni 1-2·5 μ long, closely and evenly distributed but generally not so dense to form the pseudoreticulate pattern on surface view. Coni may be interspersed with spines and verrucae in some specimens.

Comparison—*Punctatosporites* Ibr. (1933) resembles the present genus in overall shape, nature of the monolete mark and sculptural elements. *Ghoshiasporites* can, however, be easily distinguished by its laevigate proximal surface and sculptured distal one. *Laevigatosporites* Ibr. (1933) and *Latosporites* Pot. & Kr. (1954) are laevigate on both the surfaces. *Thymospora* (Kos.) Wils. & Venkat. (1963) has verrucae as sculptural elements on both the surfaces. *Luenaites* Bose & Kar (1967) are oval in shape and monolete may be present or absent but the exine is punctate. *Ghoshiasporites* can be differentiated by all the other monolete genera by its oval shape, presence or absence of monolete mark and above all differential sculptural pattern on the surfaces.

Derivation of name — After Mr. P. K. Ghosh of the Geological Survey of India for very kindly supplying the present material.

Remarks — *Ghoshiasporites* is conspicuous by its presence of differential ornamentation pattern on the surfaces among the monolete spores. In fact this genus is the first of its kind to have two kinds of sculptural elements on the surfaces. Mention may, however, be made here that among the trilete spores differential sculptural elements are found in quite a good number of genera. Streel (1964) has recorded *Apiculiretusispora* Streel (*l.c.*) and *Aneurospora* Streel (*l.c.*) from the Devonian rocks of the Lower Givétian of Belgium which are characterized by proximally laevigate and distally sculptured surfaces. *Anapiculatisporites* Pot. & Kr. (1954) is found in the Carboniferous of Europe as well as in the Permian of India (BHARADWAJ, 1962; VENKATACHALA & KAR, 1968a). *Lukugasporites* Kar & Bose (1967) described from the *Assise des schistes noir de la Lukuga* of Congo (Permian) is also characterized by differential ornamentational pattern on the surfaces. The infraturma *Varitrileti* Venkatachala & Kar (1965) accommodates all the trilete subtriangular to subcircular genera (*e.g. Microbaculispora* Bharadwaj, 1962; *Didecitriletes* Venkatachala & Kar, 1965 and *Lacinitriletes* Venkatachala & Kar, 1965) with differential sculptural pattern and germinal apperture accompanying with regular folds.

So it seems that differential sculptural pattern on the surfaces among the Palaeozoic trilete and monolete spores was a regular feature in some of the Pteridophytes. This group seems to be more dominant in the Lower Gondwanas of Australia (BALME & HENNELLY, 1956); Congo (BOSE & KAR, 1966; KAR & BOSE, 1967) and India (BHARADWAJ, 1962; BHARADWAJ & SALUJHA, 1964, 1965a, 1965b; SALUJHA, 1965; BHARADWAJ & TIWARI, 1964; TIWARI, 1965; VENKATACHALA & KAR, 1965, 1968a, 1968b and KAR, 1966, 1968). Some of the monocolpate genera also show this kind of heteropolarity. *Punctacolpites* Kar & Bose (1967) may be cited as an example. Here the puncta are found only on the proximal surface, while distally it is laevigate.

Ghoshiasporites didecus sp. nov.

Pl. 1, Figs. 10-12

Holotype — Pl. 1, Fig. 10. Size 61 × 50 μ. Slide no. 3331.

Type Locality — Bore-core no. K_2, depth 275·62-275·72M., North Karanpura coalfield, Bihar; Raniganj Stage (Permian).

Diagnosis — Spores ± oval, monolete present or absent while present extending not more than three-fourths of longitudinal axis. Exine proximally laevigate, distally mostly conied, sometimes interspersed with spines and verrucae.

Description — Spores mostly oval in fully flattened condition, size range 50-80×30-55 μ, but seems to be ± bean shaped due to irregular foldings. Monolete well or ill-developed, sometimes hardly traceable or absent. Monolete not elevated, ± uniformly broad, extending from half to three-fourths of longitudinal axis; sometimes associated with fold. Exine 2-3·5 μ thick, proximally laevigate distally sculptured with coni, coni closely placed and uniformly distributed, 1-2·5 μ long; sometimes interspersed with spines and verrucae. Sculptural elements not very densely placed to form pseudoreticulum pattern on surface view.

Turma — *Aletes* Ibr. 1933.
Subturma — *Azonaletes* (Lub.) Pot. 1956.
Infraturma — *Tuberini* Pant, 1954.

Genus — *Mammialetes* gen. nov.

Type Species — *Mammialetes mammus* sp. nov.

Diagnosis — Spores subcircular–circular in overall shape. Alete. Exine sculptured with ± mammillate processes on both sides, processes variable in size, sometimes interspersed with other elements. Exine may be folded.

Description — Spores mostly subcircular with undulated margin due to sculptural elements. Size range 40-90×30-80 μ. Haptotypic mark not seen. Exine upto 4 μ thick, generally profusedly sculptured with ± mammillate processes on both surfaces. Processes upto 15 μ long, generally emaciated at base but swollen at top, some verrucae, bacula or other elements mostly interspersed with them. Sculptural elements sometimes provide the appearance of negative reticulum on surface view. Exine in between sculptural elements when visible is laevigate and generally not infrastructured. Exine generally folded, sometimes two folds may be situated ± parallel, in others the exine is so highly folded that it seems to be crumpled.

Comparison — *Sciadopityspollenites* Raatz (1937) closely resembles the present genus in its subcircular–circular shape, in the absence of haptotypic mark and presence of sculptural elements on both the surfaces. *Sciadopityspollenites* can, however, be distinguished by its smaller size range and presence of comparatively smaller warts as sculptural elements. It may be recalled here that the mammillate processes found in *Mammialetes* may be upto 15 μ long and very strongly built and these processes are also generally intermixed with bacula and verrucae. *Duplicisporites* (Les.) Pot. (1956) is subtriangular-subcircular in shape and has verrucose sculptural elements. *Araucariacites* Cooks. (1947) approximates the present genus in circular–subcircular shape but is readily distinguished by its granulose sculptural elements. *Peltandripites* Wodeh. (1933) is ± elliptical and is spinose. *Gibeosporites* Les. (1959) is subcircular–circular and possesses coni as sculptural elements.

Mammialetes mammus sp. nov.

Pl. 1, Figs. 13-16

Holotype — Pl. 1, Fig. 14. Size 55×46 μ. Slide no. 3327.

Type Locality — Bore-core no. K_2, depth 61·09-61·19M., North Karanpura coalfield, Raniganj Stage (Permian), India.

Diagnosis — Spores subcircular-circular. Haptotypic mark absent. Exine sculptured mostly with ± mammillate processes on both surfaces.

Description — Spores mostly subcircular in overall shape with undulated margin. Size range 40-90×30-80 μ. Exine not more than 4 μ thick, studded with mammiform protuberances on both surfaces, processes narrow at base, swollen at top, bacula and verrucae are also generally interspersed with them. Sculptural elements may be upto 15 μ long, sometimes provide pseudoreticulate pattern on surface view. Processes of bigger size are generally concentrated in middle region. Exine in between the sculptural elements laevigate, mostly without any infrastructure. Exine mostly folded in middle, sometimes they are grouped in two and ± parallel to each other. In some specimens exine seems to be crumpled particularly in middle region.

Anteturma — *Pollenites* Pot. 1931.
Turma — *Saccites* Erdt. 1947.
Subturma — *Disaccites* Cooks. 1947.
Infraturma — *Podocarpoiditi* Pot. et al. 1950.

Genus — *Raniganjiasaccites* gen. nov.

Type Species — *Raniganjiasaccites ovatus* sp. nov.

Diagnosis — Bisaccate, bilaterally symmetrical, haploxylonoid pollen grains. Central body strongly horizontally oval, intramicroreticulate. Proximal attachment of sacci to central body equatorial, distally subequatorial; sulcus well recognizable. Sacci hemispherical, sometimes leathery, ± intrapunctate to coarsely intrareticulate.

Description — Pollen grains bisaccate with oval-elliptical overall shape. Central body very well developed, mostly horizontally oval without any prominent lateral ridges, mostly distinct, sometimes indistinct. Exine of central body upto 3 μ thick, intramicroreticulate structure mostly well developed, in some specimens it seems to be imperfectly developed. Attachment zone mostly well perceptible. Distally sacci in some cases cover quite a good part of the central body though in most cases sulcus is wide and easily distinguishable. Sacci hemispherical, mostly coarsely intrareticulate, mesh-size 2-3 μ, lumina shallow. In some specimens the sacci may be leathery, subsaccate (*see* JIZBA, 1962; VENKATACHALA & KAR, 1964) and seems to be intrapunctate to imperfectly intrareticulate.

Comparison — *Valiasaccites* Bose & Kar (1966) closely resembles the present genus in possessing horizontally oval central body and haploxylonoid condition and oval shape. *Valiasaccites* can, however, be distinguished by its presence of well developed lateral ridges on both sides parallel to the longer axis of the vermiculate central body. Moreover, in some specimens monolete mark may also be present in *Valiasaccites*. *Platysaccus* (Naum.) Pot. & Kl. (1954) is highly diploxylonoid and the psilate central body is circular–subcircular. *Cuneatisporites* Les. (1955) approximates the present genus in the presence of intramicroreticulate central body but can readily be differentiated by its vertically oval central body and diploxylonoid condition. *Raniganjiasaccites* is distinguished from all non-striate bisaccate genera by its strongly horizontally oval, intramicroreticulate central body without any marked lateral ridges and haploxylonoid condition.

Remarks — The present genus shows some resemblance to *Caheniasaccites* Bose & Kar (1966) by its overall shape, intramicroreticulate, horizontally oval central body. This similarity is, however, an outward manifestation and has no bearing from the organizational point of view. *Caheniasaccites* it may be mentioned here is a monosaccate with ± overlapping, subequatorial attachment of saccus to central body on both the surfaces.

Raniganjiasaccites ovatus sp. nov.

Pl. 1, Figs. 17-18

Holotype — Pl. 1, Fig. 18. Size 102×72 μ. Slide no. 3332.

Type Locality — Bore-core no. K_2, Depth 308·37-308·47M., North Karanpura coalfield, Bihar; Raniganj Stage (Permian).

Diagnosis — Bisaccate, bilaterally symmetrical, haploxylonoid pollen grains. Central body well developed, horizontally oval, intramicroreticulate. Proximal attachment of sacci to central body equatorial, distally subequatorial. Sacci hemispherical, mostly intrareticulate.

Description — Pollen grains mostly oval, sometimes elliptical in shape. Size range 80-120×50-80 μ. Central body mostly strongly horizontally oval, size range 60-90 ×50-75 μ; generally distinct, sometimes indistinct. Exine of central body 2-3 μ thick, intramicroreticulate, sometimes it is imperfectly developed. In some specimens a very faint thickening may be perceptible on margin of the central body. Attachment zone generally well defined, rarely ill-defined. Sacci on distal side cover a little part of central body, attachment area ± parallel to each other. Sulcus well defined, ± oval–subcircular, sometimes indistinct. Sacci hemispherical, sometimes leathery; coarsely intrareticulate, mesh-size upto 3 μ, lumina shallow; may be ± intrapunctate in the leathery ones.

Turma — *Polyplicates* Erdt. 1952.

Genus — *Gondwanaeaplicates* gen. nov.

Type Species—Gondwanaeaplicates bharadwajii sp. nov.

Diagnosis — Oval–subcircular pollen in fully flattened condition, but may be spindle shape due to foldings. 2-5 furrows present; furrows generally do not extend from one end to other thus providing an incipient zona like structure in fully flattened specimens; furrows may or may not be associated with folds. Exine ± laevigate and intrapunctate; rarely seems to be intrabaculate.

Description — Pollen grains mostly oval or subcircular in shape in fully flattened

TABLE 1 — SHOWING THE PERCENTAGE OF DIFFERENT GENERA IN RANIGANJ STAGE IN THE BORE-HOLE NO. K_2.

GENERA	SAMP. No. RN 265 %	SAMP. No. RN 253 %	SAMP. No. RN 238 %	SAMP. No. RN 225 %	SAMP. No. RN 198 %	SAMP. No. RN 187 %	SAMP. No. RN 147 %	SAMP. No. RN 114 %	SAMP. No. RN 109 %	SAMP. No. RN 95 %	SAMP. No. RN 87 %	SAMP. No. RN 71 %	SAMP. No. RN 47 %	SAMP. No. RN 43 %	SAMP. No. RN 23 %	SAMP. No. RN 14 %
Leiotriletes							+	1				+	+	+		
Retusotriletes								1								
Calamospora										1		+	+	+		
Psilalacinites														10		1
Aulisporites														+		
Punctatisporites		1								+		+		+		
Cyclogranisporites				+			+	6	+		2	2	4	2	+	1
Apiculatisporis	+	+	+	1		+	+	2	1	1	1	4	+	2	2	1
Cyclobaculisporites		+		+		+	2	6	1	5	5	6	4	9	2	2
Lophotriletes							1	1	1	1	1	8	8	2	1	2
Acanthotriletes							1			+	+		1	1	1	1
Neoraistrickia								1			1	+	+	+	+	1
Didecitriletes														+		
Lacinitriletes														4	1	1
Microbaculispora											1		+	6	1	1
Microfoveolatispora												+	+	2	+	1
Indospora		+					1	+		1	1	+	+	5	+	+
Divarireticulates																
Striasporis																
Laevigatosporites		2	+	+	+		2	5	1	8	2	10	24	8	2	3
Altimonoletes														+		+
Punctatosporites		+		+		+	1	1	+	1	1	+	1	+	2	1
Ghoshiasporites	1	1	2	+	2	3	6	2	8	+						
Mammialetes										+						
Zonareticulatisporis							+									
Virkkipollenites		1		+	+		+									
Parasaccites		+	+	1	+				+							
Densipollenites	32	24	26	10	12	7	+	+	+	+	1	4	2	+	+	4
Divarisaccus	1				+				+							
Striomonosaccites	+			+												
Platysaccus		+					+			+						
Cuneatisporites	1	+	+	+	1	1		+	1	+	1	+	1	+	2	8
Raniganjiasaccites	4	+		+	1	+	+		1	+	+					
Striatites	2	4	6	4	4	8	10	4	4	4	2	4	4	1	2	2
Verticipollenites	+	2	2	2	2	3	2	2	1	1	+	2	1	1	2	1
Lahirites	1	3	4	3	3	3	6	4	3	2	1		2	1	2	1
Hindipollenites	+	1	3	1	2	3	2	2	1	1	+	2	+	1	3	2
Luntaisporites	1		1	+	1	+	+	+	+	+	1	+	+	+	1	2
Strotersporites	29	28	25	47	42	40	28	31	42	40	44	36	28	24	38	26
Striatopiceites	22	26	17	30	24	28	16	20	25	28	28	20	16	20	26	22
Rhizomaspora				+			+									
Corisaccites				+			+	+	+	+	+	+		+	+	+
Hamiapollenites				+	+				+	+			+		+	+
Vittatina											+	+			+	
Distriatites		+		+												
Sulcatisporites	1	2	4	+	4	4	8	+	+	+	+	+	+	+	6	10
Labiisporites							+	+	+	+	+	+	+	+	2	2
Tumoripollenites							+									
Trochosporites							+									
Crustaesporites							+						+			
Guttulapollenites				+			6	4	2	1	1	+	1		+	1
Gnetaceaepollenites	+	+	1	+	+	+		2	1	1	1	+		+	+	1
Ephedripites	1	1	2	+	+	+	+	1	+	+	1	+	+	+	1	+
Welwitschiapites		+	1	+	+	+	+	+	1	1	1	+	+	+	1	+
Gondwanaeaplicates	4	4	6	1	2	+	6	4	6	3	3	2	2	+	2	
Boutakoffites										+						
Ginkgocycadophytus	+			+	+	+	+	+							+	+
Decussatisporites																+

\+ sign indicates that the genus is present in the assemblage but absent within the counted specimens.

TABLE 2 — SHOWING THE PERCENTAGE OF MAJOR GROUPS IN RANIGANJ STAGE IN THE BORE-HOLE NO. K_2.

MAJOR GROUPS	SAMP. No. RN 265 %	SAMP. No. RN 253 %	SAMP. No. RN 238 %	SAMP. No. RN 225 %	SAMP. No. RN 198 %	SAMP. No. RN 187 %	SAMP. No. RN 147 %	SAMP. No. RN 114 %	SAMP. No. RN 109 %	SAMP. No. RN 95 %	SAMP. No. RN 87 %	SAMP. No. RN 71 %	SAMP. No. RN 47 %	SAMP. No. RN 43 %	SAMP. No. RN 23 %	SAMP. No. RN 14 %
Trilete	+	1	+	1	0	+	5	17	3	9	12	20	17	44	8	12
Monolete	1	3	2	+	2	3	9	8	9	9	3	10	25	8	4	4
Alete	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0
Monosaccate	33	25	26	11	12	7	+	+	+	+	1	4	2	+	+	4
Bisaccate	61	66	62	87	84	90	72	64	78	76	77	64	52	48	84	76
Polysaccate	0	0	0	+	0	0	6	4	2	1	1	+	1	0	+	1
Polyplicate	5	5	10	1	2	+	8	7	8	5	6	2	+	+	4	3
Monocolpate	+	0	0	+	+	+	+	+	0	0	0	0	0	0	+	+

\+ sign indicates that the group is present in the assemblage but absent within the counted specimens.

specimens; this type is, however, rare as most of them are folded. The overall shape changes according to the nature of the foldings; in some specimens foldings are present mostly on either side of a furrow; in others they are found in association with most of the furrows producing a spindle shape appearance. Furrows are mostly well recognizable in folded specimens probably due to stress and strain of the exine in producing them. In fully flattened specimens they may not be very well developed; but traceable in most of the cases. In some specimens, one furrow is better developed than others and in some others two outer furrows may ± join each other. Three furrows are present in most of the specimens; furrows do not extend from one end to other thus forming a zona like structure. In folded specimens, however, furrows may reach ± from one margin to other due to rupture of the exine and zona is hardly perceptible among these specimens. Zona is as thick as or very slightly thicker than rest part of the pollen grains. Exine 2-4 μ thick, mostly laevigate and intrapunctate; infrastructure generally well developed, sometimes ill-developed and hardly recognizable; puncta closely placed and evenly distributed in most of the specimens. Intrabaculate structure may also seems to be present in rare cases.

Comparison — Boutakoffites Bose & Kar (1966) closely resembles the present genus in its oval–subcircular shape, presence of zona, furrows and intrapunctate to imperfectly intrareticulate structure. *Gondwanaeaplicates* can, however, be distinguished by its larger size, presence of incipient zona and less number of furrows and their tendency to be associated with strongly developed longitudinal folds affecting the overall shape of the pollen grains. *Gnetaceaepollenites* Thierg. (1938) is differentiated by its elliptical-spindle shape and presence of two arcuate folds running along the longitudinal axis of the pollen grains. Moreover this genus is not possessing incipient zona and the exine is not intrapunctate. *Ephedripites* Bolkov. (1953) is characterized by elliptical-spindle shape, azonate and the furrows are not associated with any longitudinal folds in most of the specimens. The exine is not intrapunctate and the size range is also smaller than the present specimens. *Welwitschiapites* Bolkhovitina (1953) is differentiated by their larger number of furrows, in the absence of incipient zona and the presence of rudimentary sacci in some specimens.

Gondwanaeaplicates bharadwajii sp. nov.

Pl. 1, Figs. 19-21

Holotype — Pl. 1, Fig. 19. Size 106×72 μ. Slide no. 3332.

Type Locality — Bore-core no. K_2, Depth 308·37-308·47M., North Karanpura coalfield, Bihar; Raniganj Stage (Permian).

Diagnosis — Pollen grains oval–subcircular in fully flattened condition, but may be elliptical or spindle shape due to several longitudinal foldings. Size range (in fully flattened condition) 80-130×50-120 μ. Furrows 2-5, generally not extending from one end to other thus providing an incipient zona like structure around them. Furrows well or ill-developed, may or may not be associated with folds. Exine laevigate and intrapunctate.

Description — Pollen grains in fully flattened condition are rare. Longitudinal folds are responsible for the various shapes of the pollen grains. Folds vary in number but they are always found along the longitudinal axis. Furrows distinct or indistinct, sometimes equally well developed or one is better developed than others. In folded specimens furrows are more distinct. Furrows do not extend from one margin to other and more or less end at same region producing a zona like structure in fully flattened specimens. When furrows are associated with folds this zona is not perceptible and some of them may extend ± upto margin probably due to rupture of the exine in producing them. In most of the specimens studied here there are three furrows and in some rare cases the outer furrows ± join each other. Exine 2-4 μ thick, laevigate and mostly intrapunctate; infrastructure closely placed and evenly distributed; some intrapunctate structure may not be clear and in such cases some intrabaculate structure appears to be present.

Derivation of Name — After Dr. D. C. Bharadwaj of the Birbal Sahni Institute of Palaeobotany, Lucknow.

PALYNOLOGICAL COMPOSITION

58 dispersed spores-pollen genera listed previously are not, however, represented

in all the samples studied here. In general the samples from the lower part of the core are rather commisserative in spores-pollen genera, while it is richer in the upper part of the core. Four slides (22×50 mm.) from each sample have been studied to determine the palynological assemblage. The list of genera and the major groups with their percentage in each sample are tabulated as follows: (TABLES 1 & 2).

PALYNOLOGICAL ASSEMBLAGE

The palynological assemblage of the present bore-core consists of 58 genera out of which 36 spores-pollen genera are met within the 200 counted specimens. The rest 22 genera are present in some or other samples but fail to appear within the count. The assemblage is dominated by the striate bisaccate pollen grains representing mostly by *Strotersporites* and *Striatopiceites* (TEXT-FIG. 2). The monosaccate pollen grains are almost solely represented by *Densipollenites*. Among the trilete spores, the infraturma *Apiculati* is better represented than others. *Laevigatosporites* and *Ghoshiasporites* represent mostly the monolete spores. The maximum and minimum representation of the major groups in the samples is as follws:

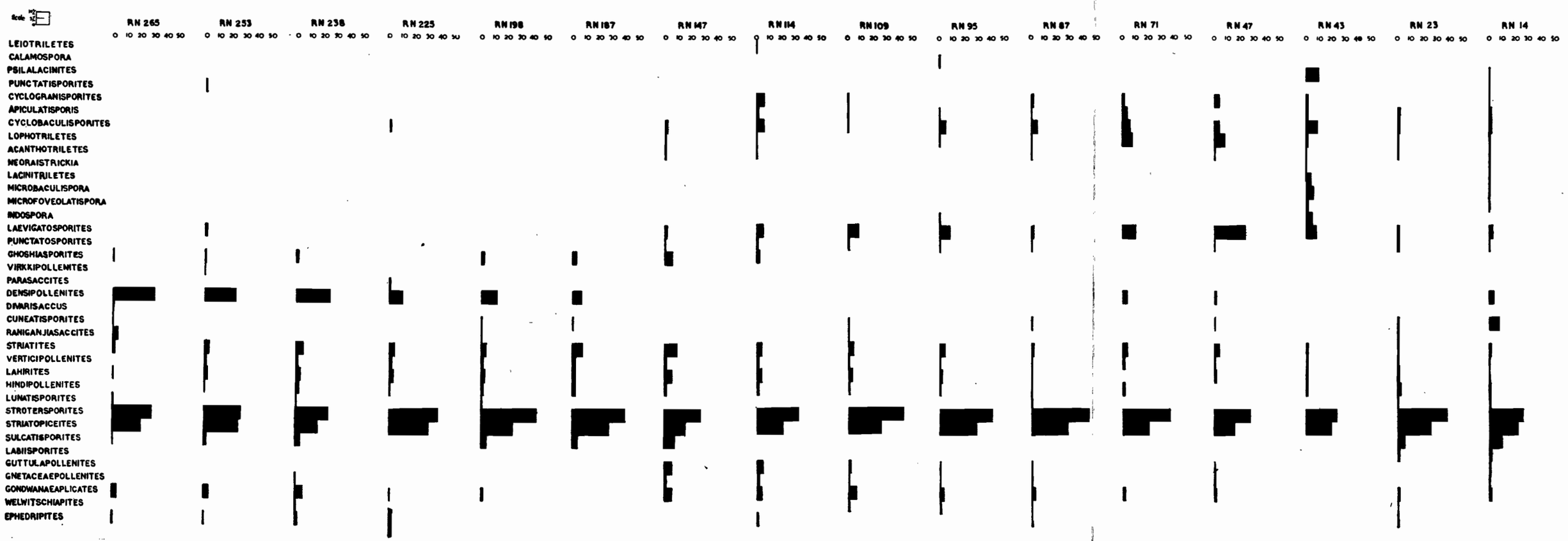
Major groups	*Percentage*		
	Maximum		*Minimum*
Trilete	44%	—	0
Monolete	25%	—	0
Alete	0	—	0
Monosaccate	33%	—	0
Bisaccate	90%	—	48%
Polysaccate	6%	—	0
Polyplicate	10%	—	0
Monocolpate	0	—	0

It may be mentioned here that the coal and shaly coal samples (Samples nos. RN 43, RN 47, RN 72, RN 87, RN 95 and RN 114) are more rich in trilete and monolete spores. In sample no. RN 43 they contribute 52 per cent to the assemblage. The percentage of these spores, however, goes down in other lithological units and in sample no. RN 265 they represent only 1 per cent of the total assemblage. This perhaps point out that the ferns and fern allies played an important part in the formation of coal. It may, however, be stated here that the trilete and monolete spores are in general more common in the upper level of the core than in the lower ones but their representation is at the zenith in the coal and shaly-coal samples. The monosaccate pollen are rather well represented in the lower samples but absent or meagrely represented in the upper ones. The polysaccate and polyplicate pollen grains are more common in the upper samples. On the basis of their representation the present assemblage has been divided into two palynological zones as follows:

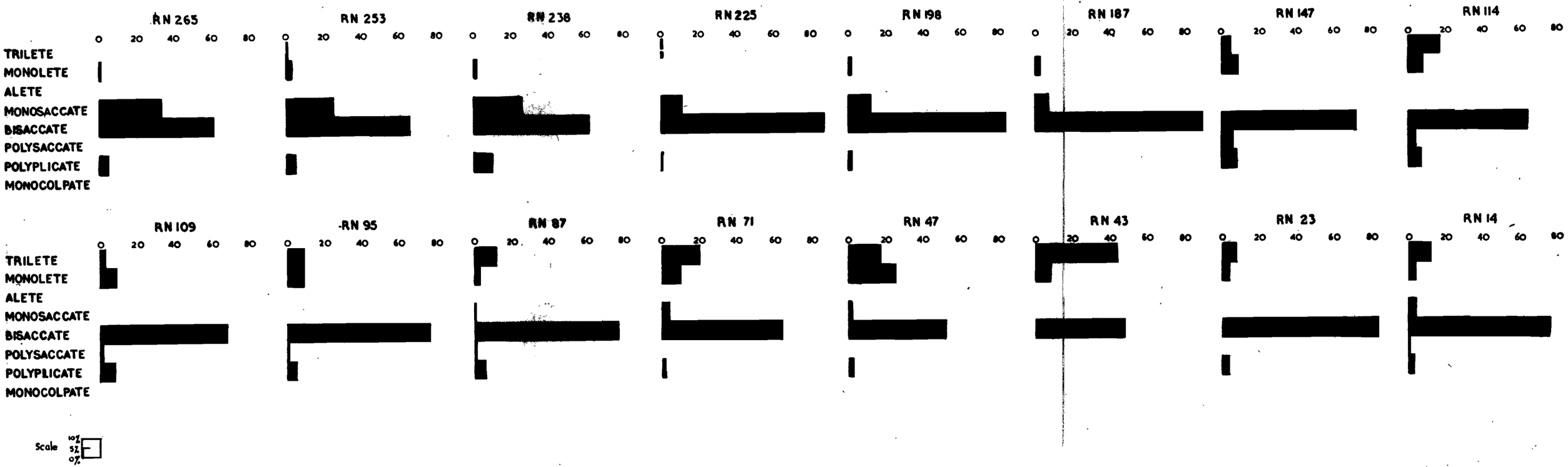
Zone B Sample nos. RN 147 - RN 14	Trilete	— Subdominant
	Monolete	— Subdominant
	Alete	— Absent
	Monosaccate	— Absent or meagrely represented
	Bisaccate	— Dominant
	Polysaccate	— Rare or accessory
	Polyplicate	— Common
	Monocolpate	— Absent
Zone A Sample nos. RN 265 - RN 187	Trilete	— Mostly absent
	Monolete	— Absent or meagrely represented
	Alete	— Absent
	Monosaccate	— Subdominant
	Bisaccate	— Dominant
	Polysaccate	— Absent
	Polyplicate	— Rare or accessory
	Monocolpate	— Absent

DISCUSSION

The present palynological assemblage closely resembles to that of Raniganj Stage of the Raniganj coalfield (*see* BHARADWAJ, 1962; BHARADWAJ & SALUJHA, 1964, 1965a, 1965b; SALUJHA, 1965). The spores-pollen genera are, however, more in number in the present assemblage than in the latter. The genera like *Psilalacinites*, *Divarireticulates*, *Striasporis*, *Altimonoletes*, *Ghoshiasporites*, *Mammialetes*, *Raniganjiasaccites* and *Gondwanaeaplicates* as far as the present knowledge goes are restricted to Raniganj Stage of the North Karanpura coalfield, Bihar. The miospore assemblage of Raniganj Stage of the Raniganj coalfield has also got some genera which have not



TEXT-FIG. 2 — Showing the distribution of various genera in Raniganj Stage in the bore-hole no. K_9.



TEXT-FIG. 3 — Showing the distribution of major groups in Raniganj Stage in the bore-hole no. K_8.

been recorded in the present assemblage. They are: *Ricaspora* Bharadwaj & Salujha (1964), *Verrucosisporites* (Ibrahim) Potonié & Kremp (1954), *Anapiculatisporites* Potonié & Kremp (1954), *Lycopodiumsporites* Thiergart (1938), *Gravisporites* Bharadwaj (1962), *Cirratriradites* Wilson & Coe (1940), *Gondisporites* Bharadwaj (1962), *Thymospora* (Kosanke) Wilson & Venkatachala (1963a), *Distriomonosaccites* Bharadwaj (1962), *Kosankeisporites* Bharadwaj (1955) and *Vesicaspora* (Schemel) Wilson & Venkatachala (1963b). This quantitative difference between the two assemblages seems to be a regional one. Mention may, however, be made here that the zonate spores represented by *Reticulatisporites* (*see* NEVES, 1964), *Lycopodiumsporites*, *Gravisporites*, *Cirratriradites* and *Gondisporites* in the Raniranj Stage of the Raniganj coalfield are conspicuous by their absence in the present assemblage. The palynological assemblage of the said stage is, however, rich in percentage of trilete and monolete spores (*see* BHARADWAJ & SALUJHA, 1965a, 1965b and SALUJHA, 1965). The monosaccate pollen grains are rare in the assemblage where the striate bisaccate pollen dominate throughout the assemblage. The polysaccate, polyplicate and monocolpate pollen grains do not play an important role in this assemblage. The palynological assemblage of Raniganj Stage as worked out by Bharadwaj and his associates (*l.c.*) can thus be equated with Zone B of the present assemblage.

The palynological assemblage of Raniganj exposure near Lungatoo, North Karanpura coalfield, Bihar, comprises 34 dispersed spores-pollen genera (*see* KAR, 1968b). All the eight samples counted there show a dominance of striate bisaccate contributing 68-96 percent to the total assemblage. Among them *Stroteršporites* and *Striatopiceites* are most common. Monosaccate pollen grains are also common and contribute upto 20 per cent. *Densipollenites* is most common among them. The trilete, monolete, polysaccate, polyplicate and monocolpate pollen grains play an insignificant role in the assemblage. This assemblage thus very closely resembles the Zone A of the present assemblage.

The three zones established by Venkatachala and Kar (1968a, 1968b) from the Barakar exposures near Badam, Hazaribagh district, Bihar, can easily be differentiated from the present zones on the presence and absence of various genera.

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EXPLANATION OF PLATE

(All photomicrographs are enlarged ca. × 500)

PLATE 1

1-4. *Psilalacinites triangulus* gen. et sp. nov. Slide no. 3325.

5. *Striasporis striatus* gen. et sp. nov. Slide no. 3335.

6-7. *Varireticulates varius* gen. et sp. nov. Slide no. 3326.

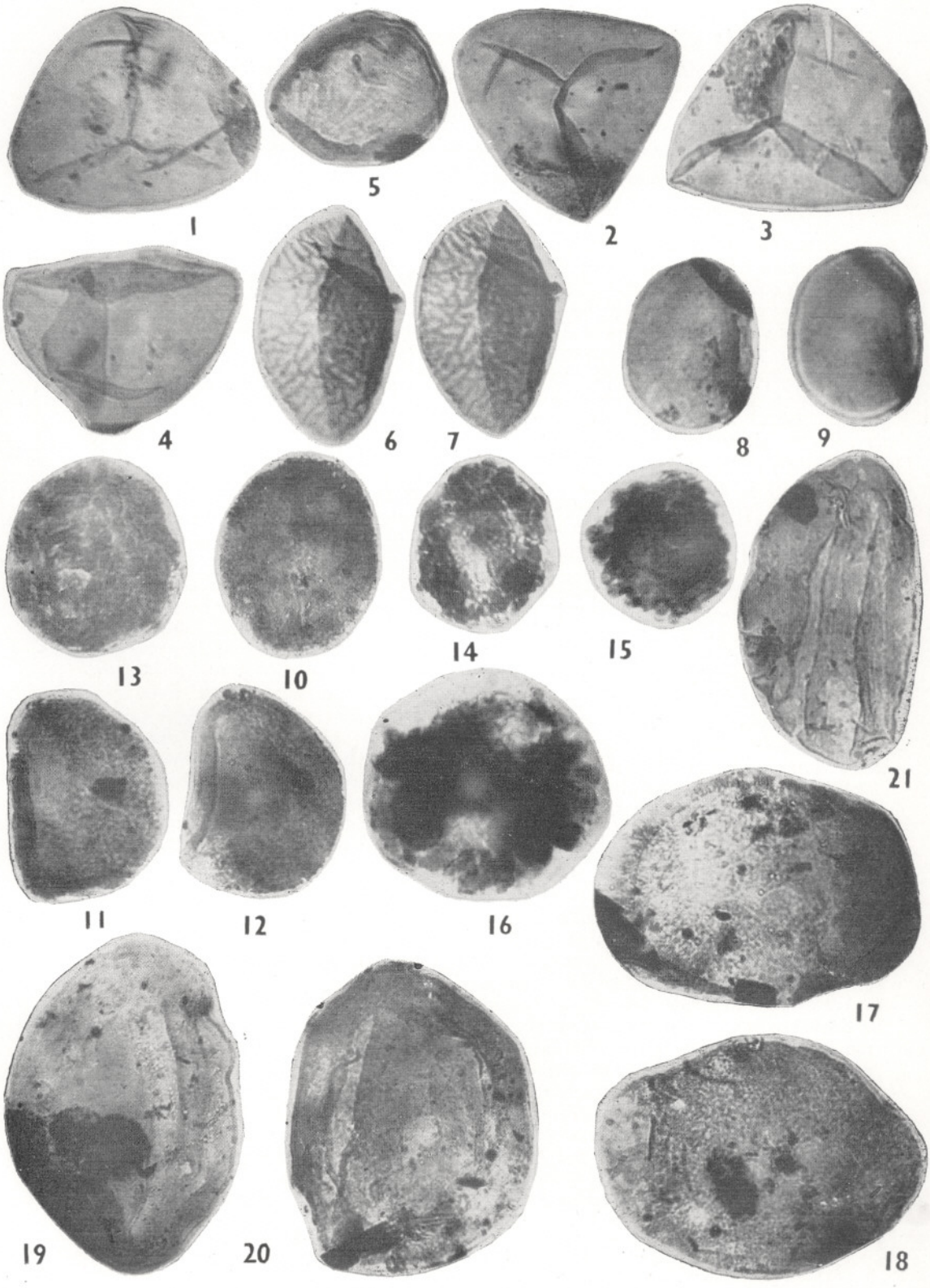
8-9. *Altimonoletes flavatus* gen. et sp. nov. Slide no. 3326.

10-12. *Ghoshiasporites didecus* gen. et sp. nov. Slide nos. 3331, 3330, 3329.

13-16. *Mammialetes mammus* gen. et sp. nov. Slide nos. 3333, 3327, 3332, 3328.

17-18. *Raniganjiasaccites ovatus* gen. et sp. nov. Slide no. 3332.

19-21. *Gondwanaeaplicates bharadwajii* gen. et sp. nov. Slide nos. 3332, 3334.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