PALYNOLOGY OF THE KARANPURA SEDIMENTARY BASIN, BIHAR, INDIA — 1. BARAKAR STAGE AT BADAM

B. S. VENKATACHALA* & R. K. KAR
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The present paper deals with the Palynology of the Barakar sediments exposed near the village of Badam, in Hazaribagh District of Bihar, India. The spores and pollen recovered have been referred to 42 spore genera and 60 species. Three Palynological zones have been marked on the abundance of striate bisaccate pollen and trilete spores.

INTRODUCTION

PALYNOLOGY, now an accepted tool in coal and oil exploration, includes a study of microfossils that are useful in age determinations; correlation of wells and outcrop sections, and suggesting favourable areas for oil exploration by interpreting environments.

Spores, pollen and other palynological fossils (Hystrichosphaerids, Dinoflagellates etc.) can be obtained in abundance from acid-insoluble residues of shales, coals, limestones, siltstones, peats and lignites. Sandstones are usually barren. The factors that make Palynology an important discipline are several. Palynological fossils are minute and well preserved in many sedimentary environments; approximately 75-80 per cent of all sedimentary rocks contain some type of microfossils. They are especially suitable for recovery from even a small amount of material. Palynological fossils are usually abundant and possess taxonomic characters which make them distinctive entities. They are found in rocks ranging in age from late Pre-Cambrian to Pleistocene and are sufficiently different in each period to serve as means of recognizing the age of the rocks in question. Pollen, Spores, Hystrichosphaerids, Dinoflagellates, Chitinozoans, Tintinids etc. occur in distinctive assemblages that indicate specific environment at the time of deposition. The determination of palaeoecological conditions has great bearing upon the recognition of smaller geological time units, the proximity of ancient shore lines, the correlation of marine and continental deposits and palaeoclimatic trends. In recent years palynological fossils have been statistically treated. Such studies reveal information relating to correlation of small lithological units and geological structures.

Palynological Studies in Gondwanaland — Palynological studies in the Gondwana continent are not extensive as compared to those in Europe, U.S.S.R. and North America. The Australian Permian deposits have been worked out by Balme (1952), Balme & Hennelly (1955, 1956a, 1956b), Hennelly (1958), Dulhunty (1946), Townrow (1962) and others. In Africa, Leschik (1959) studied spores and pollen from Karroo sandstone of Norronaub (South-West Africa). Hart (1960, 1963, 1964) investigated the microflora from the lower measures (K_2); Katewaka-Mchuchuma Coalfield, Tanganyika.

Sahni in a paper (1940) elucidated the importance of palynological (microfloral) studies in Indian coals and other sedimentary formations.

Virkki (1937, 1939) figured some winged pollen from the Gondwanas of India and Australia. Virkki (1946) also studied spore-pollen assemblages from 2½ to 25 ft. above the Talchir boulder bed, Kathwai; Middle Productus Limestone, Warcha and Jhallewali, Salt Range; Daltonganj Coalfield, (Barakar Stage) Bihar; Pali beds, Rewa. Mehta (1944) described spores and pollen from the Pali beds of South Rewa. Sen (1944) investigated spores-pollen from Satpukuria, Ghushick and associated seams of the Raniganj Stage. Ghosh & Sen (1948) described and illustrated large number of spores-pollen from the Raniganj Coalfield, West Bengal. Trivedi (1950) reported some megaspores from Singrauli Coalfield (Barakar Stage). Goswami (1952, 1956) reported some spores from the South Rewa Gondwana basin of the Barakar Stage. Surange, Prem Singh & Srivastava (1953a, 1953b) correlated a few coalseams of the West Bokaro

*Present address — Palynology Laboratory, Research & Training Institute, Oil and Natural Gas Commission, Dehradun.

Coalfield, Bihar. Surange & Lele (1955) reported microflora from the Talchir needle shales (Talchir Stage) of the Giridih Coalfield, Bihar.

Datta (1957) studied spores-pollen from the Talchir and the Barakar Stages, Madhya Pradesh. Bhattacharya, Raychoudhury and Datta (1957) illustrated and described some spore types from Raniganj and South Karanpura Coalfields. Banerjee (1958) studied spores-pollen from some coal seams of the Bakarar Stage in Hazaribagh district, Bihar. Das (1958) on the basis of microfloral assemblage correlated three seams of the Haniduha colliery of the Barakar Stage in Orissa. Potonié & Lele (1960) studied microflora from the Talchir boulder beds from South Rewa Gondwana basin.

Bharadwaj (1962) published an extensive study on the morphography of spores and pollen from the eastern part of the Raniganj Coalfield. In this treatise he recognized 42 genera, out of which 15 are new.

Lele (1964) in a critical evaluation of *Nuskoisporites* Potonié and Klaus and related genera has instituted two monosaccate genera from the Talchir Stage of India.

The present work consists of Palynological studies of the Barakar sediments from Badam, North Karanpura basin, Bihar, India.

GEOLOGY OF KARANPURA SEDIMENTARY BASIN

Area — The Karanpura basin was named by Hughes (1869) to cover an area approximately 472 square miles lying between 84°50′ to 84°30′ E. and 23°37′ N. in the district of Hazaribagh in Bihar. A part of it, in the neighbourhood of Chano and Badam was named by Williams in 1848 as the Hoharu Coalfield, the name being taken from a small stream flowing across the area. Later, Hughes (1869) changed the name and substituted it with Karanpura, after the subdistrict (parganah) of Karanpura, which embraces the entire coal bearing area. In 1925 additional areas were included within the Karanpura Coalfield by Jowett after working extensively on the geology of the region. The area now covers approximately 550 square miles and lies between 23°38′ to 23°56′ N. and 84°46′ to 85°26′ E.

Topography — The Damodar (Damuda) river apparently divides the basin into two unequal parts. Hughes (*l.c.*) restricted the name Karanpura for the northern part of the basin while the southern part was referred to as South Karanpura. Jowett (*l.c.*) also apparently seems to agree with this position. Later workers (e.g. Pascoe, 1959) found it more convenient to call the northern part of the basin as North Karanpura Coalfield and the southern part as South Karanpura Coalfield.

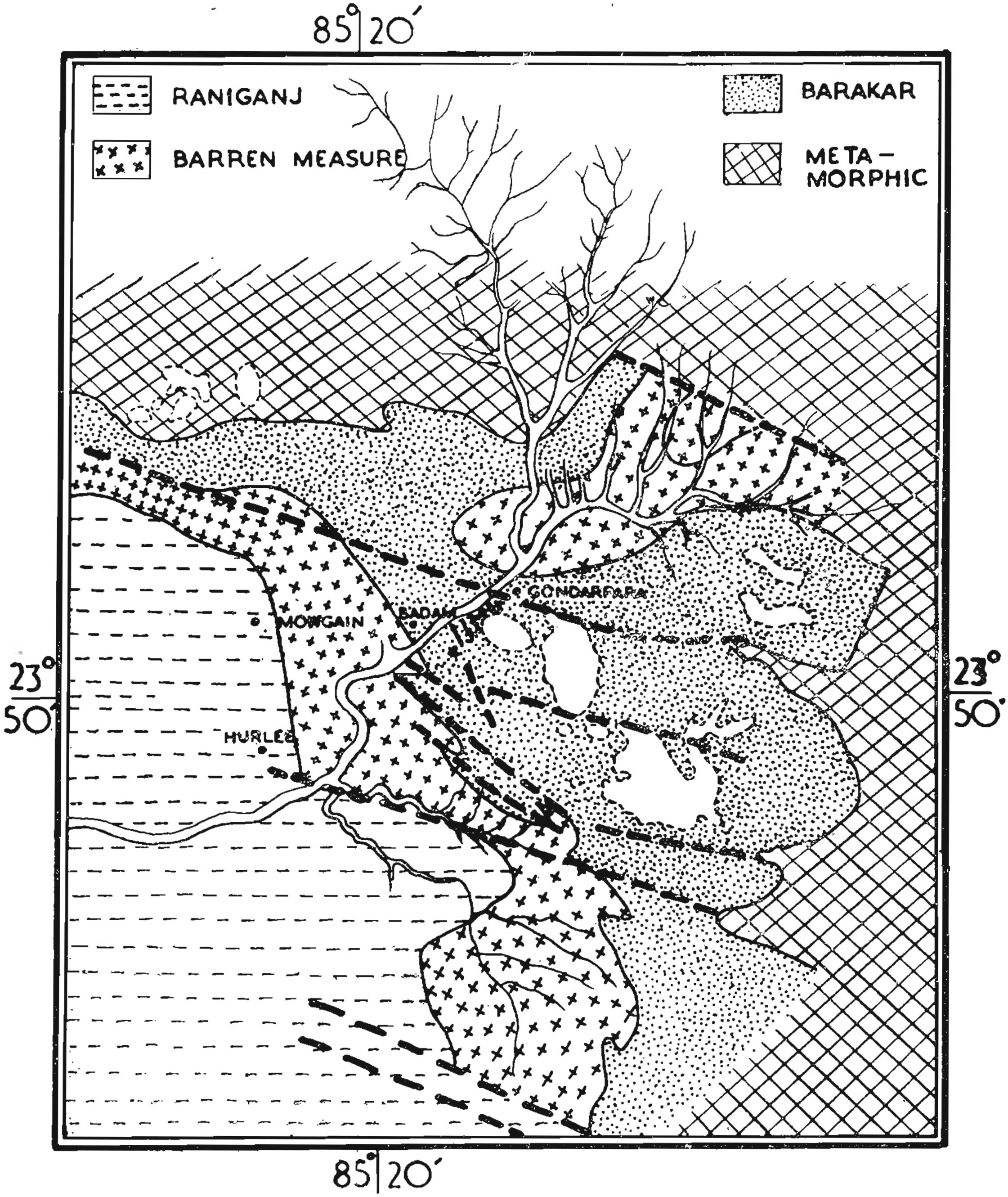
South Karanpura Basin — The approximate boundary of the South Karanpura basin covers an area of about 23 miles in length from east to west and about 4 miles in width. The total area average about 75 square miles. The sedimentary formations met with in this basin belong to the Lower Gondwana System. The Talchir conglomerate is usually the basal-most bed which rests unconformably over the metamorphic rocks. The different rock groups of the area are exposed in the following sequence:

	Series	*Stage*
Lower Gondwana	Damuda	Raniganj Ironstone Shales Barakar
	Talchir	
	Unconformity	
	Metamorphics	

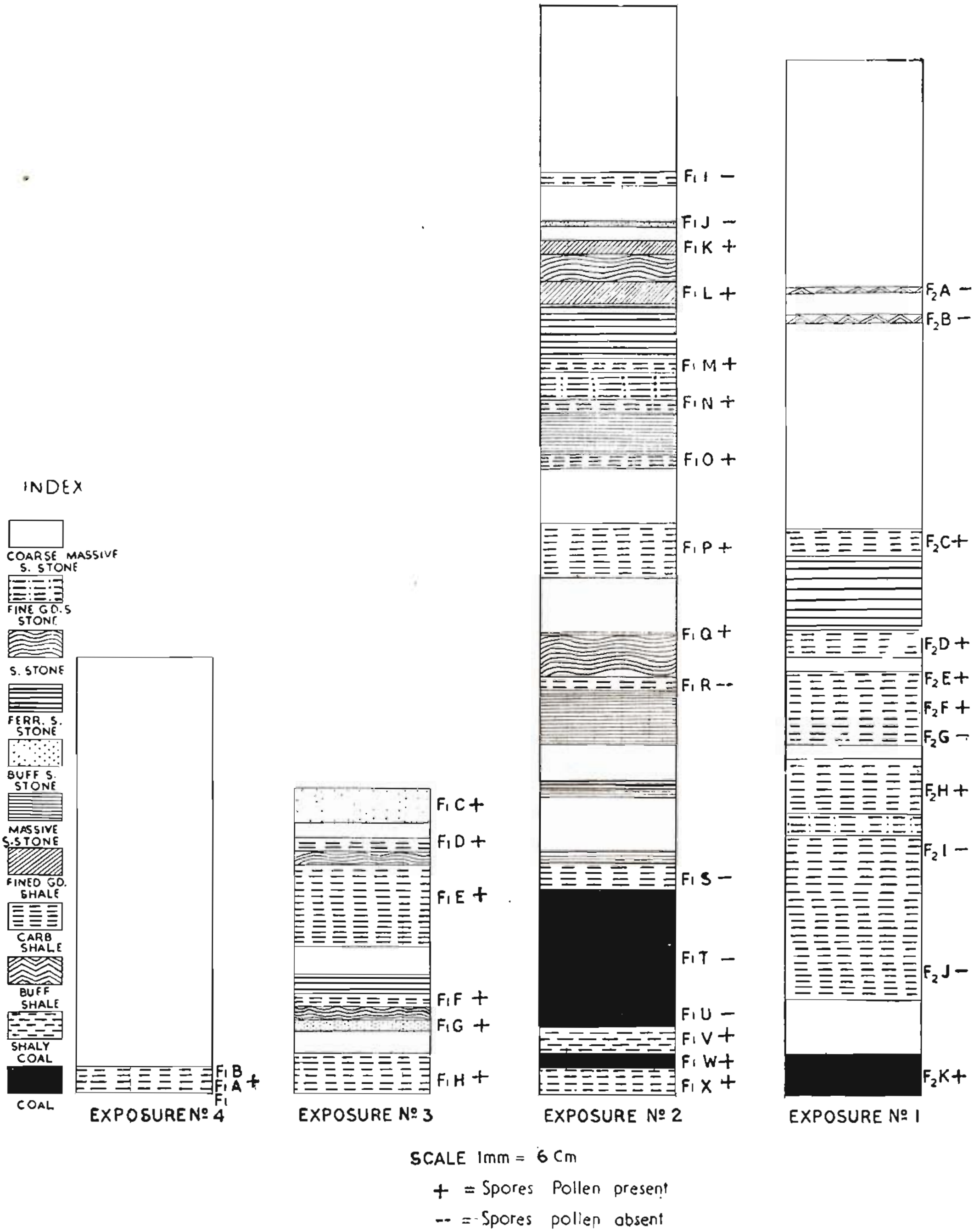
The Talchirs are rather poorly represented as thin fringes and are at present seen as outcrops at only three or four places. The Barakar formations are best developed occupying more or less three-fourth of the whole area and also appear rich in having a number of coal seams. The Raniganj and the Ironstone Shale Stages are comparatively poorly developed.

North Karanpura Basin — The North Karanpura basin covers an area of 470 square miles and extends at its maximum length to 40 miles and 20 miles in breadth. The outcrops of the Gondwana formations that are exposed in this coalfield are found in the following sequence:

	Series	*Stage*
Upper Gondwana	Mahadeva Panchet	
Lower Gondwana	Damuda	Raniganj Ironstone Shales Barakar
	Talchir	
	Unconformity	
	Metamorphics	



TEXT-FIG. 1 — Locality Map — showing samples studied.



TEXT-FIG. 2 — Composite columnar section of Barakar rocks at Badam, showing positions of samples collected.

The rocks of the Talchir Series occupy an area roughly 9 square miles. Two larger patches are exposed at the northern part of the basin. The other exposures are very small and scattered throughout the basin. This series comprises of interbedded shales and fine-ground sandstones with the boulder conglomerate at the base.

Rocks of the Barakar Stage cover nearly half the area, consisting mostly of sandstones. Several coal seams usually occur within these, some of them attaining considerable thickness. The three substages of the Barakar formation met with in this basin are as follows:

3 — Shales and shaly sandstone with thin coal seams with usually ironstone shales at the top.

2 — Predominant sandstones, less coarse than those below, coal seams of moderate thickness and several beds of iron-ore, no conglomerate.

1 — Conglomerate composed of small quartz, pebbles, coarse sandstones and grits with some thick coal seams.

The ironstone shales are present in the northern and eastern regions of the basin. The shale bands belonging to this Stage are generally pale yellow, more sandy in character and less carbonaceous.

The rocks of the Raniganj Stage crop out as bands averaging some two to three miles in width, surrounding the Panchets and Mahadevas in the middle region of the basin (Pascoe, *l.c.*). There are several coal seams in this Stage but only a few are of considerable thickness.

The Panchet rocks cover a considerable area in the North Karanpura basin. They appear to rest conformably over the Raniganj formation, so much so that the uppermost beds of the Raniganj formation possess certain characteristics of Panchets. The rock types belonging to the Panchet Series are variable, ranging from sandstones and shales to red clays. The rocks are generally shaly in character, sometimes fairly coarse or less micaceous sandstones. The red clays are usually common in the middle and upper part of the Series.

The Mahadevas mostly form the hills in the neighbourhood of Maudih (Mahudi) and Sathpahari; almost in the central region of the basin. They overlie the Panchets, usually in conformable sequence, except where the boundary between the two is faulted. The Mahadeva rocks are generally more or less horizontal, dipping steadily towards south and west. The rocks consist of massive sandstones with rare intercalations of hard and shaly beds. The pebbles in the sandstones are usually sub-angular and iron-stained.

MATERIAL AND METHODS

Collections — Four sections of the Barakar Stage (Permian) of the Lower Gondwana formations were measured and collected near the Badam village in Hazaribagh dist., Bihar (*see* TEXT-FIG. 1). Samples were collected from each lithological unit, from the bottom of the section upward. The following is the table of four measured stragitraphic sections (*see* TEXT-FIG. 2).

Measured outcrop sections of the Barakar Stage at Badam (North Karanpura), Hazaribagh district, Bihar:

Exposure No. 4

Lithology:	Thickness (in foot)
Coarse grained, massive sandstone	30′
Carbonaceous shale (F_1, F_1A, F_1B)	exact thickness unknown; exposed about 2′
Total	32′

Exposure No. 3

Lithology:	Thickness (in foot)
Buff coloured shale (F_1C)	2′-6″
Massive sandstone	1′
Carbonaceous shale (F_1D)	0-8″
Sandstone	0-8″
Carbonaceous shale (F_1E)	6′-0
Coarse grained, massive sandstone	2′-0
Ferruginous sandstone	1′-6″
Carbonaceous shale (F_1F)	0-8″
Sandstone	1′-0
Buff coloured shale (F_1G)	0-10″
Coarse grained, massive sandstone	1′-6″
Carbonaceous shale (F_1H)	exact thickness unknown, exposed about 3′-0″
Total	18′-4″

Exposure No. 2

Lithology:	Thickness (in foot)
Massive sandstone	12′-0
Carbonaceous shale (F_1I)	1′-0
Massive sandstone	2′-6″

Exposure No. 2

Lithology:	Thickness (in foot)
Buff coloured shale (F_1J)	0-6″
Coarse grained sandstone	1′-0
Fine grained shale (F_1K)	1′-0
Sandstone	2′-0
Fine grained shale (F_1L)	1′-6″
Ferruginous sandstone	4′-0
Carbonaceous shale (F_1M)	1′-0
Fine grained sandstone	2′-0
Carbonaceous shale (F_1N)	1′-0
Black, hard, compact, fine grained sandstone	3′-0
Carbonaceous shale (F_1O)	1′-0
Massive sandstone	4′-0
Carbonaceous shale (F_1P)	4′-0
Massive sandstone (coarse grained)	4′-0
Carbonaceous shale (F_1Q)	0-3″
Sandstone	3′-0
Carbonaceous shale (F_1R)	1′-0
Massive sandstone	4′-0
Black, fine grained, compact sandstone	2′-6″
Ferruginous sandstone	0-9″
Black, fine grained, compact sandstone	0-6″
Massive sandstone	4′-0″
Black sandstone	0 9″
Carbonaceous shale (F_1S)	2′-0
Coal (F_1T, F_1U)	10′-0
Shaly coal (F_1V)	1′-0
Carbonaceous shale (F_1X)	exact thickness unknown, exposed about 2′-0
Total	79′-3″

Exposure No. 1

Lithology:	Thickness (in foot)
Massive sandstone	16′-0
Buff coloured shale (F_2A)	0-6″
Sandstone	1′-6″
Buff coloured shale (F_2B)	0-8″
Massive sandstone	15′-0
Carbonaceous shale (F_2C)	2′-0
Ferruginous sandstone	5′-0
Carbonaceous shale (F_2D)	2′-0
Sandstone (fine grained)	1′-0
Carbonaceous shale (F_2E, D_2F, F_2G)	5′-0
Sandstone (coarse grained)	1′-0
Carbonaceous shale (F_2H)	4′-0
Fine grained sandstone	1′-6″
Carbonaceous shale (F_2I, F_2J)	12′-0
Sandstone (coarse grained)	4′-0
Coal (F_2K)	exact thickness unknown, exposed about 3′-0
Total	74′-2″

About 30 grams of material was treated with commercial Nitric acid (40 per cent) for 3-6 days followed by a treatment of 5 per cent Potassium hydroxide for 5-10 minutes. Macerates containing silica were subsequently treated with Hydrofluoric acid (40 per cent) for 2-4 days. The macerate after several washings was mounted in glycerine jelly. The slides, photographs and unused material are preserved at the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow, India.

SYSTEMATIC PALYNOLOGY

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

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

Type Species — *Leiotriletes sphaerotriangulus* (Loose) Potonié & Kremp, 1954.

Leiotriletes sp.

Pl. 1, Figs. 1, 2

Description — Spores triangular in polar view. Overall size range 32-36 $\mu \times$ 41-46 μ. Apices rounded, interapical margins straight to slightly convex. Trilete well developed extending upto equator, rays narrow, uniformly broad. Commissure well marked. Exine more or less 2 μ thick; laevigate and translucent.

Comparison — This species is comparable to *Leiotriletes adnatus* (Kosanke) Potonié & Kremp (1954) in general size range. *L. adnatus*, however, differs from the present species in having concave interapical margins and the trilete-rays extending upto three-fourth the radius of the spore. *L. adnatoides* possesses straight to slightly convex interapical margins but can be distinguished from *Leiotriletes* sp. by the presence of very well developed, tapering trilete extending upto three-fourth the equator.

Genus *Retusotriletes* Naumova, 1953

Type Species — *Retusotriletes simplex* Naumova, 1953.

Retusotriletes sp.

Pl. 1, Figs. 3, 4

Description — Spores circular in polar view. Overall size range 32-41 $\mu \times$ 33-41 μ.

Trilete distinct, extending upto half the radius, rays equal in size, narrow and uniformly broad, ray-ends not tapering, inter-radial area darkened, imperfect curvature present. Commissure well marked. Exine smooth to infragranulose.

Remarks — Bharadwaj (1962) has described similar specimens from the Raniganj Stage (Upper Permian) of the Lower Gondwana Succession of India. *Retusotriletes* distinguishes in possessing well demarcated contact area which though present is not conspicuous here. This thickening seen in the inter-radial area may indicate the presence of an inner body. Similar inner bodies have been reported in *Calamospora densa* Venkatachala & Bharadwaj (1964); *Calamospora microrugosa* Schopf, Wilson & Bentall (1944) and also recorded in the spores recovered from *Huttonia spicata* Weiss by Hartung (1933; PL. 9, FIGS. 9-12).

Retusotriletes sp. shows a close resemblance with the spores of *Sphagnum*. Neuberg (1960) has recorded megafossil remains of *Sphagnum* from the Permian sediments of U.S.S.R.

Genus *Leschikisporis* Potonié, 1958

Type Species — *Leschikisporis aduncus* (Leschik) Potonié, 1958.

Remarks — *Leschikisporis* was instituted by Potonié (1958) to include circular to oval spores with an asymmetrical trilete mark and granulose ornamentation. Similar spores have also been found from the Pennsylvanian of U.S.A. by Kosanke (1950), who described them as *Punctatisporites obliquus*. The species has further been transferred to *Punctatosporites obliquus* by Venkatachala & Bharadwaj (1964) and subsequently to *Leschikisporis obliquus* by Wilson and Venkatachala (in press).

Spores illustrated here as well the ones described by Leschik (1955), Kosanke (1950), Venkatachala & Bharadwaj (1964), Wilson and Venkatachala (Ms.), where two of the rays form a wide obtuse angle, while the third is perpendicular to the other two. Such feature has also been recorded by Nathorst (1908) and Bharadwaj & Singh (1956) in the spores of *Asterotheca meriani* Staur.

The occurrence of such spores with asymmetrical trilete mark appears to be common and constant and hence it is proposed to maintain it as distinct from *Punctatisporites* and *Punctatosporites* as suggested by Potonié (1958) and Wilson & Venkatachala (in press). Wilson & Venkatachala (1967) have reviewed the status of *Leschikisporis* Potonié, 1958 and indicated that *Circlettisporites* Miller, 1966 is a synonym of the former.

Leschikisporis baccatus sp. nov.

Pl. 1, Figs. 23, 24

Holotype — Pl. 1, Fig. 23, size 46 × 36 μ, Slide No. 2415/5.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Circular-subcircular, size range 27-41 μ × 32-46 μ. Trilete unequal, two of the rays forming a wide obtuse angle and the third ray almost at right angles to the other two, ray-ends not tapered. Exine ornamented with coni, coni upto 2 μ long and closely placed.

Description — Spores mostly found in polar view. Trilete well developed, two of the rays form an obtuse angle, while the third is almost perpendicular to the other two. Commissure well marked. Exine about 1·5 μ thick; coni closely spaced, sometimes forming a pseudoreticulum (PL. 1, FIG. 24); 50-70 coni can be counted along the equatorial margin.

Comparison — *Leschikisporis aduncus* Potonié compares closely with the present species in size but differs in possessing laevigate to finely granulose exine. *Leschikisporis obliquus* (Kosanke) Wilson and Venkatachala (1967) is bigger in size with sparsely spaced sculptural elements.

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

Genus *Verrucosisporites* (Ibrhim) Smith *et al.*, 1964

Type Species — *Verrucosisporites verrucosus* Ibrahim, 1933.

Verrucosisporites sp.

Pl. 1, Fig. 5

Description — Spore circular in polar view; 50 × 46 μ. Trilete well marked, rays equal, uniformly broad, extending upto equator. Exine upto 2 μ thick; verrucae 1-2 μ long and 1-1·5 μ broad at base; closely placed.

Comparison — The present specimen differs from the specimen figured by Bharadwaj

(1962, Pl. 1, Fig. 15) in the extension of the trilete almost upto equator.

Remarks — *Verrucosisporites* seems to be rare in the Permian sediments of India. The various species attributed by Balme and Hennelly (1956b, Pl. 4, Figs. 45-47) whose sculptural elements may not be verrucae at all. In other forms (Pl. 4, Figs. 42-44) the trilete seems to be associated with folds and hence belong to a different group other than *Verrucosisporites*.

Genus *Anapiculatisporites* Potonié & Kremp, 1954

Type Species — *Anapiculatisporites isselburgensis* Potonié & Kremp, 1954.

General Remarks — *Anapiculatisporites* was instituted by Potonié & Kremp (1954) to accommodate subtriangular to circular trilete spores with proximally more or less laevigate and distally ornamented surfaces. *A. isselburgensis* Potonié & Kremp (1954) is not illustrated properly. The photograph of the holotype is laterally falttened with the result its exact shape can not be determined. Potonié and Kremp (*l.c.*) diagnose it as circular, though the illustration appears to give an impression that it is roundly triangular in shape.

The spores that can be assigned to *Anapiculatisporites* in the present material show two distinct shapes, one is predominantly triangular in overall shape while the other is circular. The ornamentation in both the forms is essentially proximally laevigate and distally conate. The inclusion of these two distinct shapes in the same genus may easily be questioned. On the analogy of taxonomic practice adopted in delimiting genera like *Lophotriletes* (Naumova) Potonié & Kremp, *Granulatisporites* (Ibrahim) Potonié & Kremp, *Apiculatisporis* Potonié & Kremp and others, one could easily separate the triangular forms from the circular ones. However, for the present they have been included as different species under *Anapiculatisporites*.

Anapiculatisporites veritas sp. nov.

Pl. 1, Figs. 6, 7

Holotype — Pl. 1, Fig. 6, size 39 μ×39 μ. Slide No. 2415/2.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Spores triangular, 39-40 μ. Trilete, rays upto equator, exine proximally laevigate, distally ornamented with closely set coni simulating a vermiculate pattern.

Description — Triangular with acutely rounded apices and straight to slightly convex interapical margins. Trilete, rays well developed, equal in size; often tapering at ends. Commissure marked. Coni 1-1·5 μ in length, equally broad, sometimes simulating a vermiculate pattern.

Comparison — *Anapiculatisporites isselburgensis* Potonié & Kremp, is from the Westphalian sediments of Germany having circular overall shape. *A. spinosus* (Kosanke) Potonié & Kremp, which is closely comparable is from the Pennsylvanian of Illinois, U.S.A.

Anapiculatisporites sp. A

Pl. 1, Figs. 8-10

Description — Size range 25-30 μ×25-36 μ. Apices bluntly rounded, interapical margin straight to convex. Trilete well developed, lips narrow and straight. Commissure distinct. Exine thin, less than 1 μ, granulose or microverrucose, sculptural elements comparatively small in size, upto 0·5 μ in size.

Comparison — *Anapiculatisporites veritas* is larger in size and possesses distinct coni for its ornamentation. *A.* sp. is distinctly small with thin granulose-microverrucose exine.

Anapiculatisporites consonus sp. nov.

Pl. 1, Figs. 11, 12

Holotype — Pl. 1, Fig. 11; Size 28 μ along the trilete mark, Slide No. 2435/8.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Spores subcircular to roundly triangular in polar view. Size range 28-42 μ. Trilete, rays upto equator. Exine proximally laevigate, distally ornamented with coni or spines.

Description — *Anapiculatisporites isselburgensis* Potonié & Kremp, is bigger in size with a poorly developed trilete. *A. spinosus* (Kosanke) Potonié & Kremp, *A. veritas* and *A.* sp. described here are triangular in polar view. *A. consonus* distinguishes from other species in possessing prominent trilete apparatus and subcircular to roundly triangular overall shape.

Anapiculatisporites sp. B

Pl. 1, Fig. 13

Description — Spore triangular in polar view, 46×46 μ. Trilete prominent, tapering at ends and extending upto three-fourth of the radius. Exine proximally laevigate, distally ornamented with closely placed, robust coni. Coni 2-4 μ long and more or less 2 μ broad.

Comparison — The present specimen differs from *A. spinosus* (Kosanke) Potonié & Kremp, *A. veritas* and *A. granulatus* in possessing larger, densely placed coni.

Genus *Apiculatisporis* Potonié & Kremp, 1956

Type Species — *Apiculatisporis aculeatus* Potonié & Kremp, 1955.

Apiculatisporis sp.

Pl. 1, Figs. 20-22

Description — Circular-subcircular spores in polar view. Size range 20-30 μ ×22-32 μ. Trilete, rays ill-developed. Coni 1·5-2·5 μ, 20-35 on the margin.

Genus *Lophotriletes* (Naumova) Potonié & Kremp, 1954

Type Species — *Lophotriletes gibbosus* (Ibrahim) Potonié & Krdmp, 1954.

Lophotriletes rectus Bharadwaj & Salujha, 1964

Pl. 1, Figs. 14-19

Holotype — Bharadwaj & Salujha, 1964; Pl. 2, Fig. 26.

Description — Spores triangular in polar view, size range 36-40 μ × 37-41 μ, apices broadly rounded, inter-apical margin straight to convex. Trilete upto three-fourth the radius; rays tapering at ends. Coni sparsely placed, in between coni exine laevigate. Coni 1-1·5 μ long, equally broad, mostly blunt with slightly broadened tips.

Remarks — Bharadwaj & Salujha (1964) have noted 8-12 coni along the equatorial margin, however, in the specimens studied by us as well as in the holotype there seem to be more or less 30 coni along the equatorial margin.

Genus *Neoraistrickia* Potonié, 1956

Type Species — *Neoraistrickia truncatus* (Cookson, 1953) Potonié, 1956.

Neoraistrickia sp.

Pl. 1 Figs. 25-27

Description — Spores triangular in polar view. Size range 23-27 μ×27-32 μ. Trilete, rays poorly developed, extending three-fourth the radius. Exine thin, ornamented with sparsely set, 2-3 μ long bacula, often curved at top; 10-15 bacula along equatorial margin.

Genus *Altitriletes* gen. nov.

Type Species — *Altitriletes densus* sp. nov.

Generic Diagnosis — Spores circular to subcircular. Trilete elevated, vertex and apex high, labra thick. Exine thick, proximally laevigate, distally ornamented with coni, verrucae and warts.

Generic Description — Spores mostly circular in polar view, 46-59μ ×61-64 μ. Trilete well developed, ± upto equator; raised, apex and vertex high, labra upto 4 μ thick on either side of the suture. Exine upto 4 μ thick, rarely folded. Exine on distal side warted, warts may be pinheaded, baculate or irregular in shape, a few coni can be seen interspersed among the sculptural elements.

Comparison — *Anapiculatisporites* Potonié & Kremp (1954) shows much similarity with this genus in having laevigate proximal surface but differs in not possessing a raised trilete mark possessing broad lips. The distal ornamentation in *Anapiculatisporites* is either spinose or conate while in *Altitriletes* it is warted or verrucose. *Didecitriletes* Venkatachala & Kar (1965) is triangular in polar view and characterized by granulose and achinate exine on proximal and distal surface respectively. *Lacinitriletes* Venkatachala & Kar (1965) is distinguished by the presence of granulose to microverrucose ornamentation on distal side and the trilete is always associated with folds. *Apiculatisporis* Potonié & Kremp is ornamented on both the surfaces.

Derivation of name — The name *Altitriletes* is derived from the elevated trilete mark. Latin: *Altus* = high.

Altitriletes densus sp. nov.

Pl. 2, Figs. 38-42

Holotype — Pl. 2, Figs. 38, 39; Size 64×55 μ. Slide No. 2435/7.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Subcircular to circular in polar view. Trilete raised and well developed. Exine thick, proximally laevigate and distally warted.

Description — Size range 46-59μ ×61-64 μ. Trilete mostly extending upto equator; apex and vertex high, labra ± 4 μ thick on either side of the suture. Exine 2-4 μ thick; warts variable in size and shape; may be pinheaded, baculate and even irregular in shape; a few coni are generally found interspersed with the sculptural elements.

Subinfraturma—*Varitrileti* Venkatachala & Kar, 1965

Remarks — *Microbaculispora* Bharadwaj, *Microfoveolalispora* Bharadwaj, *Didecitriletes* Venkatachala & Kar and *Lacinitriletes* Venkatachala & Kar, share in common a sub-triangular to triangular shape with well marked trilete apparatus constantly associated with a fold pattern and differential proximal-distal ornamentation. These genera seem to be of the same plexus and appear to be confined to the Lower Gondwana sediments.

Genus *Microbaculispora* Bharadwaj, 1962

Type Species — *Microbaculispora gondwanensis* Bharadwaj, 1962.

Microbaculispora minutus sp. nov.

Pl. 1, Figs. 28-32

Holotype — Pl. 1, Fig. 28, Size 41×41 μ. Slide No. 2414/2.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Spores triangular, 36-46 μ×36-46 μ; trilete upto equator, associated with folds, bacula 0·5-1 μ wide and equally long.

Description — Triangular to roundly triangular in polar view and cordate in equatorial view; apices broadly rounded, interapical margins convex. Trilete well developed, commissure well marked, associated folds in most of specimens upto equator. Exine often folded, thin ± 1 μ thick, baculate, bacula closely placed and evenly distributed.

Comparison — *Microbaculispora gondwanensis* Bharadwaj is larger in size though possessing similar sculptural elements. In *M. villosa* (Balme & Hennelly) Bharadwaj (1962) the bacula are 3-5 μ long and the overall size range is also larger than the present species.

Genus *Didecitriletes* Venkatachala & Kar, 1965

Type Species — *Didecitriletes horridus* Venkatachala & Kar, 1965.

Didecitriletes horridus Venkatachala & Kar, 1965

(Not illustrated here; *see* VENKATACHALA & KAR, 1965)

For diagnosis and description — *see* Venkatachala & Kar, 1965.

Genus *Lacinitriletes* Venkatachala & Kar, 1965

Type Species — *Lacinitriletes badamensis* Venkatachala & Kar, 1965.

Lacinitriletes badamensis Venkatachala & Kar, 1965

(Not illustrated here; *see* VENKATACHALA & KAR, 1965)

For diagnosis and description — *see* Venkatachala & Kar, 1965.

Lacinitriletes minutus sp. nov.

Pl. 2, Figs. 33-37

Holotype — Pl. 2, Fig. 33. Size 46×36 μ. Slide No. 2435/8.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Spores triangular, size range 32-36 μ × 36-46 μ. Trilete associated with folds. Exine proximally laevigate, distally microverrucose.

Description — Spores found mostly in polar view. Apices acute to bluntly rounded. Interapical margins convex, occasionally constricted at one end. Trilete well developed, extends upto equator with constant association of fold. Exine thin, microverrucae on distal slide abundant, ± evenly distributed, mixed with grana.

Comparison — *Lacinitriletes badamensis* differs from the present species in having bigger size range and predominantly granulose ornamentation on distal side.

Infraturma—*Murornati* Potonié & Kremp, 1954

Genus *Dictyotriletes* (Naumova) Potonié & Kremp, 1954

Type Species — *Dictyotriletes bireticulatus* (Ibrahim) Potonié & Kremp, 1954.

Dictyotriletes sp.

Pl. 2, Figs. 43-44

Description — Spore roundly triangular in polar view. Trilete prominent, apex and vertex raised, labra thick, rays extending upto the equator. Exine proximally laevigate, distally reticulate with low flat muri forming regular 8-20 μ wide polygonal meshes; equatorial margin notched due to protruding muri; about 25 meshes along the equatorial contour.

Comparison — *Dictyotriletes invisus* Bharadwaj & Salujha (1964) differs from the present specimen in having smaller size range and poorly developed trilete mark.

Remarks — Bharadwaj (1962) referred a specimen (Pl. 3, Fig. 64) to *Reticulatisporites* (Ibrahim) Potonié & Kremp which is also closely comparable to the present specimen. *Reticulatisporites* as emended and diagnosed by Neves (1964) is restricted to cingulate miospores with a peripheral zone of thickening and a further band of thickening adjacent to and slightly overlapping the spore cavity outline and bearing a distinct mesh forming muri for its ornamentation. *Dictyotriletes* as opposed to *Reticulatisporites* is azonate and possesses flat reticulate muri, confined to the distal surface. According to Neves (1964, p. 1066) many species at present classified under *Reticulatisporites* could be transferred to *Dictyotriletes*. For the present due to paucity of material investigated and non-availability of type specimens of several of these species we defer making any emendment of the genus *Dictyotriletes*.

Turma —*Monoletes* Ibrahim, 1933
Subturma —*Azonomonoletes* Luber, 1935
Infraturma—*Psilamonoleti* Hammen, 1955

Genus *Laevigatosporites* (Ibrahim) Schopf, Wilson & Bentall, 1944

Type Species — *Laevigatosporites vulgaris* Ibrahim, 1933.

Laevigatosporites colliensis (Balme & Hennelly, 1956) comb. nov.

Pl. 2, Figs 45-50

Synonym — *Laevigatosporites vulgaris* forma *colliensis* Balme & Hennelly, 1956a.

Holotype — Balme & Hennelly 1956a; Pl. 1, Fig. 1.

Specific Diagnosis — *see* Bharadwaj, 1962, p. 85.

Description — Spores oval; monolete well marked, extends upto three-fourth along longitudinal axis. Exine less than 1 μ thick, sometimes folded irregularly, very faint striations could be observed in some specimens.

Remarks — This species of *Laevigatosporites* was originally described under *Laevigatosporites vulgaris* forma *colliensis* by Balme & Hennelly (1956a). Bharadwaj (1962) transferred it to *Latosporites* without any comment on the shape of the spore. *Latosporites* as diagnosed by Potonié & Kremp (1954) is distinctly circular. The type species of *Latosporites* chosen by above authors is *Latosporites latus* which was originally described under *Laevigatosporites* by Kosanke (1950). In his diagnosis of *Laevigatosporites latus* Kosanke (*l.c.*) describes his species as having " broadly bean to oval shaped in the plane of longitudinal symmetry "; hence this transfer is not commendable. *Laevigatosporites* is maintained here for oval-circular as well as broadly bean shaped monolete spores.

Infraturma—*Ornati* Potonié, 1956

Genus *Punctatosporites* Ibrahim, 1933

Type Species — *Punctatosporites minutus* Ibrahim, 1933.

Punctatosporites dulcis sp. nov.

Pl. 3, Figs. 52-56

Holotype — Pl. 3, Fig. 52, Size 59×32 μ. Slide No. 2418/7.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Oval to bean shaped, 28-57μ × 50-82 μ. Monolete. Exine sparsely microverrucose to granulose.

Description — Broadly oval bean shaped, monolete mark developed, suture three-fourth of the radius along longitudinal axis, lip narrow, uniformly broad, sometimes open. Exine about 1 μ thick, sparsely microverrucose or granulose, scluptural elements less than 1 μ wide, 20-40 elements could be counted along the equatorial margin. Exine irregularly folded, mostly on longitudinal axis.

Comparison — *Punctatosporites minutus* Ibrahim (1933) differs from the present species in having closely set granulose ornamentation and extension of monolete suture from one margin to other. *P. curvus* Leschik (1959) is oval in shape and ornamented with closely set coni.

Remarks — *Punctatosporites* is not a well represented genus in the Lower Gondwana Succession of India and so far reported only from the Raniganj (Permian) sediments of India by Bharadwaj & Salujha (1964).

Punctatosporites morosus sp. nov.

Pl. 3, Figs. 57-63

Holotype — Pl. 3, Fig. 57. Size 36×36 μ. Slide No. 2423/5.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Subcircular to circular, 36-46μ ×36-50 μ. Monolete. Exine microverrucose to granulose.

Description — Spores circular or subcircular, generally folded to give an oval or bean shaped appearance. Monolete well developed, suture extends three-fourth the radius; lip narrow, sometimes bent or bifurcated to give the appearance of a trilete; exine granulose or microverrucose.

Comparison — *Punctatosporites dulcis* closely resembles this species in the nature of sculptural elements; but can be distinguished by the oval to bean shaped equatorial outline and the distribution of grana and microverrucae. *P. minutus* Ibrahim is comparable to this species in the nature of the monolete suture but differs in having closely set granulose ornamentation. *P. curvus* Leschik, is oval in overall shape.

Genus *Thymospora* Wilson & Venkatachala, 1963

Type Species — *Thymospora thiessenii* (Kosanke) Wilson & Venkatachala, 1963.

Thymospora sp.

Pl. 2, Fig. 51

Description — Spores bilateral, monolete, oval in the plane of longitudinal symmetry. 41×27 μ. Exine thick, verrucose, verrucae 2-3 μ long, about 35 verrucae present on the margin. Monolete extends two-third along the longitudinal plane, lip narrow, uniformly broad and slightly elevated.

Anteturma —*Pollenites* Potonié, 1931
Turma —*Saccites* Erdtman, 1947
Subturma —*Monosaccites* (Chitaley) Potonié & Kremp, 1954
Infraturma—*Apertacorpiti* Lele, 1964

Genus *Virkkipollenites* Lele, 1964

Type Species — *Virkkipollenites triangularis* (Mehta) Lele, 1964.

Virkkipollenites sp.

Pl. 3, Fig. 64

Description — Subcircular, 69×59 μ. Central body circular, 32×32 μ, exine thin, finely inframicroreticulate. Saccus comparatively smaller than central body; proximally equatorially, distally subequatorially attached, frilled, coarsely infrareticulate, mesh size 1-3 μ; lumina shallow.

Remarks — Similar pollen have been earlier included under *Nuskoisporites* by Balme (1956), Bharadwaj & Salujha (1964) and others. Lele (1964) in a study from the Lower Gondwana sediments has instituted two genera *Plicatipollenites* and *Virkkipollenites* to accommodate *Nuskoisporites* — like pollen. *Virkkipollenites* appears to be a junior synonym of *Cannanoropollis* Potonié & Sah (1959). The problem needs a careful study before the transfer can be effected.

Infraturma—*Aletisacciti* Leschik, 1956

Genus *Densipollenites* Bharadwaj, 1962

Type Species — *Densipollenites indicus* Bharadwaj, 1962.

Densipollenites indicus Bharadwaj, 1962

Pl. 3, Figs. 65-67

Holotype — Bharadwaj, 1962; Pl. 6, Fig. 103.

Description — Circular, monosaccate, 70-87 μ×78-92 μ. Central body ill-defined, saccus without any fold pattern, broadly infrareticulate, meshes 1-3 μ wide, lumina shallow, often forming vermiculate pattern.

Densipollenites invisus Bharadwaj & Salujha, 1964

Pl. 4, Figs. 68-73

Holotype — Bharadwaj & Salujha, 1964; Pl. 4, Fig. 74.

Description — Circular, usually folded to appear broadly oval, 60-69 μ ×80-115 μ.

Central body exine very thin, occasionally distinct. Monosaccate, exine of saccus thin, folded longitudinally in irregular fashion; coarsely infrareticulate, mesh size 1-3 μ.

Densipollenites minimus sp. nov.

Pl. 4, Figs. 74-77

Holotype — Pl. 4, Fig. 74; Size 57×55 μ. Slide No. 2418/3.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Subcircular to circular, 50-57 μ × 52-50 μ. Central body not discernible. Monosaccate, saccus infrareticulate.

Description — Monosaccate. Central body outline is hardly perceptible and the line of attachment not clearly seen.

Comparison — *Densipollenites minimus* is comparable with certain species of *Florinites* Schopf, Wilson & Bentall and *Wilsonites* (Kosanke) Kosanke. Both these genera are from the Carboniferous of the Northern Hemisphere and they can be distinguished by the nature of distal attachment and presence of trilete respectively. *D. indicus* Bharadwaj and *D. invisus* Bharadwaj & Salujha differ from the present species in having larger size range and presence of folds in the saccus.

Infraturma—*Striasacciti* Bharadwaj, 1962

Genus *Striomosaccites* Bharadwaj, 1962

Type Species — *Striomonosaccites ovatus* Bharadwaj, 1962.

Striomonosaccites ovatus Bharadwaj, 1962

Pl. 5, Figs. 78-80

Holotype — Bharadwaj, 1962; Pl. 7, figs. 107-108.

Description — Subcircular-circular, monosaccate pollen grains. Size range 51-60 μ × 55-70 μ. Central body well defined, horizontally striated; exine upto 2 μ thick, inframicroreticulate. Saccus well developed, coarsely infrareticulate, mesh size 2-3 μ, lumina shallow.

Subturma —*Disaccites* Cookson, 1947
Infraturma—*Podocarpoiditi* Potonié, Thomson & Thiergart, 1950

Genus *Platysaccus* (Naumova) Potonié & Klaus, 1954

Type Species — *Platysaccus papilionis* Potonié & Klaus, 1954.

Platysaccus sp.

Pl. 5, Figs. 81-82

Description — Size range 36-41 μ × 50-78 μ. Central body dense, subcircular, size range 27-27 μ × 32-33 μ, exine thick, microverrucose. Proximal attachment of sacci to central body equatorial, distal attachment straight, closely placed, sulcus narrow, sacci infrareticulate with close meshes.

Remarks — Hart (1964) has placed *Platysaccus* as a synonym of *Pityosporites* (Seward, 1914) Manum (1960) along with *Pinuspollenites* Raatz, *Cuneatisporites* Leschik and *Podocarpidites* Cookson making the genus *Pityosporites* a heterogeneous grouping. This treatment is not acceptable. *Platysaccus* is here considered in the original sense.

Genus *Cuneatisporites* Leschik, 1955

Type Species — *Cuneatisporites radialis* Leschik, 1955.

Remarks — Hart (1964) has suggested the inclusion of *Platysaccus* (Naumova) Potonié & Klaus (1947), *Pinuspollenites* Raatz (1937), *Podocarpidites* Cookson (1947) and *Cuneatisporites* Leschik in *Pityosporites* (Seward) Manum. A critical study of these genera reveal that the organization and sculpture of the central body and saccus attachment in each of these is distinct and sufficient to diagnose them. Hence in the present study they are maintained as separate genera in the original sense. It may, however, be mentioned that both *Pinuspollenites* and *Podocarpidites* occur in younger sediments, while *Cuneatisporites* and *Platysaccus* are mostly found in the Permian-Triassic sediments. *Platysaccus* and *Cuneatisporites* share in common a central body devoid of any haptotypic mark or striations. *Platysaccus* and *Cuneatisporites* can be distinguished by the nature of the central body and distal attachment. In *Platysaccus* the central body is subcircular to circular and the distal attachment is straight. On the other hand *Cuneatisporites* is distinguished by having mostly a vertically oval central body and convex distal attachment

Cnueatisporites sp.

Pl. 5, Figs. 83-84

Description — Only few specimens have been recovered. 32-42 μ × 69-73 μ. Central body vertically oval, size range 30-36 μ × 41

50 μ, exine thin, inframicroreticulate. Proximal attachment of saccus to central body equatorial, distal attachment convex. Saccus hemispherical, coarsely infrareticulate, mesh size upto 4 μ.

Genus *Illinites* (Kosanke) Potonié & Klaus in Potonié & Kremp, 1954

Type Species — *Illinites unicus* Kosanke, 1950.

General Remarks — Potonié and Klaus emended *Illinites* and diagnosed it to include disaccate pollen with well or ill-developed trilete mark and possessing sacci as large or larger than the half of the central body. Leschik (1956) regarded *Illinites* as the link towards the evolution and development of monolete disaccate pollen like *Limitisporites* Leschik, through intermediate stages showing a bilete condition as seen in *Jugasporites* Leschik. Grebe & Schweitzer (1962) included *Limitisporites rectus* Leschik, the type species of the very genus as a junior synonym of *Illinites delasaucei* (Potonié & Klaus) Grebe & Schweitzer along with *Jugasporites delasaucei* Leschik, *J. lectus* Leschik and some species of *Illinites* described by Leschik (1956) thus suggesting *Limitisporites* should be included in *Illinites*.

After a study of variations among the spores of *Ullmannia frumentaria* (Schlotheim) Goeppert, Grebe & Schweitzer (1962) came to the conclusion that the dispersed spore genera *Illinites*, *Limitisporites* and *Jugasporites* are closely similar to the spores of *Ullmannia frumentaria*. Potonié (1962), however, opined that *Lueckisporites virkkiae* resembles with the spores of *U. frumentaria*. *Lueckisporites* is characterized by exo-exinal thickenings on the central body and in the opinion of Grebe and Schweitzer (*l.c.*) this character is not represented in the spores of above mentioned fructification. Klaus (1963) in a recent study has maintained *Illinites*, *Jugasporites* and *Limitisporites* as distinct genera.

Illinites sp.

Pl. 5, Fig. 85

Description — Overall size 55×27 μ, central body circular, 27×27 μ; exine thin, granulose. Monolete extends from one end to other along longer axis bifurcating at the tip. Proximal attachment of sacci to central body equatorial, distal attachment subequatorial, associated with vertical, semilunar fold on each side. Sacci semicircular, infrareticulate, mesh size 1-2 μ; lumina narrow.

Infraturma—*Striatiti* (Pant) Bharadwaj, 1962

Genus *Striatites* (Pant) Bharadwaj, 1962

Type Species — *Striatites sewardii* (Virkki) Pant, 1955.

Remarks — The genus *Striatites* was proposed by Pant in 1954, subsequently he (1955) diagnosed this genus to include all the striated forms and thought it synonymous with *Lueckisporites*.

Bharadwaj (1962) emended this genus to make it a homogenous taxon by accepting the type species from Virkki (1937, Pl. 32, Figs. 1A, 2A). He emended the diagnosis to include striated bisaccate pollen with microverrucose central body and hemispherical sacci.

Striatites and *Lahirites* according to Bharadwaj (*l.c.*) differ only in possessing different structure of the central body, the former possessing microverrucose sculptural elements while the latter having infrapunctate central body. The authors have taken up a study of the Salt Range material from which Virkki (1937) originally described *Striatites* and other saccate genera. This study it is hoped will help to solve several of these nomenclatural problems. For the present the name *Striatites* is used in the emended sense of Bharadwaj (1962).

Hart has combined the following genera under *Protohaploxypinus* (Samolovich) Hart (1964):

Striatopinites Sedova, 1956
Striatopiceites Sedova, 1956
Lueckisporites Potonié & Klaus, 1954 (in parts)
Lunatisporites Leschik, 1956
Protosacculina Malyavkina, 1953 (in parts)
Striatites Pant, 1956
Taeniaesporites Leschik, 1956 (in parts)
Faunipollenites Bharadwaj, 1962
Rhytisaccus Naumova, 1939 (in parts)
Striatocordaites ex Abramova and Marchenko, 1960
Striatoconiferites ex Abramova & Marchenko, 1960
Striatohaploxypinites ex Abramova & Marchenko, 1960
Pemphygaletes Luber and Valts (in parts)
Coniferaletes Andreyeva, 1956 (in parts)

This has made *Protohaploxypinus* a heterogenous group, and this practice is not acceptable to the present authors. Each of these genera has its own individualistic character which is sufficient enough to give it a generic status.

Striatites ornatus sp. nov.

Pl. 5, Figs. 86-90

Holotype — Pl. 5, Fig. 86, 96×41 μ, central body 36×41 μ, sacci 46×55 μ and 41×64 μ. Slide No. 2420/1.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Disaccate, diploxylonoid pollen grains with bilateral symmetry. Overall size range 41-55 μ×64-115 μ. Central body light or dense, well marked, size range 23-44 μ×32-46 μ. Central body vertically oval without any lateral ridge with slight marginal equatorial thickening, horizontal grooves 6-10, distal attachment straight, sulcus uniformly broad.

Description — Broadly oval, often elongated with a distinct central body and two hemispherical sacci. Central body microverrucose, proximally grooved, grooves more or less straight, often branched without any vertical partitions. Proximal attachment of sacci to central body equatorial, distal attachment covers major part of body to form a narrow but well defined sulcus. Sacci coarsely infrareticulate, mesh size 1-3 μ, lumina shallow.

Comparison — *Striatites communis* Bharadwaj & Salujha (1964) shows similarity with this species in having the similar size range, circular to subcircular central body without any lateral ridges and vertical grooves but can easily be distinguished by the presence of biconcave sulcus. *S. lentus* and *S. solitus* Bharadwaj & Salujha (1964) are characterized by circular to horizontally oval central body with lateral ridges.

Striatites alius sp. nov.

Pl. 6, Figs. 91-95

Holotype — Pl. 6, Fig. 91. 46×23 μ, Central body 23×18 μ, sacci 23×27 μ and 23×32 μ. Slide No. 2420/4.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Disaccate, diploxylonoid with bilateral symmetry. Central body comparatively thick, well defined. 23-27 μ×46-60 μ. Central body subcircular, 18-27 μ×18-27 μ. Grooves present only on proximal side; distal attachment convex and diverging on lateral sides.

Description — Broadly oval with distinct central body without any lateral ridge. Exine upto 2 μ thick, microverrucose, 5-10 grooves present proximally; grooves ± straight, rarely branched. Proximal attachment of saccus to body equatorial. Distal attachment covers most part of central body leaving a narrow sulcus. Sacci more than semicircle, infrareticulete, mesh size 1-2 μ, lumina shallow.

Comparison — *Striatites lentus*, *S. solitus*, *S. communis* described by Bharadwaj and Salujha (1964) and *S. ornatus* described here resemble with the present species in lacking vertical striations. *S. alius* is recognizable by small overall size, and convex distal saccus attachment.

Striatites tectus sp. nov.

Pl. 6, Figs. 96-98

Holotype — Pl. 6, Fig. 96. Overall size 64×32 μ, central body 32×32 μ, sacci 32×46 μ and 32×46 μ. Slide No. 2415/8.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Disaccate, diploxylonoid, bilaterally symmetrical pollen grains. Overall size range 27-50 μ×50-69 μ. Central body subcircular to vertically oval; grooves present proximally. Distal attachment juxtaposed leaving a narrow slit-like sulcus.

Description — Broadly oval, sometimes approaching a circular shape. Central body well marked, light or dense, microverrucose. Grooves 6-10, ± parallel; bifurcation rare. Proximal attachment of sacci to central body equatorial, distal attachment covers most of the central body leaving a very narrow slit-like sulcus. Sacci hemispherical, infrareticulate, mesh size 1-2 μ, lumina shallow.

Comparison — *Striatites ornatus* closely resembles with this species in size range and general organization; but differs in the presence of a well defined, uniformly broad sulcus. *S. alius* is smaller in size range and characterized by convex distal attachment. *S. communis* Bharadwaj & Salujha (1964) is having biconvex sulcus. *S. lentus* and *S. solitus* Bharadwaj & Salujha (1964) can be distinguished by the presence of lateral ridges on the central body.

S. tectus can be distinguished by its very narrow sulcus.

Striatites communis Bharadwaj & Salujha, 1964

Pl. 6, Fig. 99

Holotype — Bharadwaj & Salujha, 1964, Pl. 7, Fig. 105.

Description — Diploxylonoid disaccate, overall size range 39-48 μ × 80-100 μ. Central body ± subcircular. Exine thin, microverrucose, lateral ridge ill-developed. 6-10 grooves present proximally. Proximal attachment equatorial; distal attachment ± straight; sulcus narrow. Sacci hemispherical, infrareticulate, often leathery; mesh size 1-3 μ, lumina shallow.

Genus *Verticipollenites* Bharadwaj, 1962

Type Species — *Verticipollenites secretus* Bharadwaj, 1962.

Remarks — *Verticipollenites* distinguishes from *Lahirites* and *Striatites* in possessing distinct pitcher shaped sacci and a very narrow bladder-free sulcus area on the central body.

Verticipollenites debilis sp, nov.

Pl. 6, Figs. 100-103

Holotype — Pl. 6, Fig. 100. Overall size 78 × 32 μ, central body 32 × 32 μ, sacci 32 × 46 μ and 36 × 46 μ. Slide No. 2421/2.

Tvpe Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Diploxylonoid, bilateral, disaccate pollen grains. 23-32 μ × 50-78 μ. Central body subcircular, minutely microverrucose, proximally horizontally grooved; sacci pitcher shaped infrareticulate, attached distally leaving a very narrow sulcus area.

Description — Central body distinctly circular or broadly oval; grooved; grooves 4-10 in number, rarely branched. Proximal attachment of sacci to central body equatorial, distal attachment close, exposing only a fourth or less part of the central body. Sacci hemispherical, pitcher shaped, sometimes closely infrareticulate.

Comparison — *Verticipollenites gibbosus* Bharadwaj & Salujha (1964) also lacks vertical partitions; but can be differentiated by the presence of a thick ridged central body. *V. simplex* Bharadwaj & Salujha (1964) is larger with an overall size range of 79-120 μ and central body possessing lateral, marginal ridges.

Genus *Lahirites* Bharadwaj, 1962

Type Species — *Lahirites raniganiensis* Bharadwaj, 1962.

Remarks — Bharadwaj (1962) instituted the genus *Lahirites* to accommodate striated (grooved) bisaccate pollen grains with microverrucose or laevigate sculpture and intrapunctate structure from the Raniganj Stage (Upper Permian) of India. This genus strongly resembles with *Hindipollenites* Bharadwaj (1962) in structure and sculpture but differs in possessing straight to convex saccus attachment. In *Hindipollenites* the pitcher-shaped sacci are conspicuous. *Lahirites* and *Striatites* share many of the characters in common. According to Bharadwaj (1962) *Striatites* differs from *Lahirites* " in lacking any obvious structure in the exine of the central body. . ."

A good number of specimens of *Striatites* — *Lahirites* group have been studied from the Karanpura sediments. Intermediate forms being common, it is not easy to differentiate them.

Lahirites alutas sp. nov.

Pl. 6, Figs. 104-107

Holotype — Pl. 6, Fig. 104. Overall size 75 × 41 μ, central body 41 × 36 μ, sacci 41 × 41 μ and 32 × 50 μ. Slide No. 2422/5.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Diploxylonoid, bisaccate; 32-41 μ × 69-92 μ. Central body distinct, vertically oval to subcircular, proximally grooved; sparsely and feebly infrapunctate, sacci leathery with dense, closely spaced infrastructure.

Description — Broadly oval with a distinct central body. Central body laevigate to sparsely infrapunctate, grooves 6-10, ± parallel. Attachment of sacci to central body proximally equatorial, distal attachment ± straight, sulcus narrow, uniformly broad. Sacci hemispherical, mesh close and indistinct.

Comparison — *Lahirites rarus* Bharadwaj & Salujha (1964) shows similarity with the present species in possessing only horizontal grooves and uniformly broad sulcus; but can be differentiated by bigger overall size range and uniformly infrapunctate central body. *L. parvus* Bharadwaj & Salujha (1964) has coarsely infrapunctate central body with well developed marginal ridges.

Lahirites angustus sp. nov.

Pl. 6, Figs. 107-112

Holotype — Pl. 6, Fig. 108. Overall size 64×32 μ, central body 32×23 μ, sacci 27×42 μ and 32×36 μ. Slide No. 2415/5.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Diploxylonoid, bisaccate, bilaterally symmetrical, overall size range 32-41 μ×64-105 μ. Central body vertically oval, proximally grooved, ± unifromly infrapunctate. Distal attachment very closely placed leaving a fine line of sacci free-body-area.

Description — Central body distinct without any lateral ridges; grooves 6-12 in number, ± parallel to each other, often branched. Proximal attachment of sacci equatorial; distal attachments cover central body except a narrow strip almost in the form of a vertical line. Sacci ± spherical; coarsely infrareticulate, mesh size 1-3 μ, lumina ± deep.

Comparison — *Lahirites alutas* can be distinguished from the species described here by its uniformly broad sulcus and sparesely infrapunctate central body. *L. parvus* Bharadwaj & Salujha possesses central body with marginal ridge and coarsely infrapunctate exine. *L. rarus* Bharadwaj & Salujha is larger in size, i.e. 82-120 μ and has a uniform sulcus.

Lahirites minutus sp. nov.

Pl. 7, Figs. 113-117

Holotype — Pl. 7, Fig. 113. Overall size 46×20 μ, central body 18×18 μ, sacci 23×27 μ and 23×26 μ. Slide No. 2414/1.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Diploxylonoid, bisaccate, 20-23 μ×46-59 μ. Central body circular, 18-23 μ×18-23 μ. Proximally grooved, weakly infrapunctate.

Description — Central body almost half the size of the sacci without any lateral ridge. Grooves 6-10 in number, occasionally ill-developed, rarely bifurcating. Proximal attachment equatorial, distal attachment straight, juxtaposed leaving a narrow sulcus. Sacci circular, infrareticulate, mesh size 1-2 μ, lumina shallow.

Comparison — This species closely resembles *Lahirites angustus* in possessing very close distal attachment and horizontally grooved central body; but can be differentiated by its smaller size and circular central body. *L. alutas* and *L. parvus* are larger in size.

Lahirites rarus Bharadwaj & Salujha, 1964

Pl. 7, Figs. 118-120

Holotype — Bharadwaj & Salujha, 1964; Pl. 9, Fig. 128.

Description — Diploxylonoid, disaccate with bilateral symmetry. Overall size range 32-50 μ×64-87 μ. Central body uniformly infrapunctate. Proximal grooves 5-10, rarely branched. Proximal attachment equatorial, distal attachment ± straight, sulcus uniformly broad. Sacci more than hemisphere, infrareticulate, mesh size 1-2 μ, lumina shallow.

Lahirites parvus Bharadwaj & Salujha, 1964

Pl. 7, Figs. 121-122

Holotype — Bharadwaj & Salujha, 1964; Pl. 9, Fig. 131.

Description — Diploxylonoid, disaccate. Overall size range 27-32 μ×69-82 μ. Central body dense, vertically oval with marginal ridge; size range 23-25 μ×27-32 μ; sparsely infrapunctate. Grooves on proximal side 5-10, ± parallel, rarely branched. Proximal attachment equatorial, distal attachment straight; sulcus narrow. Sacci more than hemisphere, infrareticulate, mesh size 1-2 μ, lumina shallow.

Genus *Hindipollenites* Bharadwaj, 1962

Type Species — *Hindipollenites indicus* Bharadwaj, 1962.

Remarks — Bharadwaj (1962) differentiates *Hindipollenites* and *Verticipollenites* on the basis of differential structure of the exine on the central body; *Hindipollenites* is infrapunctate with microverrucose ornamentation and *Verticipollenites* is without any infrastructure.

Though only a limited number of specimens have been studied here, it is apparent that occurrence of intermediate conditions makes it difficult to distinguish these genera.

Hindipollenites formosus sp. nov.

Pl. 7, Figs. 123-127

Holotype — Pl. 7, Fig. 123. Overall size 92×32 μ, central body 32×27 μ, sacci 46×59 and 46×64 μ. Slide No. 2421/4.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Diploxylonoid, bilateral, bisaccate pollen grains. 18-36 μ× 50-95 μ. Central body subcircular to vertically oval, uniformly infrapunctate, horizontal grooves present proximally. Distal attachment juxtaposed. Sacci pitcher shaped; infrareticulate.

Description — Central body well defined, devoid of lateral ridges. Grooves 5-12 in number, often branched, ± parallel to each other. Proximal attachment of sacci to central body equatorial, distal attachment close to each other covering most of the central body area leaving a narrow bladder free sulcus. Sacci ± circular, radial folds sometimes present, infrareticulate, mesh size 1-3 μ, lumina shallow.

Comparison — *Hindipollenites indicus* Bharadwaj (1962) and *H. oblongus* Bharadwaj & Salujha (1964) differ from the present species in possessing horizontal as well as vertical grooves and is larger in size.

Strotersporites Wilson, 1962

Type Species — *Strotersporites communis* Wilson, 1962.

Remarks — See Venkatachala & Kar, 1964a.

Strotersporites sp.

Pl. 7, Figs. 128-130

Description — Diploxylonoid, bisaccate, bilateral pollen grains. Size range 46-69 μ× 82-124 μ. Central body well defined, vertically oval, size range 45-50 μ×59-69 μ, inframicroreticulate, 6-10 horizontal striations present proximally. Proximal attachment of sacci to central body equatorial, distal attachment straight to slightly convex. Sacci hemispherical, mesh size 2-3 μ, lumina shallow.

Genus *Striatopiceites* (Zoricheva & Sedova, 1954), Sedova, 1956

Type Species — *Striatopiceites suchonensis* Sedova, 1956.

Remarks — Zoricheva and Sedova (1954) proposed the name *Striatopiceites* without proper generic diagnosis or description. They also did not designate any type species. Sedova (1956), however, validated this genus and included the haploxylonoid disaccate pollen grains with horizontal striations and finely reticulate (? inframicroreticulate) central body. She did not mention the nature of the central body. The text-figure illustrated by her and the photograph published by Hart (1956) point out that the central body has an ill-defined outline. Potonié (1958) rejected this name as invalid taking into account only the publication of Zoricheva and Sedova (1954). He perhaps did not have access to Sedova's (1956) paper. Bharadwaj (1962) instituted *Faunipollenites* to include bisaccate, bilateral, haploxylonoid pollen grains with ill-defined, inframicroreticulate central body having a number of horizontal striations with a distal biconvex sulcus area. *Faunipollenites* Bharadwaj (1962) is considered here as a junior synonym of *Striatopiceites* (Zoricheva & Sedova) Sedova, 1956.

Hart (1964) emended *Protohaploxypinus* Samoilovich (1952) and included *Striatopiceites* along with *Striatopinites* Sedova, *Lueckisporites* Potonié & Klaus (in parts), *Lunatisporites* Leschik, *Striatites* Pant, *Taeniaesporites* Leschik (in parts), *Faunipollenites* Bharadwaj and other genera in it. *Protohaploxypinus* in the sense defined by Hart (*l.c.*) is not acceptable to the present authors.

Striatopiceites minutus sp. nov.

Pl. 8, Figs. 135-138

Holotype — Pl. 8, Fig. 135. Overall size 92×41 μ, sacci 36×41 and 36×50 μ. Slide No. 2414/5.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Haploxylonoid, bisaccate, bilateral pollen grains. Size range 32-46 μ×70-92 μ. Central body ill-defined, infrareticulate, sacci hemispherical.

Comparison — *Striatopiceites minutus* is distinguished from *Faunipollenites varius* Bharadwaj in its smaller size range and less number of horizontal striations on the central body.

Genus *Schizopollis* Venkatachala & Kar, 1964b

Type Species — *Schizopollis wodehousei* Venkatachala & Kar, 1964b.

Schizopollis wodehousei Venkatachala & Kar, 1964b

Pl. 8, Figs. 144-146

Holotype — Venkatachala & Kar, 1964b; Pl. 1, Fig. 1 and Pl. 8, Fig. 144. Overall size 50×42 μ, central body 36×36 μ. Slide No. 2424/4.

For diagnosis and description — See Venkatachala & Kar, 1964b.

Schizopollis extremus Venkatachala & Kar, 1964b

Pl. 9, Figs. 151, 153-157

Holotype — Venkatachala & Kar, 1964; Pl. 2, Fig. 11 and Pl. 9, Fig. 154. Overall size 55×38 μ. Central body 36×32 μ. Slide No. 2415/7.

For diagnosis and description — See Venkatachala & Kar, 1964b.

Genus *Hamiapollenites* Wilson, 1962

Type Species — *Hamiapollenites saccatus* Wilson, 1962.

Hamiapollenites sp.

Pl. 8, Fig. 140

Description — Bilateral, bisaccate pollen grain measuring 82×50 μ; central body vertically oval, size 50×46 μ; 8 horizontal striations and 3 vertical striations present; exine thin, inframicroreticulate. Proximal attachment of sacci to central body equatorial; distal attachment subequatorial. Sacci small, half the size of the pollen body, infrareticulate, mesh size 1-2 μ.

Genus *Korbapollenites* Tiwari, 1964

Type Species — *Korbapollenites novus* Tiwari, 1964.

Korbapollenites novus Tiwari, 1964

Pl. 9, Figs. 164, 165

Holotype — Tiwari, 1964; Pl. 1, Figs. 7 & 8.

Description — Bisaccate, bilateral, pollen grains, 32-42 μ×69-73 μ. Central body dense, vertically oval, 27-36 μ×32-42 μ, uniformly infrapunctate, 6-10 horizontal grooves forming reticuloid pattern on proximal side. Proximal attachment equatorial, distal attachment straight, closely placed, sacci hemispherical, infrareticulate, mesh size 1-2 μ.

Remarks — *Korbapollenites* Tiwari (1964) closely resembles *Rhizomaspora* Wilson (1962). The central body in *Rhizomaspora* is ornamented with radiating or diverging ribs which may be smooth or minutely pitted. In *Korbapollenites* also the grooves are present only on the proximal surface and the central body is infrapunctate. Wilson (*l.c.*), however, did not mention about reticuloid pattern on the central body, it appears from the photograph given by Wilson (1962, Pl. 2, Figs. 5-7) that they also possess reticuloid pattern.

Genus *Rhizomaspora* Wilson, 1962

Type Species — *Rhizomaspora radiata* Wilson, 1962.

Rhizomaspora sp.

Pl. 9, Figs. 166-167

Description — Bisaccate, bilateral, diploxylonoid pollen grains. Central body subcircular to verically oval, ornamented proximally with radiating or diverging grooves; exine of central body upto 2 μ thick, laevigate and intrapunctate. Proximal attachment of sacci to central body equatorial, distal attachment juxtaposed. Sacci hemispherical, intrareticulate, mesh size 2-3 μ, lumina shallow.

Vittatina (Luber) Wilson, 1962

Type Species — *Vittatina subsaccata* Samoilovich, 1953.

General Remarks — The genus *Vittatina* was proposed by Luber (1941) to include striate Permian pollen grains with or without incipient sacci. Samoilovich (1953) extended and elaborated this genus and also instituted a new species, *Vittatina subsaccata*. The presence of horizontal ribs and vertical foldings perpendicular to them led Potonié to include this genus within *Polyplicates* along with genera like *Gnetaceaepollenites* and *Ephedripites*. *Vittatina* — like pollen grains have also been reported from the Lower Gondwana succession by Balme and Hennelly (1956a), Hart (1960) and Bharadwaj (1962). Balme and Hennelly (*l.c.*), however, included all the striated forms with or without a trilete in the genus *Marsupipollenites* Balme and Hennelly.

Bharadwaj (1962) restricted *Marsupipollenites* for trilete forms and transferred the rest to *Vittatina*, considering *Vittatina* as monocolpate with striations on both the surfaces.

Zauer (1960) extensively studied the *Vittatina* group of pollen from Solikamsk basin (Late Permian) and agreed with Luber (1941) that *Vittatina* is indicative of physiological xerophytic conditions of deposition. Like other striated disaccate pollen it is well represented in the Permian and extends upto the Lower Triassic (ROMANOVAKAJA, 1959).

Zauer (1960) assumed that *Vittatina* type of pollen grains were shed by some herbaceous seed ferns and probably for this reason she emphasized on the " Harmomegate " (presence of a single ray-aperture on the proximal side) function of *Vittatina* with well drawn test-figures and its subsequent development in others striated bisaccate genera. In her opinion the aperture in *Vittatina* is short, mono-radial and forms a minute channel between two ribs. The exine on the proximal surface is costate while the same may be distally smooth, granulose or costate. The unstability of sculptural elements is attributed by Zauer (*l.c.*) to the perisporal nature of the sexine in *Vittatina*. Mention should, however, be made here that Samoilovich (1953) did not emphasise these characters and the text-figures given by her also do not reveal the monoradial slit on which Zauer laid much emphasis.

Vittatina and allied pollen, have been classed differently by different Palynologists. Jansonius (1962) and Wilson (1962) emended *Vittatina* designating *Vittatina subasaccata* Samoilovich (1953) as the type species. Hart (1963) instituted a new genus *Striatoluberae* using the same type species. He, however, transferred it back to *Vittatina*.

Jansonius (1962) assumed that exine in *Vittatina* consists of a thin intexine and an infrapunctate exoexine which is generally reduced or absent on distal surface. In the opinion of Zauer (1960) it is composed of nexine and sexine with generally a distinct columnar layer in it providing the characteristic reticulate structure of the ribs. The hypothetical relation postulated by Jansonius (*l.c.*) between *Vittatina* and Welwitschiaceae seems to be more apparent than real. This has already been pointed out by Zauer (*l.c.*) that a comparison of the exine structure between the two groups shows practically nothing in common because the *Welwitschia* pollen is devoid of the columnar layer. She, however, opines that *Vittatina* shows similarity with the pollen grains of *Ephedra antisiphilitica* (ERDTMAN, 1957) as both of them possess more or less same exine structure.

Wilson (1962) restricted the genus *Vittatina* for the forms without sacci and thought that the germinal structure is on the distal side in between the two ribs. Zauer (1960) considered the germinal aperture proximal and attributed *Vittatina* to seed ferns or true ferns.

Vittatina lata Wilson, 1962

Pl. 8, Figs. 141-143

Holotype — Wilson, 1962; Pl. 3, Fig. 11.

Description — Oval, 30-35 $\mu \times$ 40-46 μ. Exine thin, occasionally folded, perpendicular to longer axis, infrastructured, horizontal striations 8-12.

Infraturma — *Disacciatrileti* (Leschik) Potonié

Genus *Sulcatisporites* (Leschik) Bharadwaj, 1962

Type Species — *Sulcatisporites interpositus* Leschik, 1955.

Sulcatisporites sp.

Pl. 9, Figs. 169-174

Description — Haploxylonoid, circular to oval in shape, 50-55 $\mu \times$ 50-73 μ. Central body not well defined, exine thin, inframicroreticulate. Proximal attachment equatorial; distal attachment closely placed leaving a narrow funnel shaped sulcus, sacci semicircular, infrareticulate, mesh size 1-2 μ, lumina shallow.

Genus *Vesicaspora* (Schemel) Wilson & Venkatachala, 1953

Type Species — *Vesicaspora wilsonii* Schemel, 1951.

? *Vesicaspora* sp.

Pl. 9, Fig. 168

Description — Bilateral, oval pollen grain in polar view. Central body subcircular, laevigate to finely granulose. Saccus oval, infrareticulate, mesh size 1-2 μ, lumina shallow.

Turma — *Polyplicates* Erdtman, 1952

Genus *Gnetaceaepollenites* Thicrgart, 1938

Type Species — *Gnetaceaepollenites ellipticus* Thiergart, 1938.

Gnetaceaepollenites sinuous (Balme & Hennelly) Bharadwaj, 1962

Synonym — *Marsupipollenites sinuous* Balme and Hennelly, 1956b. Pl. 10, Fig. 177.

Holotype — Balme & Hennelly, 1956b, Pl. 2, Fig. 251.

Description — Elliptical, 32-50 μ × 64-78 μ. Two longitudinal folds run closely parallel to each other with tapering ends. Exine about 2 μ thick; almost laevigate with faint longitudinal striations.

Gnetaceaepollenites punctatus sp. nov.

Pl. 10, Figs. 178-182

Holotype — Pl. 10, Fig. 178. Size 73 × 36 μ. Slide No. 2434/7.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Elliptical, two longitudinal folds run closely parallel to each other; exine infrapunctate.

Description — Size range 36-41 μ × 73-78 μ; longitudinal folds almost extend end to end, tapering at ends. Exine about 2 μ thick; infrapunctate, puncta evenly spaced.

Comparison — *Gnetaceaepollenites punctatus* differs from *G. sinuous* in having infrapunctate structure of the exine.

Genus *Ephedripites* Bolchowitina, 1953

Type Species — *Ephedripites mediolobatus* Bolchowitina, 1953.

Ephedripites sp.

Pl. 10, Figs. 183-184

Description — Oval-elliptical. Size range 30-55 μ. Exine about 2 μ thick; exo-exinous layer sometimes preserved. Furrow 3-5 in number; followed by ridges.

Turma — *Monocolpates* Iversen & Troels-Smith, 1950
Subturma — *Intortes* (Naumova) Potonié, 1958

Genus *Ginkgocycadophytus* Samoilovich, 1953

Synonym — *Entylissa* Naumova, 1937.

Type Species — *Ginkgocycadophytus caperatus* (Luber) Somoilovich, 1953).

Ginkgocycadophytus cymbatus (Balme & Hennelly, 1956a) Potonié & Lele, 1959

Pl. 10, Figs. 175-176

Holotype — (Lectotype designated by Potonié & Lele, 1959) Balme & Hennelly 1956a; Pl. 3, Fig. 55.

Description — Pollen grains elliptical, 32-41 μ × 46-69 μ, exine upto 2 μ thick, infragranulose. Colpus extending through the whole length of the pollen, funnel shaped.

Subturma — *Monoptyches* (Naumova) Potonié, 1958

Genus *Decusstisporites* Leschik, 1955

Type Species — *Decussatisporites delineatus* Leschik, 1955.

Decussatisporites pilus sp. nov.

Pl. 10, Figs. 185-187

Holotype — Pl. 10, Fig. 185. Size 73 × 46 μ. Slide No. 2435/4.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Spindle shaped, colpus extending from one end to other; constricted in middle, horizontal striations outnumber vertical striations.

Description — Overall size range 38-48 μ × 68-75 μ, exine less than 2 μ thick, infrastructured; horizontal striations 8-15 and vertical striations 3-6. Colpus often overlapping in the middle and open only at ends.

Comparison — *Decussatisporites delineatus* is smaller in size with a uniformly broad colpus.

Decussatisporites dubius sp. nov.

Pl. 10, Figs 189-190

Holotype — Pl. 10, Fig. 189. Size 55 × 50 μ. Slide No. 2428/2.

Type Locality — Badam, North Karanpura basin, Bihar; Barakar Stage (Permian).

Specific Diagnosis — Subcircular to oval; exine thick; colpus extending from one end to other, unequally broad.

Description — Size range 41-56 × 46-73 μ. Exine 1·5-2·5 μ, thick, infrastructure indistinct. Horizontal striations 10-13, vertical striations 2-5. Colpus distinct with flappy lips.

Comparison — *Decussatisporites pilus* differs from the present species in having spindle shape and constricted colpus. *D. delineatus* is also spindle shaped and the colpus in mostly closed.

Incertae Sedis

***Guttulapollenites* (Goubin, 1965) Venkatachala, Goubin & Kar, 1967**

Type Species — *Guttulapollenites hannonicus* (GOUBIN, 1965) Venk, Goubin & Kar, 1967

Emmended Diagnosis — *see* Venk. *et al.* 1967.

Guttulapollenites hannonicus Venk, Goubin & Kar, 1967

Pl. 10, Figs. 191-199

Holotype — Goubin, 1965; Pl. 6, Figs. 5 & 6.

For diagnosis and description — *see* Venk. *et al.* 1967.

PALYNOLOGICAL COMPOSITION

The North Karanpura basin represents a continuous deposition of the Damuda Series.

The sedimentary rocks of the Barakar Stage at Badam are exposed in four outcrops adjacent to each other, comprising a total height of 203′9″. To study the comparative vegetational history of this sedimentary deposition, samples were collected from each lithological unit and macerated. The spores and pollen grains from each yielding sample were counted upto 200, noting the different genera to which they belong. When the material was very rich so as to contain more than 200 spores per slide, only one hundred specimens were counted at random and the rest were counted at slide margins to get a uniform representation of the whole assemblage. To ensure efficiency, check counts were taken from different slides, it is noted that there has been a variation upto 5 per cent in the percentages.

Exposure No. 1 — Eleven samples (F_2K-F_2A) were collected at close intervals (vide (TEXT-FIG. 1). Six samples yielded spores and pollen grains. The trilete group of spores is dominant in this section. Spores of the Infraturma (*Apiculati* and Subinfraturma *Varitrileti* are the most abundant. Monosaccate, polyplicate and colpate pollen grains are rare. Striated bisaccate genera are present throughout the assemblage as subdominant group.

Lophotriletes and *Apiculatisporis* are dominant and represent 17·5 and 13·5 per cent respectively. *Microbaculispora*, *Didecitriletes*, *Lacinitriletes* and *Altitriletes* are subdominant in the assemblage. *Leiotriletes*, *Laevigatosporites* *Punctatosporites*, *Platysaccus*, *Verticipollenites*, *Schizopollis*, *Sulcatisporites*, *Ginkgocycadophytus*, *Gnetaceaepollenites*, *Decussatisporites* and *Guttulapollenites* are present in less than 2 per cent in the material.

Sample F_2H is populated by 29 genera. Among them trilete spore are in overwhelming majority and represents 80 per cent of the whole assemblage. *Microbaculispora*, *Didecitriletes*, *Lacinitrilets* and *Altitriletes* are dominant. *Lophotriletes* and *Apiculatisporis* are subdominant. *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Laevigatosporites*, *Punctatosporites*, *Platysaccus*, *Cuneatisporites*, *Verticipollenites*, *Hindipollenites*, *Strotersporites*, *Striatopiceites*, *Rhizomaspora*, *Sulcatisporites*, *Ginkgocycadophytus*, *Ephedripites*, *Decussatisporites*, *Guttulapollenites* respresenting less than 2 per cent individually. *Dictyotriletes*, *Thymospora*, *Virkkipollenites*, *Parasaccites*, *Striomonosaccites*, *Densipollenites*, *Korbapollenites*, *Hamiapollenites*, *Vittatina*, *Vesicaspora*, *Gnetaceaepollenites* are not met within the counting of 200 specimens.

The sample F_2F is populated by 29 genera. Trilete spores are very rich in the assemblage. *Didecitriletes* is the dominant genus in this preparation. *Apiculatisporis*, *Lophotriletes*, *Laevigatosporites*, *Strotersporites* and *Schizopollis* are subdominant. *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Thymospora*, *Platysaccus*, *Cuneatisporites*, *Verticipollenites*, *Rhizomaspora*, *Ginkgocycadophytus*, *Decussatisporites*, and *Guttulapollenites* are present (individually less than 2 per cent). *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Parasaccites*, *Striomonosaccites*, *Densipollenites*, *Illinites*, *Vittatina*, *Korbapollenites*, *Hamiapollenites*, *Vesicaspora*, *Gnetaceaepollenites* and *Ephedripites* are absent within 200 specimens.

Sample F_2E contains 26 genera. Trilete genera are well represented. *Altitriletes*, *Lacinitriletes*, *Didecitriletes*, and *Microbaculispora* are dominant. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Laevigato-*

sporites, *Punctatosporites*, *Playsaccus*, *Verticipollenites*, *Hindipollenites*, *Rhizomaspora*, *Vittatina*, *Ginkgocycadophytus* and *Guttulapollenites* each present in less than 2 per cent in the assemblage. *Leschikisporis*, *Dictyotriletes*, *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Densipollenites*, *Vittatina*, *Korbapollenites*, *Hamiapollenites*, *Gnetaceaepollenites*, *Ephedripites*, *Decussatisporites* and *Guttulapollenites* are absent within 200 specimens.

F_2D sample is represented by 26 genera. Trilete genera are most abundant and contributing 62 per cent to the whole assemblage. *Lacinitriletes*, *Didecitriletes*, *Microbaculispora* and *Altitriletes* are dominant in the assemblage. *Anapiculatisporites*, *Neoraistrickia*, *Laevigatosporites*, *Punctatosporites*, *Illinites*, *Verticipollenites*, *Hindipollenites*, *Rhizomaspora*, *Ginkgocycadophytus*, *Ephedripites*, *Decussatisporites* represent less than 2 per cent individually. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Dictyotriletes*, *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Parasaccites*, *Striomonosaccites*, *Densipollenites*, *Korbapollenites*, *Hamiapollenites*, *Vittatina*, *Vesicaspora* and *Gnetaceaepollenites* are not met within 200 specimens.

F_2C is populated by 22 genera. *Lacinitriletes*, *Didecitriletes*, *Altitriletes* and *Microbaculispora* are dominant. *Schizopollis*, *Strotersporites*, *Striatopiceites* and *Striatites* are also present in good percentage. *Apiculatisporis*, *Laevigatosporites*, *Punctatosporites*, *Platysaccus*, *Cuneatisporites*, *Verticipollenites*, *Hindipollenites*, *Rhizomaspora*, *Ginkgocycadophytus* and *Decussatisporites* present each in less than 2 per cent in the assemplage. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Anapiculatisporites*, *Neoraistrickia*, *Dictyotriletes*, *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Densipollenites*, *Illinites*, *Korbapollenites*, *Hamiapollenites*, *Vittatina*, *Vesicaspora*, *Sulcatisporites*, *Gnetaceaepollenites*, *Ephedripites* are absent within the counted 200 specimens.

Exposure No. 2—Exposure No. 2 is sampled along vertical thickness of 79′3″. Sixteen samples were collected from the shale and coal of this section and ten samples yielded spores and pollen grains. The trilete genera are dominant and along them the group *Apiculati* is abundant in all the samples except three (F_1X, F_1W and F_1V). Monosaccate pollen are very poorly represented. Bisaccate pollen are present in all the samples and dominant in the upper parts (F_1L, F_1K) of the section. Polyplicate and colpate pollen grains are fairly represented in most of the samples.

The Carbonaceous shale sample (F_1X) is the lower most sample and is populated by 22 genera. *Lacinitriletes*, *Didecitriletes*, *Microbaculispora* and *Altitriletes* are subdominant in the assemblage. *Leiotriletes*, *Verticipollenites*, *Lahirites*, *Strotersporites*, *Striatopiceites*, *Schizopollis*, *Sulcatisporites*, *Ginkgocycadophytus* and *Decussatisporites* are represented with less than 2 per cent each. *Verrucosisporites*, *Leschikisporis*, *Dictyosporites*, *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Densipollenites*, *Platysaccus*, *Cuneatisporites*, *Illinites*, *Hindipollenites*, *Rhizomaspora*, *Vittatina*, *Hamiapollenites*, *Korbapollenites*, *Vesicaspora*, *Gnetaceaepollenites* and *Ephedripites* are absent within 200 specimens.

The sample F_1W represents coal and is overlain by a coaly shale. There are 23 genera. Trilete spores are in great abundance and contribute 77 per cent of the whole assemblage. *Lacinitriletes* is the most dominant contributing 21 per cent of the assemblage. *Altitriletes*, *Didecitriletes* and *Microbaculispora* are also quite dominant. *Anapiculatisporites*, *Neoraistrickia*, *Thymospora*, *Striatites*, *Verticipollenites*, *Hindipollenites*, *Ginkgocycadophytus*, *Gnetaceaepollenites* and *Guttulapollenites* each represents less than 2 per cent in the assemblage. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Densipollenites*, *Platysaccus*, *Cuneatisporites*, *Illinites*, *Rhizomaspora*, *Korbapollenites*, *Hamiapollenites*, *Vesicaspora*, *Ephedripites* and *Decussatisporites* are absent within 200 specimens.

The sample F_1V is a coaly shale and is overlain by 10 feet coal. There are 24 genera and the total percentage of the trilete is very high. *Lacinitriletes*, *Microbaculispora*, *Didecitriletes* and *Altitriletes* are dominant. *Leschikisporis*, *Thymospora*, *Verticipollenites*, *Lahirites*, *Schizopollis*, *Vittatina*, *Sulcatisporites*, *Ginkgocycadophytus*, *Gnetaceaepollenites*, *Ephedripites*, *Decussatisporites* and *Guttulapollenites* are each less than 2 per cent in the population. *Leiotriletes*, *Retusotriletes*, *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Densipollenites*, *Platysaccus*, *Cuneatisporites*, *Illinites*, *Rhizomaspora*, *Hamiapollenites* and *Vesicaspora* are not found within 200 specimens.

The sample F_1Q has trilete spores in great majority. The assemblage is represented by 30 genera. *Lophotriletes* and *Apiculatisporis* are dominant. *Verrucosisporites*, *Leiotriletes* and *Microbaculispora* are also well represented in the assemblage. *Thymospora*, *Densipollenites*, *Cuneatisporites*, *Verticipollenites*, *Striatopiceites*, *Schizopollis*, *Sulcatisporites*, *Ephedripites*, *Decussatisporites* and *Guttulapollenites* are less than 2 per cent in the assemblage individually. *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Platysaccus*, *Illinites*, *Hindipollenites*, *Rhizomaspora*, *Hamiapollenites*, *Korbapollenites* and *Vesicaspora* are not present among 200 counted specimens.

The sample F_1P has trilete spore upto 61·5 per cent of the total assemblage. *Lophotriletes* and *Apiculatisporis* are dominant. *Verrucosisporites*, *Anapiculatisporites* and *Laevigatosporites* are subdominant. *Leiotriletes*, *Altitriletes*, *Thymospora*, *Densipollenites*, *Verticipollenites*, *Lahirites*, *Schizopollis*, *Sulcatisporites*, *Gnetaceaepollenites* and *Guttulapollenites* are less than 2 per cent individually. *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Platysaccus*, *Cuneatisporites*, *Illinites*, *Hindipollenites*, *Korbapollenites*, *Rhizomaspora*, *Hamiapollenites* and *Vesicaspora* are not found within 200 specimens.

The sample F_1O shows an overwhelming majority of the trilete spores. In all there are 30 genera. *Lophotriletes* and *Apiculatisporis* are dominant contributing 16 and 14 per cent respectively. *Anapiculatisporites*, *Microbaculispora*, *Laevigatosporites* and *Striatites* are also common in the assemblage. *Densipollenites*, *Verticipollenites*, *Hindipollenites*, *Schizopollis*, *Sulcatisporites*, *Gnetaceaepollenites* and *Decussatisporites* contribute less than 2 per cent individually. *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Striomonosaccites*, *Platysaccus*, *Cuneatisporites*, *Illinites*, *Korbapollenites*, *Rhizomaspora*, *Hamiapollenites* and *Vesicaspora* are not found within 200 specimens.

The sample F_1N has 34 genera. Trilete ones contribute 46 per cent of the total assemblage. *Lophotriletes* and *Apiculatisporis* are dominant and contributing 19 and 11 per cent respectively. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Lacinitriletes*, *Altitriletes*, *Tymospora*, *Striomonosaccites*, *Densipollenites*, *Platysaccus*, *Cuneatisporites*, *Verticipollenites*, *Hindipollenites*, *Schizopollis*, *Rhizomaspora* are present less than 2 per cent in the assemblage individually. *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Illinites*, *Korbapollenites*, *Hamiapollenites*, *Vesicaspora* are not present within 200 specimens that have been counted.

The carbonaceous shale designated F_1M is overlain by 4′ massive, red-coloured sandstone. 33 genera are recovered from the sample. Trilete spores contribute 53·5 per cent to the assemblage. *Lophotriletes* and *Apiculatisporis* are dominant. *Leiotriletes*, *Lacinitriletes* and *Striatites* are also quite common. *Retusotriletes*, *Verrucosisporites*, *Altitriletes*, *Thymospora*, *Striomonosaccites*, *Densipollenites*, *Platysaccus*, *Cuneatisporites*, *Verticipollenites*, *Hindipollenites*, *Strotersporites*, *Schizopollis* and *Sulcatisporites* are present less than 2 per cent individually in the assemblage. *Virkkipollenites*, *Plicatipollenites*, *Illinites*, *Korbapollenites*, *Rhizomaspora*, *Hamiapollenites* and *Vesicaspora* are not met within 200 specimens.

The sample F_1L contains trilete, monolete, bisaccate and colpate spores and pollen classed into 38 genera, bisaccate pollen contributing 50 per cent to the assemblage. *Schizopollis*, *Striatites*, *Strotersporites* and *Striatopiceites* are dominant. *Lophotriletes*, *Laevigatosporites*, *Verticipollenites* and *Hindipollenites* are subdominant. *Verrucosisporites*, *Leschikisporis*, *Microbaculispora*, *Didecitriletes*, *Lacinitriletes*, *Altitriletes* *Striomonosaccites*, *Densipollenites*, *Platysaccus*, *Cuneatisporites*, *Illinites*, *Korbapollenites*, *Hamiapollenites*, *Vesicaspora*, *Sulcatisporites* and *Ginkgocycadophytus* are less than 2 per cent individually. *Dictyotriletes*, *Virkkipollenites* and *Plicatipollenites* are absent among 200 specimens counted.

The sample F_1K is populated by 34 genera. Bisaccate pollen contribute 59·5 per cent to the assemblage. *Striatites* and *Lahirites* are dominant. *Apiculatisporis*, *Laevigatosporites*, *Verticipollenites* and *Strotersporites* are subdominant. *Retusotriletes*, *Leschikisporis*, *Neoraistrickia*, *Microbaculispora*, *Didecitriletes*, *Lacinitriletes*, *Altitriletes*, *Thymospora*, *Striomonosaccites*, *Platysaccus*, *Illinites*, *Schizopollis*, *Vittatina*, *Korbapollenites*, *Ginkgocycadophytus*, *Ephedripites* and *Guttulapollenites* contribute less than 2 per cent individually. *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Rhizomaspora*, *Hamiapollenites*, *Vesicaspora* and *Gnetaceaepollenites* are not found within 200 specimens.

Exposure No. 3 — Six samples (F_1H-F_1C) were collected from this exposure (18′4″) and all of them yielded spores and pollen grains. Bisaccate is the most contributing group in all the samples of this section. Trilete group is subdominant while monosaccate, polyplicate and colpate pollen grains are also fairly well represented. F_1H represents 34 genera. Bisaccate is very common and contributes 65·5 per cent to the assemblage. *Striatites* and *Lahirites* are dominant. *Lophotriletes*, *Verticipollenites*, *Strotersporites* and *Striatopiceites* are subdominant. *Retusotriletes*, *Verrucosisporites*, *Neoraistrickia*, *Didecitriletes*, *Lacinitriletes*, *Altitriletes*, *Laevigatosporites*, *Punctatosporites*, *Striomonosaccites*, *Platysaccus*, *Cuneatisporites*, *Hindipollenites*, *Schizopollis*, *Vittatina*, *Korbapollenites*, *Rhizomaspora*, *Ginkgocycadophytus*, *Gnetaceaepollenites*, *Ephedripites*, *Decussatisporites* and *Guttulapollenites* represent less than 2 per cent each. *Dictyotriletes*, *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Illinites*, *Hamiapollenites* and *Vesicaspora* are not found within 200 counted specimens.

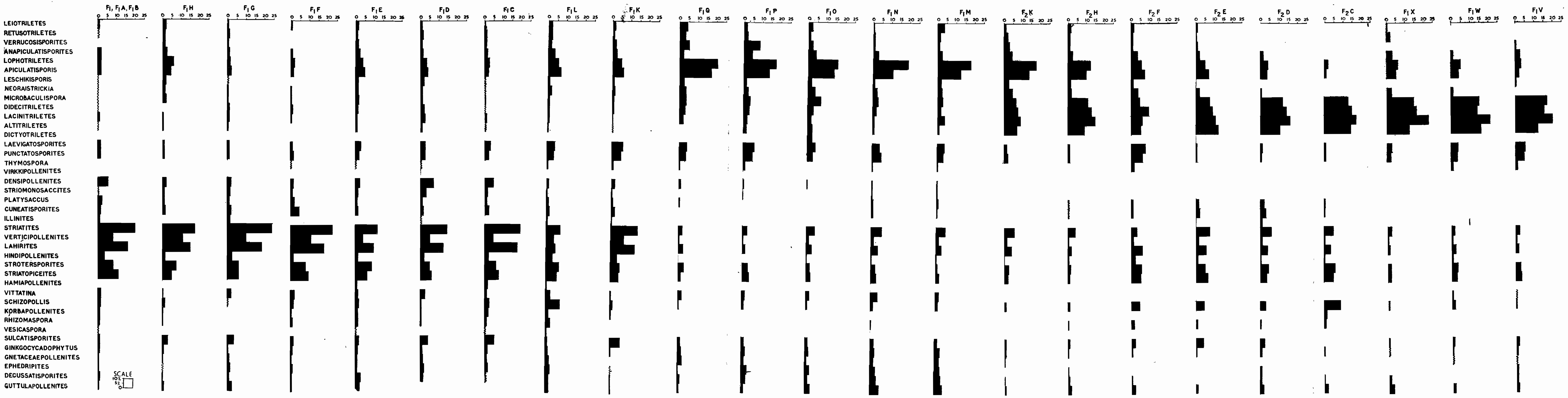
The sample F_1C shows an enormous development of bisaccate pollen contributing 75·5 per cent to the whole assemblage. *Striatites* and *Lahirites* are again in dominance. *Verticipollenites*, *Strotersporites* and *Striatopiceites* are subdominant. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Anapiculatisporites*, *Lohpotriletes*, *Neoraistrickia*, *Microbaculispora*, *Didecitriletes*, *Lacinitriletes*, *Altitriletes*, *Laevigatosporites*, *Punctatosporites*, *Striomonosaccites*, *Platysaccus*, *Illinites* *Schizopollis*, *Ginkgocycadophytus*, *Gnetaceaepollenites*, *Ephedripites* and *Decussatisporites* each contribute less than 2 per cent. *Dictyotriletes*, *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Korbapollenites*, *Rhizomaspora*, *Hamiapollenites* and *Vesicaspora* are not found within 200 counted specimens.

The sample F_1F is represented by 31 genera. Bisaccate pollen are very rich contributing 81·5 per cent to the assemblage. *Striatites* and *Lahirites* are dominant. *Verticipollenites*, *Strotersporites* and *Striatopiceites* are also quite common. *Leiotriletes*, *Apiculatisporis*, *Anapiculatisporites*, *Neoraistrickia*, *Microbaculispora*, *Didecitriletes*, *Lacinitriletes*, *Laevigatosporites*, *Punctatosporites*, *Thymospora*, *Striomonosaccites*, *Densipollenites*, *Hindipollenites*, *Schizopollis*, *Korbapollenites*, *Rhizomaspora*, *Sulcatisporites*, *Ginkgocycadophytus*, *Gnetaceaepollenites*, *Ephedripotes*, *Decuasatisporites* and *Guttulapollenites* contribute less than 2 per cent individually in the assemblage. *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Altitriletes*, *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Illinites*, *Hamiapollenites* and *Vesicaspora* are absent within 200 counted specimens.

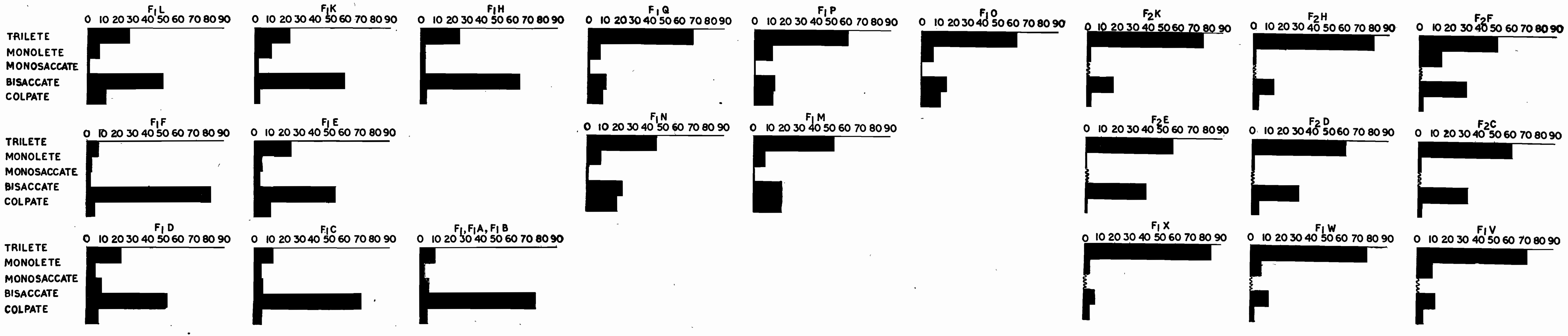
The sample F_1E represents 37 genera. Bisaccate pollen are in the majority and contribute 54·5 per cent to the assemblage. *Striatites*, *Lahirites* and *Strotersporites* are dominant. *Lophotriletes*, *Verticipollenites* and *Striatopiceites* are subdominant. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Leschikisporis*, *Neoraistrickia*, *Didecitriletes*, *Lacinitriletes*, *Altitriletes*, *Thymospora*, *Striomonosaccites*, *Platysaccus*, *Cuneatisporites*, *Hindipollenites*, *Korbapollenites*, *Hamiapollenites*, *Vittanita*, *Vesicaspora*, *Ginkgocycadophytus* and *Gnetaceaepollenites* are present less than 2 per cent individually in the assemblage. *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites* and *Illinites* are not found within 200 counted specimens.

The sample F_1D is represented by 35 genera. Bisaccate contributes 53·5 per cent to the assemblage. *Striatites* and *Lahirites* are dominant. *Densipollenites*, *Verticipollenites*, *Strotersporites* and *Striatopiceites* are subdominant. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Anapiculatisporites*, *Neoraistrickia*, *Microbaculispora*, *Altitriletes*, *Thymospora*, *Platysaccus*, *Cuneatisporites*, *Illinites*, *Schizopollis*, *Korbapollenites*, *Rhizomaspora*, *Ginkgocycadophytus*, *Gnetaceaepollenites* and *Decussatisporites* are present in less than 2 per cent individually in the assemblage. *Dictyotriletes*, *Virkkipollenites*, *Plicatipollenites*, *Hamiapollenites*, *Vesicaspora* and *Guttulapollenites* are not found within 200 counted specimens.

The sample F_1C represents 35 genera. Bisaccate is in great majority and contributes upto 71 per cent to the assemblage. *Striatites* and *Lahirites* are dominant.



TEXT-FIG. 3a — Histograms illustrating relative abundance of fossil spores-pollen genera.



TEXT-FIG. 3b — Histograms illustrating abundance of trilete, monolete, monosaccate, bisaccate, polyplicate and colpate spores-pollen groups (arranged according to the sections studied).

Densipollenites, *Verticipollenites*, *Strotersporites* and *Sulcatisporites* are also quite common in the assemblage. *Leiotriletes*, *Retusotriletes*, *Verrucosisporites*, *Lechikisporis*, *Anapiculatisporites*, *Neoraistrickia*, *Microbaculispora*, *Didecitriletes*, *Lacinitriletes*, *Altitriletes*, *Striomonosaccites*, *Platysaccus*, *Rhizomaspora*, *Vittatina*, *Hamiapollenites* and *Sulcatisporites* are less than 2 per cent individually in the assemblage. *Dictyotriletes*, *Thymospora*, *Virkkipollenites*, *Plicatipollenites*, *Illinites* and *Guttulapollenites* are not present in 200 specimens.

Exposure No. 4 — The exposure No. 4 consists of massive sandstone at the top (30′) and carbonaceous shale (2′) at the bottom. Only three samples (F_1, F_1A and F_1B) from this shale were collected and all of them yielded spores and pollen grains. Spores-pollen percentages have been computed taking into account of the distribution in all the three samples. Bisaccate pollen form the most dominant group. Trilete spores are poorly represented while monosaccate, polyplicate and colpate pollen are represented as subdominant and accessory types respectively.

The samples F_1, F_1A, F_1B, represent 35 genera. Bisaccate contributes 76 per cent to the assemblage. *Striatites* and *Lahirites* are dominant. *Densipollenites*, *Verticipollenites*, *Strotersporites* and *Striatopiceites* are subdominant. *Leiotriletes*, *Retusotriletes*, *Leschikisporis*, *Anapiculatisporites*, *Neoraistrickia*, *Microbaculispora*, *Didecitriletes*, *Lacinitriletes*, *Altitriletes*, *Laevigatosporites*, *Punctatosporites*, *Striomonosaccites*, *Cuneatisporites*, *Illinites*, *Schizopollis*, *Vittatina*, *Korbapollenites*, *Rhizomaspora*, *Vesicaspora*, *Sulcatisporites*, *Ginkgocycadophytus*, *Gnetaceaepollenites*, *Ephedripites*, *Decussatisporites* and *Guttulapollenites* are present in less than 2 per cent individually in the assemblage. *Verrucosisporites*, *Dictyotriletes*, *Thymospora*, *Virkkipollenites* and *Plicatipollenites* are not present within 200 specimens.

PALYNOLOGICAL ZONATION

A perusal of the histogram pattern (TEXT-FIGS. 3a, b) of the four exposures investigated here reveals three distinct palynological zones.

Zone A — The first zone (Zone A) is represented by the section in exposure No. 1 (Samples F_2K-F_2C) and three lowermost samples (F_1X, F_1W and F_1V) of the second exposure (*see* TEXT-FIG. 2). This zone is dominated by trilete spores. Among these *Microbaculispora*, *Didecitriletes* and *Lacinitriletes* representing the group *Varitrileti* outnumber the other group of trilete spores represented by the groups *Apiculati* and *Laevigati*. *Lophotriletes*, *Apiculatisporis* are found in good number in the two lowermost samples (F_2K and F_2H) of the first exposure; their percentage, however, decrease in the upper most samples studied (F_1W and F_1V). The *Laevigati* group represented by *Leiotriletes* and *Retusotriletes* are present in small number of lowermost samples (F_2K-F_2E), but not encountered in the uppermost samples (F_1W and F_1F) of this zone.

Monolete spores represented by *Laevigatosporites* and *Punctatosporites* form a minor percentage in the assemblage. *Thymospora* is only found in two uppermost samples (F_1W and F_1V) of this zone.

Monosaccate pollen are not recorded from this zone.

Platysaccus, *Cuneatisporites* and *Illinites* of the nonstriate group are either absent or poorly represented in this zone.

Striate bisaccate pollen are well represented. *Striatites*, *Lahirites*, *Strotersporites* and *Striatopiceites* are present in all the samples in sizable percentage. *Hamiapollenites*, *Vittatina*, *Korbapollenites* and *Rhizomaspora* are either absent or found in small number in this zone.

Polyplicate and colpate pollen represented by *Decussatisporites*, *Ginkgocycadophytus* and *Guttulapollenites* are found in most of the samples in a low percentage. *Gnetaceaepollenites* and *Ephedripites* are sporadic in appearance. This group shows a gradual increase towards the upper part of the zone represented by Sample F_1V.

Zone B — The second zone (Zone B) is present only in exposure No. 2 represented by samples F_1Q-F_1M representing the upper part of the second exposure (*see* TEXT-FIGURE 2). This zone is also characterized by the dominance of trilete spores, the group *Apiculati* contributing to the bulk of the assemblage. *Lophotriletes* and *Apiculatisporis* are very dominant. The group *Varitrileti*, a dominant group in zone A is well represented but is only second in position to the group *Apiculati*. *Leiotriletes* and *Retusotriletes* of the *Laevigati* group are also well represented in this zone.

Monolete spores represented by *Laevigatosporites* and *Punctatosporites* are common, but *Thymospora* is found in very small percentage.

Monosaccate pollen represented by *Virkkipollenites*, *Densipollenites* and *Striomonosaccites* are mostly absent except for *Densipollenites* in the lowermost samples (F_1Q, F_1P, F_1O) and found in poor percentage in the uppermost sample (F_1N and F_1M) of this zone.

Nostriated bisaccate pollen represented by *Platysaccus*, *Cuneatisporites* and *Illinites* are either absent or meagrely represented in this zone.

Striated bisaccate pollen form the second largest group in this assemblage of this zone. *Striatites*, *Lahirites*, *Strotersporites*, *Striatopiceites* and *Vittatina* are well represented.

Hamiapollenites, *Korbapollenites*, *Hindipollenites* and *Schizopollis* are poorly represented.

Polyplicate and colpate pollen represented by *Gnetaceaepollenites*, *Ephedripites*, *Decussatisporites*, *Ginkgocycadophytus* are present in good percentage in all the samples as well as *Guttulapollenites* which is interpreted here as polysaccate.

Zone C — The third zone (Zone C) includes the uppermost section (Samples F_1 L and F_1K) of the second exposure and the section exposed in the third (F_1H-F_1C) and the fourth (F_1, F_1A, F_1B) exposures. This zone is dominated by striated bisaccate pollen. The lowermost sample (FiL) is constituted of 50 per cent striated bisaccate pollen. The percentage of this group gradually increases in the uppermost (younger) sections. It is represented by over 81 per cent in the sample F_1F of the third exposure. *Striatites*, *Verticipollenites*, *Lahirites*, *Strotersporites* and *Striatopiceites* are found in great abundance in all the samples investigated here. *Vittatina*, *Schizopollis*, *Korbapollenites* and *Rhizomaspora* are poorly represented. The nonstriated bisaccate pollen represented by *Platysaccus*, *Cuneatisporites* and *Illinites* are not found in sizable percentage.

Trilete spores of the *Laevigati*, *Apiculati* and *Varitrileti* groups are poorly represented in most of the samples. *Anapiculatisporites*, *Lophotriletes* and *Apiculatisporis* are well represented in lower most samples (F_1L, F_1K and F_1H) of this zone. *Microbaculispora*, *Didecitriletes*, and *Lacinitriletes* are found with a percentage of less than ·5 per cent in the uppermost sample (F_1, F_1A, F_1B). *Leiotriletes* and *Retusotriletes* are present throughout the zone in small percentage.

Monolete spores are represented mostly by *Laevigatosporites* and *Punctatosporites*.

Gnetaceaepollenites, *Ephedripites*, *Decussatisporites*, *Guttulapollenites* and *Ginkgocycadophytus* are not well represented in this zone.

The above data can be summarized in Table 1

TABLE 1 — SHOWING THE THREE DIFFERENT ZONES

Zone C	Trilete	Rare or accessory
	Monolete	Absent or rare
	Monosaccate	Rare or accessory
	Nonstriated bisaccate	Rare or accessory
	Striated bisaccate	Dominant
	Polyplicate and Colpate	Rare or accessory
Zone B	Trilete	*Apiculati* dominant, *Varitrileti* subdominant, *Laevigati* accessory
	Monolete	Rare or accessory
	Monosaccate	Absent or rare
	Nonstriated bisaccate	Rare or accessory
	Striated bisaccate	Subdominant
	Polyplicate and Colpate	Subdominant
Zone A	Trilete	*Varitrileti* dominant, *Apiculati*, *Laevigati* subdominant
	Monolete	Rare or accessory
	Monosaccate	Absent or rare
	Nonstriated bisaccate	Rare or accessory
	Striated bisaccate	Subdominant
	Polyplicate and Colpate	Rare or accessory

PALAEOECOLOGICAL INTERPRETATION

The dominance of trilete and monolete spores in Zone A and B in the bottom section indicates that the ferns and fern allies were the main type of vegetation around the basin during the period of deposition. In Zone A, *Microbaculispora*, *Didecitriletes* and *Lacinitriletes* are the most dominant genera. It indicates that the ferns or fern allies which produced triangular to subtriangular spores (in polar view) with differential ornamentation pattern on the exine and regular folds associated with trilete germinal apeture, were the dominant type of vegetation in Zone A. The dominance of the group *Apiculati* in the zone B points out change in vegetational type among the ferns and fern allies.

The presence of bisaccate spores-pollen in small percentage in Zone A and B probably shows that the Coniferous Gymnosperms, occupied upland regions or there were only a few of them in and around the basin during that period.

The good percentage of polyplicates and colpate pollen particularly in Zone B indicates that Cycads and Chlamydospermous plants constituted a substantial part of the vegetation around the basin in that particular period.

The gradual dominance of bisaccate spores-pollen in Zone C reflects the luxurious vegetation of Coniferous Gymnosperms around the basin. Probably they invaded the swamp from upland regions perhaps due to shallowing up of the swamp by silting. Whatever may be the reason, the Coniferous Gymnosperms once getting a solid ground and favourable flourishing condition dominated throughout the Zone C and shadowed the ferns, fern allies and Cycads. Thus three distinct zones of vegetation can be seen in the sections studied here.

REFERENCES

BALME, B. E. (1952). On some spore specimens from British Upper Carboniferous Coals. *Geol. Mag.* **89**: 175-184.

BALME, B. E. & HENNELLY, J. P. F. (1955). Bisaccate sporomorphs from Australian Permian coals. *Aust. J. Bot.* **3**: 89-98.

Idem (1956a) Monolete, monocolpate and alete sporomorphs from Australian Permian sediments. *Ibid.* **4** (1): 54-67.

Idem (1956b). Trilete sporomorphs from Australian Permian sediments. *Ibid.* **5**: 240-260.

BANERJEE, R. (1958). The coal seams of the Barakar Measure of the area around Ray, Hazaribagh District. *Quart. J. geol. Soc. India* **30** (4): 195-210.

BHARADWAJ D. C. (1962). The miospore genera in the coals of Raniganj Stage (Upper Permian), India. *Palaeobotanist* **9** (1 & 2): 68-106 (1960).

Idem (1964). The organization in pollen grains of some early conifers. *Ibid.* **12** (1): 18-27 (1963).

BHARADWAJ, D. C. & SALUJHA, S. K. (1964). Sporological study of seam VIII in Raniganj Coalfield, Bihar, India. Pt. 1. Description of the *Sporae dispersae*. *Ibid.* **12**: 181-215 (1963).

BHARADWAJ, D. C. & SINGH, H. P. (1957). *Asterotheca meriani* (Brongn.) Stur. and its spores from the Upper Triassic of Lunz (Austria). *Ibid.* **5**: 51-55 (1956).

BHATTACHARYA, D.; RAYCHOWDHURY, T. & DATTA, K. (1957). On fossil spores and pollen from the Lower Gondwanas of the Raniganj and South Karanpura coalfields. *Quart. J. geol. Soc. India.* **29**: 51-52.

BOLKHOVITINA, N. A. (1953). Spore-pollen characteristics of the Cretaceous sediments of the central regions of the U.S.S.R. *Tr. Geol. in-ta* AN — S.S.R. 145, Geol. Seria **61**.

COOKSON, I. C. (1947). Plant microfossils from the lignites of Kerguelen Archipelago. *B.A.N.* **2**. *Ant. Res. Exped.* 1929-31. *Rept. Series.* A. **2**: 127-142.

DAS, D. K. (1958). On the microfloral content of the Barakar coals of the Talchir coalfield, Orissa. *Quart. J. Geol. Soc. India.* **30** (4): 233-234.

DATTA, A. K. (1957). Notes on the Palaeontology of the sedimentary rocks in the Jhagarkhand area, Madhya Pradesh. *Ibid.* **29**: 1-18.

DULHUNTY, J. A. (1946). Principal microspore-types in the Permian coals of N.S. Wales. *Proc. Linn. Soc. N. S. W.* **71** (5-6): 239-251.

GHOSH, A. K. & SEN, J. (1948). A study of the microfossils and the correlation of some productive coal seams of the Raniganj coalfield, Bengal, India. *Trans. Min. Geol. Met. Inst. India.* **43** (2): 67-95.

GOSWAMI, S. K. (1952). Microfossils from coals from the South Rewa Gondwana basin. *J. Sci. Res. B.H.U.* **2**: 189-199.

Idem (1956). Occurrence of megaspores in the coals from the South Rewa Gondwana basin. *Curr. Sci.* Nov.: 365-366.

GREBE, H. & SCHWEITZER, H. (1962). Die *Sporae dispersae* des Niederrheinischen Zechsteins. *Fortsehr. Geol. Rheinld. U. Westf. Krefeld*: 1-24.

HART, G. F. (1960). Microfloral investigations of the Lower Coal Measures (K_2); Katewaka-Mchuchuma coalfield, Tanganyika. *Bull. geol. Surv. Tanganyika.* **30**: 1-18.

Idem (1963). A probable pre-Glossopteris microfloral assemblage from Lower Karroo sediments. *S. Afr. J. Sci.* **59**: 135-146.

Idem (1964). A review of the classification and distribution of the Permian miospores. Disaccate *Striatiti*. *C.R.5. Cong. Strat. Geol. Carbon.* No. **3**: 1171-1199.

HARTUNG, W. (1933). Die sporenverhaltnisse der Calamariacean: *Inst. Palaobot. U. Petrog. der Brennsteine Arb.* **3** (3): 95-149.

HENNELLY, J. P. F. (1958). Spores and Pollen from a Permian-Triassic transition, N.S.W. *Proc. Linn. Soc. N.S.W.* **83** (3): 363-369.

HUGHES, T. W. H. (1869). The Karanpura coalfield. *Mem. geol. Surv. India* **7**(1): 285-330.

IBRAHIM, A. C. (1933). Sporenformen des Aegirhorizonts des Ruhr-Reviers. Dissertation, Berlin; privately published 1933 by Konard Triltsch, Wurzburg: 1-47.

JANSONIUS, J. (1962). Palynology of Permian and Triassic sediments, Peace river area, Western Canada. *Palaeontographica*. **110** (B): 35-98.

JOWETT, A. (1925). On the Geological Structure of the Karanpura coalfield, Bihar and Orissa. *Mem. geol. Surv. India* **52** (1): 1-44.

KLAUS, W. (1963). Sporen aus dem südalpinen Perm. *Geol. Jb.* **106:** 229-363.

KOSANKE, R. M. (1950). The Pennsylvanian spores of Illinois and their use in correlation. *Bull. Ill. geol. Surv.* **74:** 1-128.

LELE, K. M. (1964). Studies in the Talchir Flora of India: 2. Resolution of the spore genus *Nuskoisporites* Pot. and Kl. *Palaeobotanist.* **12** (2): 147-168.

LESCHIK, G. (1955). Die Keuperflora von Neuewelt bei Basel. II. Die Iso- und Mikrosporen. *Schweiz. Palaeont. Abh.* **72**: 1-70.

Idem (1956). Sporen aus dem Salton des Zechsteins von Neuhof (bei Fulda). *Palaeontographica* **100** (B): 125-141

Idem (1959). Sporen aus dem ' Karrusandsteinen ' von Norronaub (Südwest Afrika). *Senck. Leth.* **40**: 51-95.

MANUM, S. (1960). On the genus *Pityosporites* Seward 1914 with a new description of *Pityosporites antarcticus* Seward. *Nytt. Mag. Bot.* **8:** 11-15.

MEHTA, K. R. (1944). Microfossils from a carbonaceous shale from the Pali beds on the South Rewa Gondwana basin. *Proc. nat. Acad. Sci. India.* **14:** 125-141.

MILLER, F. X. (1966). *Circlettisporites dawsonensis* gen. et sp. nov. from the Dawson coal of Oklahoma *Pollen Spores.* **8** (1): 223-228.

NATHORST, A. G. (1908). Palaeobotanische mitteilungen 4-6. *Kgl. Svenk. Vetensk. Akad. Handl.* **43** (6). 1-20.

NEUBERG, M. F. (1960). Permian fossil flora of Angaraland. *Sci. Acad. U.S.S.R.* **19:** 1-104.

NEVES, R. (1964). The stratigraphic significance of the small spore assemblages of the la Camocha Mine, Cyon. N. Spain. *C.R.* 5. *Cong. Strat. Geol.* **3:** 1229-1238.

PANT, D. D. (1954). Suggestion for the classification and nomenclature of fossil spores and pollen grains. *Bot. Rev.* **20:** 33-60.

Idem (1955). On two disaccate spores from the Bacchus Marsh Tillite, Victoria, Australia. *Ann. Mag. nat. Hist.* **8:** 757-764.

PASCOE, E. H. (1959). A Manual of the Geology of India and Burma. **2:** Publ. Div. Govt. India, New Delhi.

POTONIÉ, R. (1956). Synopsis der Gattungen der *Sporae dispersae*. Pt. I. *Beih. Geol. Jb.* **23:** 1-103.

Idem (1958). Synopsis der Gattungen der *Sporae dispersae*. Pt. 12. *Beih. Geol. Jb.* **31:** 1-114.

Idem (1962). Synopsis der *Sporae* in situ. *Ibid.* **52:** 1-204.

POTONIÉ, R. & KLAUS, W. (1954). Einige sporengattungen des Alpinen Salzgebirges. *Geol. Jb.* **68:** 517-544.

POTONIÉ, R. & KREMP, G. (1954). Die Gattungen der palaeozoischen *Sporae dispersae* und ihre Stratigraphie. *Ibid.* **69:** 111-193.

POTONIÉ, R. & LELE, K. M. (1961). Studies in the Talchirs of India. 1. *Sporae dispersae* from the Talchir beds of South Rewa Gondwana basin. *Paleobotanist.* **8:** 22-37 (1959).

POTONIÉ, R. & SCHWEITZER, H. J. (1960). Der Pollen von *Ullamannia frumentaria. Paläontol.* **34:** 27-39.

RAATZ, C. V. (1937). Mikrobotanisch-stratigraphische Untersuchung der Braunkohle des Muskauer Bogens. *Abb. Preuss. Geol.* L.A.N.F. **183:** 1-48.

SAHNI, B. (1940). The palaeobotanical correlation of coal seams in India. *Proc. nat. Inst. Sci. India.* **6** (3): 1.

SAMOILOVICH, S. R. (1952). Pollen und sporen der permischen Ablagerungen von Tscherdin U. Aktjubinsk imm Vorural. *Arbeit. Erdöl. Geol. Inst.* U.S.S.R. N.S. **75**: 5-57 (Translation *Okla. geol. Surv. Cir.* 56, 1961).

SCHOPF, J. M., WILSON, L. R. & BENTALL, R. (1944). An annotated synopsis of Palaeozoic fossil spores and the definition of generic groups. *Ill. St. Geol. Sur. Report* **91:** 1-66.

SEDOVA, M. A. (1956). " The definition of 4 genera of disaccate striatiti " in material of Palaeontology. new families and genera. VSEGEI New Sries **12:** 246-249. Hart Paly. Trans.

SEN, J. (1944). A preliminary note on the microfloral correlations of Satpukriya, Ghusick and associated seams. *Sci. & Cul.* **10:** 58-59.

SEWARD, A. C. (1914). Antarctic fossil plants. Brit. Antarctic (Terra Nova) Exped. 1910. *Nat. Hist. Report. Geol.* **1:** 1-49.

SMITH, A. H. V. (1964). *Verrucosisporites* (Ibrahim) emend. Report of C.I.M.P. working Group No. 6. *C.R.* 5. *Cong. Strat. Geol. Carb.* **3:** 1071-1077.

SURANGE, K. R. & LELE, K. M. (1956). Studies in the Glossopteris flora of India-3. Plant fossils from the Talchir Needle shale from Giridih Coalfield. *Palaeobotanist.* **4:** 153-157 (1955).

SURANGE, K. R., SRIVASTAVA, P. N. & SINGH, H. P. (1953a). Microfossil analysis of some Lower Gondwana coal seams of West Bokaro, Bihar. *Bull. nat. Inst. Sci. India.* **2**: 111-127.

Idem (1953b). Megaspores from the West Bokaro coalfield (Lower Gondwana) of India. *Palaeobotanist.* **2:** 9-17.

TOWNROW, J. A. (1962). On some disaccate pollen grains of Permian to Middle Jurassic age. *Grana Palynologica.* **3** (2): 13-44.

TRIVEDI, B. S. (1950). Megaspores from Lower Gondwana of Singrauli coalfield, District Mirzapur. *Curr. Sci.* **19:** 126.

VENKATACHALA, B. S. & BHARADWAJ, D. C. (1964). Sporological study of the coals from Falkenberg (Faulquemont) colliery, Lothringen (Lorrain), France. *Palaeobotanist.* **12** (1): 159-207 (1963).

VENKATACHALA, B. S. & KAR, R. K. (1964a). Nomenclatural notes on *Striatopodocarpites* Sedova, 1956. *Ibid.* **12** (3): 313-314 (1963).

Idem (1964b). *Schizopollis* Venkatachala & Kar, a new pollen genus from the Permian of North Karanpura Coalfield, Bihar, India. *Grana Palynologica* **5** (3): 413-425.

Idem (1965). Two new trilete spore genera from the Permian of India. *Palaeobotanist* **13** (2-13): 337-340.

VENKATACHALA, B. S., GOUBIN, N. & KAR, R. K. (1967). Morphological study of *Guttulapollenites* Goubin, 1965. *Pollen et Spores.* **9** (2): 357-362.

VIRKKI, C. (1937). On the occurrence of winged spores in the Lower Gondwana rocks of India and Australia. *Proc. Ind. Acad. Sci.* **6** (6): 428-431.

Idem (1939). On the occurrence of similar spores in a Lower Gondwana glacial tillite from Australia and in Lower Gondwana shales in India. *Ibid.* **9**: 7-12.

Idem, (1946). Spores from the Lower Gondwanas of India and Australia. *Proc. nat. Acad. Sci. India.* **15** (4 & 5). 93-176.

WILSON, L. R. (1962). Permian Plant microfossils from the Flowerpot formation Greer country, Oklahoma. *Circ. Okla. geol. Surv.* **49**: 5-50.

WILSON, L. R. & VENKATACHALA, B. S. (1963). *Thymospora*, a new name for *Verrucososporites*. *Okla. geol. Notes.* **23** (3): 75-79.

Idem (1967). *Circlettisporites* Miller 1966, a synonym of *Leschikisporis* Potonié, 1958. *Pollen et Spore*, **9** (2): 363-365.

Idem (Ms.). Palynology of the Dawson coal, Tulsa Co. Oklahoma, U.S.A. *Circ. Okla. geol. Surv.* (In Press).

ZAUER, V. V. (1960). On Late Permian floras from Solikamsk. *Palaeont. J.* **4**: 114-124.

ZORICHEVA, A. J. & SEDOVA, M. A. (1954). Sporen und pollen Komplexe der oberpermischen Ablagerungen einiger nördlicher Gebeite des europaischenteils der U.S.S.R. (in Russian). *Arb. d. geol. Forsch.*. 1-40.

EXPLANATION OF PLATES

(*All magnifications* × 500)

PLATE 1

1-2. *Leiotriletes* sp. Photo Nos. 55/22, 52/9.

3-4. *Retusotriletes* sp. Photo Nos. 53/20, 54/6.

5. *Verrucosisporites* sp. Photo No. 47/1.

6-7. *Anapiculatisporites veritas* sp. nov. Photo Nos. 50/18, 46/30.

8-10. *Anapiculatisporites* sp. A Photo Nos. 53/9, 53/23, 53/25.

11-12. *Anapiculatisporites consonus* sp. nov. Photo Nos. 54/21, 57/14.

13. *Anapiculatisporites* sp. B. Photo No. 54/26.

14-19. *Lophotriletes rectus* Bharadwaj and Salujha Photo Nos. 54/23, 54/9, 46/24, 57/28, 52/18, 47/27.

20-22. *Apiculatisporis* sp. Photo Nos. 51/22, 51/1, 48/12.

23-24. *Leschikisporis baccatus* sp. nov. Photo Nos. 51/22, 51/2.

25-27. *Neoraistrickia* sp.

28-32. *Microbaculispora minutus* sp. nov. Photo Nos. 55/9, 55/25, 55/2, 55/21, 55/7.

PLATE 2

33-37. *Lacinitriletes minutus* sp. nov. Photo Nos. 54/19, 70/9, 70/10, 70/12, 48/18.

38-42. *Altitriletes densus* gen. et sp. nov. Photo Nos. 54/15, 54/30, 57/17, 54/18.

43-44. *Dictyotriletes* sp. Photo No. 54/22.

45-50. *Laevigatosporites colliensis* (Balme & Hennelly) comb. nov. Photo Nos. 46/16, 50/7, 49/18, 46/20, 45/34, 52/30.

51. *Thymospora* sp. Photo No. 50/2.

PLATE 3

52-56. *Punctatosporites dulcis* sp. nov. Photo Nos. 47/25, 57/27, 49/3, 57/21, 57/26.

57-63. *Punctatosporites morosus* sp. nov. Photo Nos. 48/6, 52/12, 53/17, 57/23, 52/5, 49/9, 52/21.

64. *Virkkipollenites* sp. Photo No. 45/30.

65-67. *Densipollenites indicus* Bharadwaj. Photo Nos. 45/23, 46/21, 45/3.

PLATE 4

68-73. *Densipollenites invisus* Bharadwaj & Salujha, Photo Nos. 47/24, 49/21, 45/6, 46/35, 53/33, 48/16.

74-77. *Densipollenites minimus* sp. nov. Photo Nos. 46/12, 47/22, 46/35, 46/29.

PLATE 5

78-80. *Striomonosaccites ovatus* Bharadwaj, Photo Nos. 55/27, 53/18, 55/17.

81-82. *Platysaccus* sp. Photo Nos. 57/24, 53/7.

83-84. *Cuneatisporites* sp. Photo Nos. 50/21, 48/21.

85. *Illinites* sp. Photo No. 57/8.

86-90. *Striatites ornatus* sp. nov. Photo Nos. 46/2, 46/34, 47/2, 48/27, 46/26.

PLATE 6

91-95. *Striatites alius* sp. nov. Photo Nos. 46/14, 45/2, 50/11, 47/20, 45/5.

96-98. *Striatites tectus* sp. nov. Photo Nos. 51/24, 54/16, 49/4.

99. *Striatites communis* Bharadwaj & Salujha. Photo No. 47/3.

100-103. *Verticipollenites debilis* sp. nov. Photo Nos. 45/8, 51/13, 47/7, 54/12.

104-106. *Lahirites alutas* sp. nov. Photo Nos. 49/8, 49/13, 45/26.

107-112. *Lahirites angustus* sp. nov. Photo Nos. 55/15, 50/35, 46/18, 55/14, 48/24, 51/6.

PLATE 7

113-117. *Lahirites minutus* sp. nov. Photo Nos. 55/4, 57/30, 52/17, 47/4, 45/25.

118-120. *Lahirites rarus* Bharadwaj & Salujha. Photo Nos. 45/29, 55/23, 46/32.

121-122. *Lahirites parvus* Bharadwaj & Salujha. Photo Nos. 50/14, 47/26.

123-127. *Hindipollenites formosus* sp. nov. Photo Nos. 45/13, 47/11, 45/27, 45/15. 47/34.

128-130. *Striatosporites* sp. Photo Nos. 45/28, 55/26, 46/23.

131. *Striatopiceites varius* (Bharadwaj) comb. nov Photo No. 46/25.

Plate 8

132-134, 139. *Striatopiceites varius* (Bharadwaj) comb. nov. Photo Nos. 49/22, 47/10, 48/17, 46/17.

135-138. *Striatopiceites minutus* sp. nov. Photo Nos. 55/29, 50/22, 48/2, 45/20.

140. *Hamiapollenites* sp. Photo No. 50/6.

141-143. *Vittatina lata* Wilson. Photo Nos. 46/9, 47/28, 48/14.

144-146. *Schizopollis wodehousei* Venkatachala & Kar, Photo Nos. 52/7, 51/28, 55/24.

147-148. *Schizopollis disaccoidis* Venkatachala & Kar. Photo Nos. 51/4, 57/20.

Plate 9

149-150, 152, 158-163. *Schizopollis disaccoidis* Venkatachala & Kar. Photo Nos. 51/21, 51/17, 55/5, 55/35, 50/29, 50/10, 50/17, 50/19, 51/19.

151, 153-157. *Schizopollis extremus* Venkatachala & Kar. Photo Nos. 55/28, 51/5, 51/18, 54/29, 50/4, 50/33.

164-165. *Korbapollenites novus* Tiwari. Photo Nos. 55/12, 55/32.

166-67. *Rhizomaspora* sp. Photo Nos. 57/12, 54/12.

168. ? *Vesicaspora* sp. Photo No. 50/15.

169-174. *Sulcatisporites* sp. Photo. Nos 55/34 51/31, 48/26, 52/16, 48/11, 50/31.

Plate 10

175-176. *Ginkgocycadophytus cymbatus* (Balme & Hennelly) Potonié & Lele. Photo Nos. 46/22, 54/13.

177. *Gnetaceaepollenites sinuous* (Balme & Hennelly) Bharadwaj. Photo No. 49/15.

178-182. *Gnetaceaepollenites punctatus* sp. nov. Photo Nos. 54/28, 46/33, 54/27, 50/28, 46/7

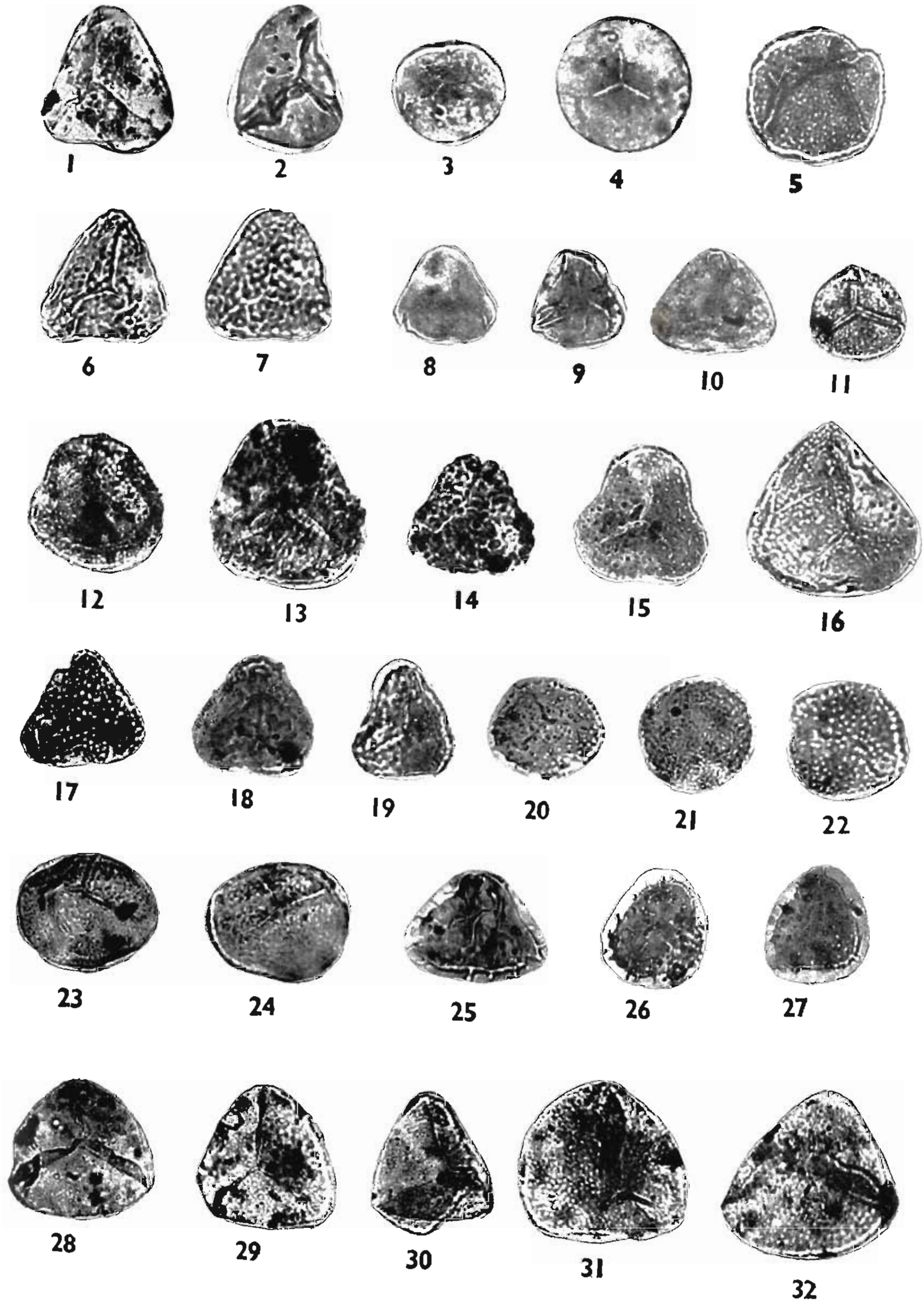
183-184. *Ephedripites* sp. Photo Nos. 46/3, 46/31.

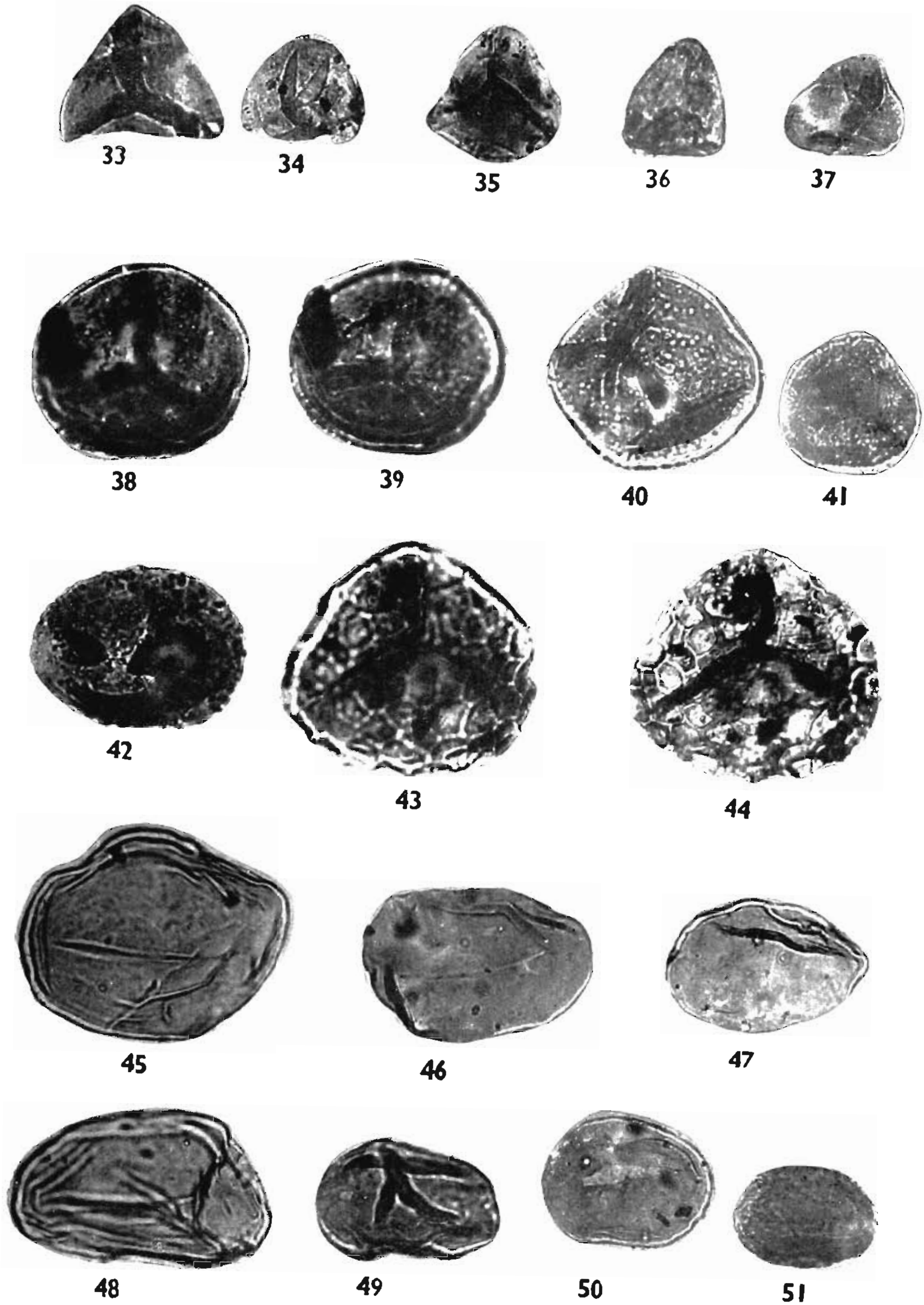
185-187. *Decussatisporites pilus* sp. nov. Photo Nos. 53/32, 54/24, 55/30.

188. *Decussatisporites* sp. Photo No. 50/30.

189-190. *Decussatisporites dubius* sp. nov. Photo Nos. 57/25, 50/26.

191-199. *Guttulapollenites hannonicus* (Goubin) Venk. Goubin & Kar. Photo Nos. 55/1, 46/19, 51/3, 50/24, 50/27, 54/1, 49/6, 50/32, 45/32.

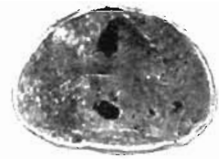

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32


33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51

52

53

54



55

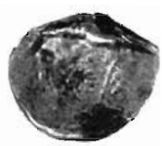
56

57

58

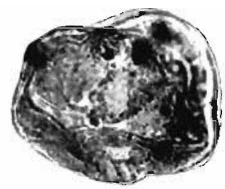
59

60



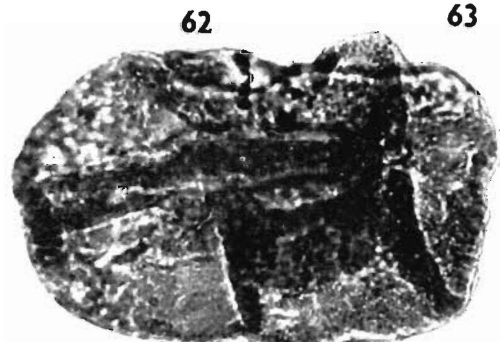
61

62



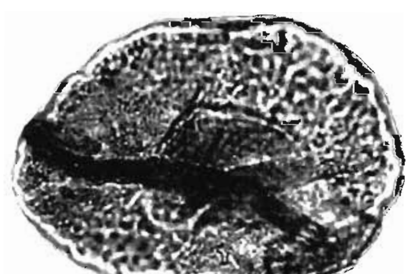
63

64



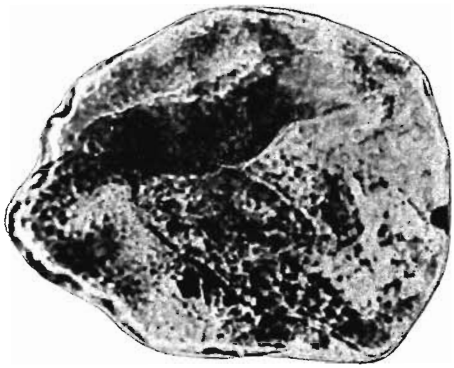
65

66

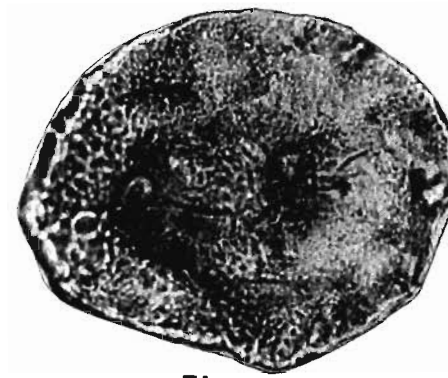


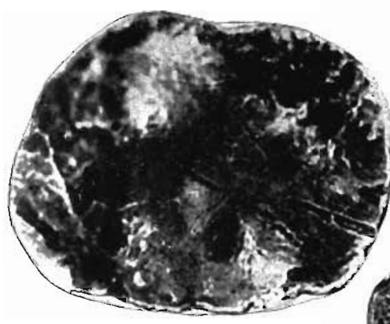
67


68


69


70


71


72

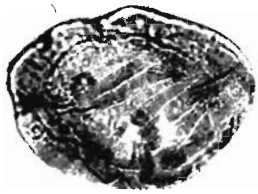
77


73


74

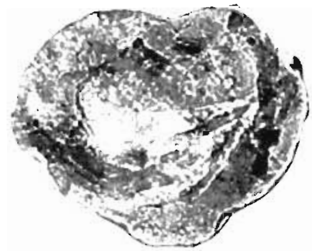

75


76



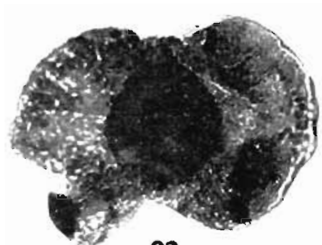
78

79

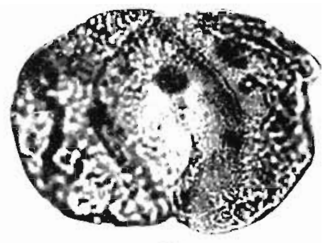


80

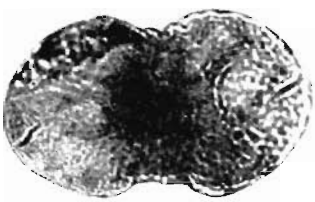
81



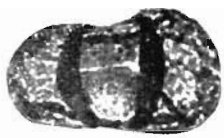
82



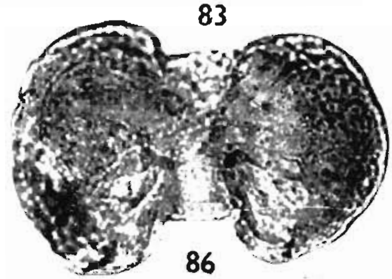
83



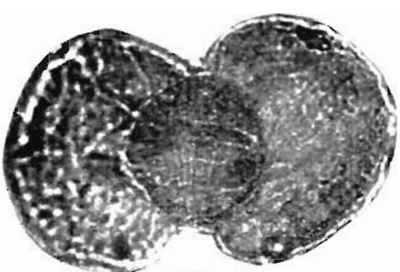
84



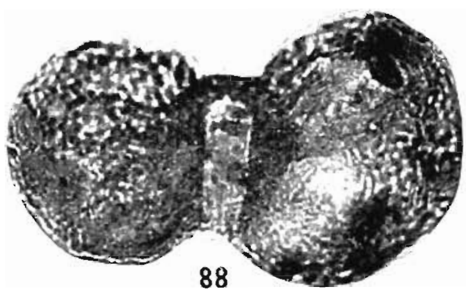
85



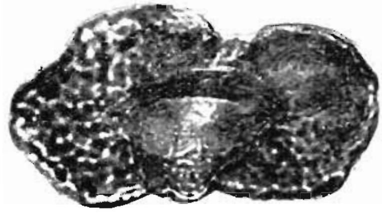
86



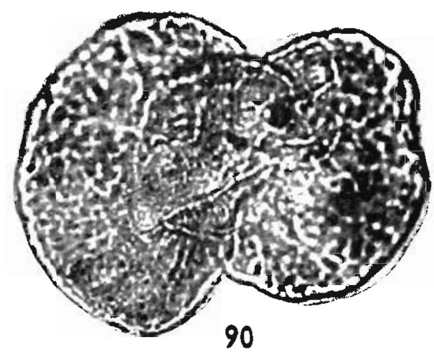
87



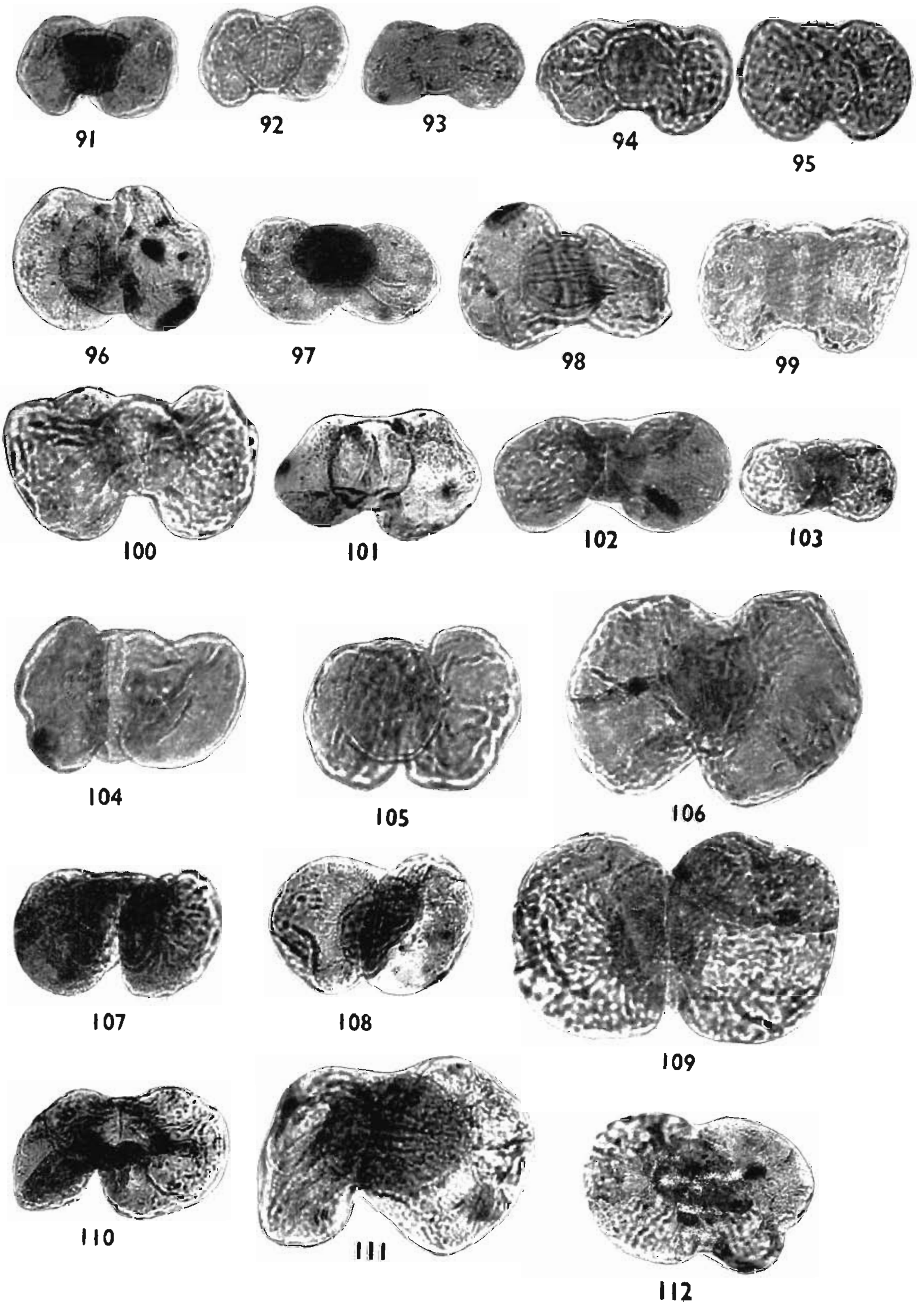
88

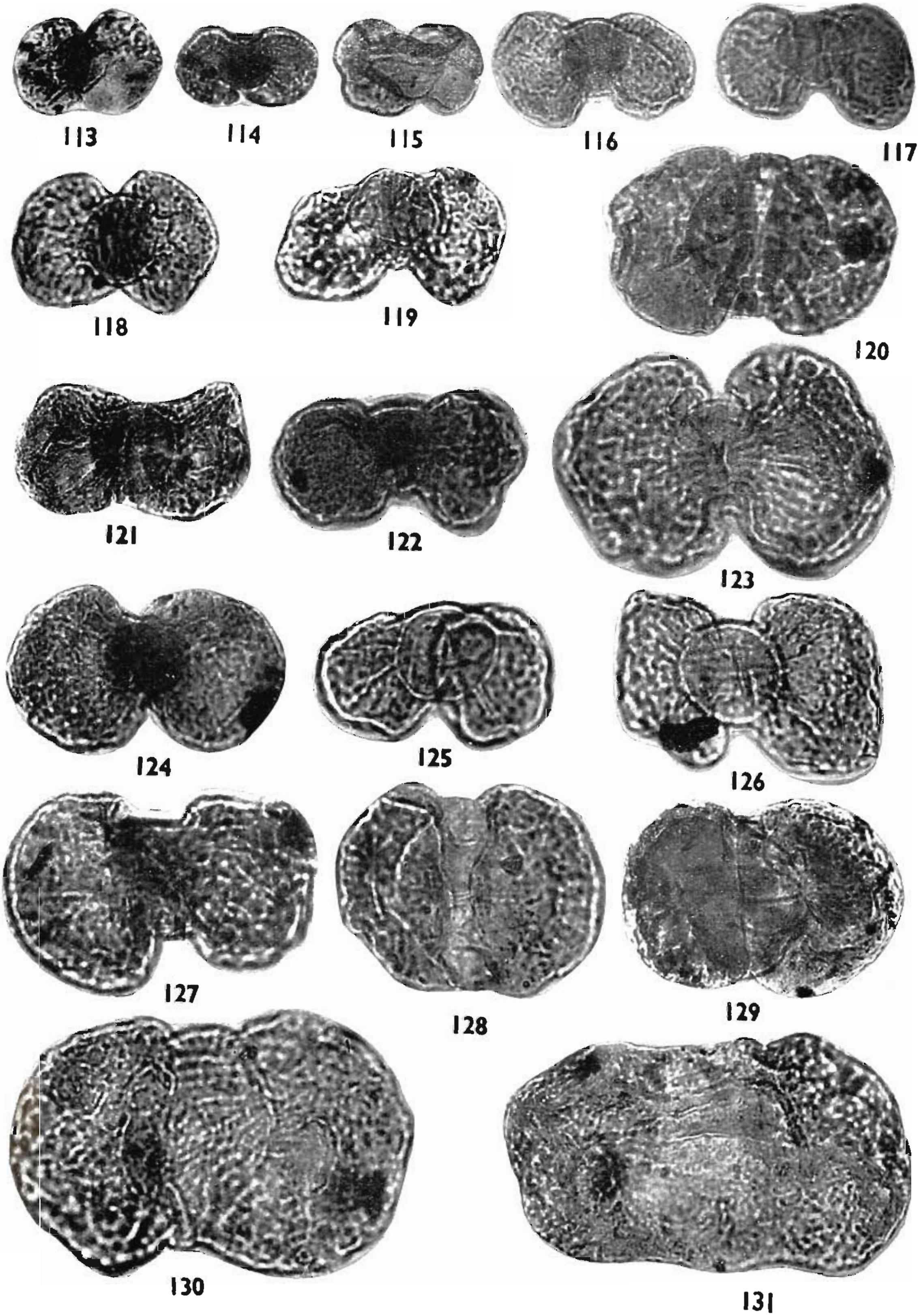


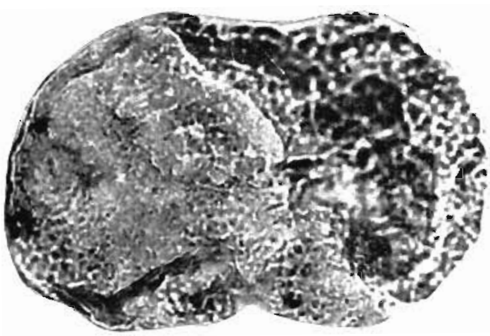
89



90


91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112


113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131


132

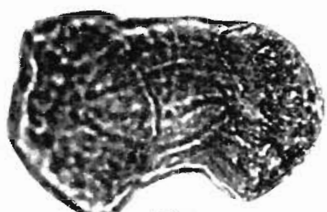

133

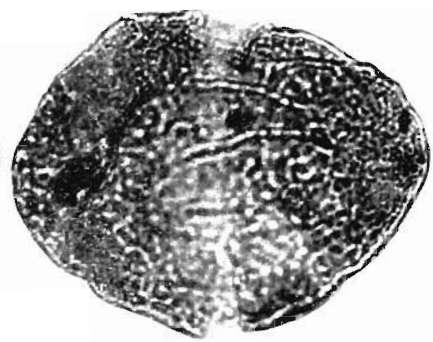

134


135


136


137


138


139


140


141


142


143

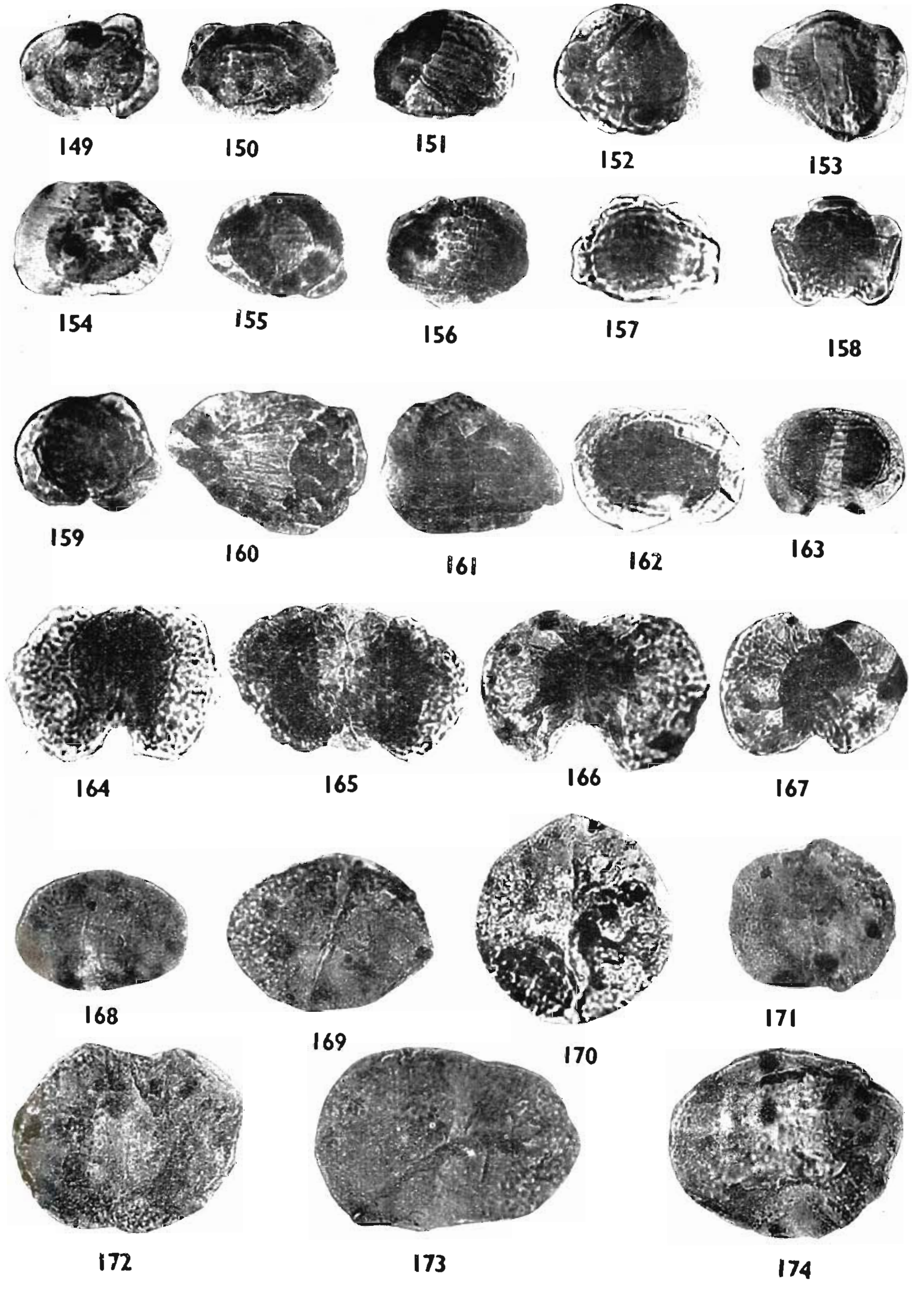

144

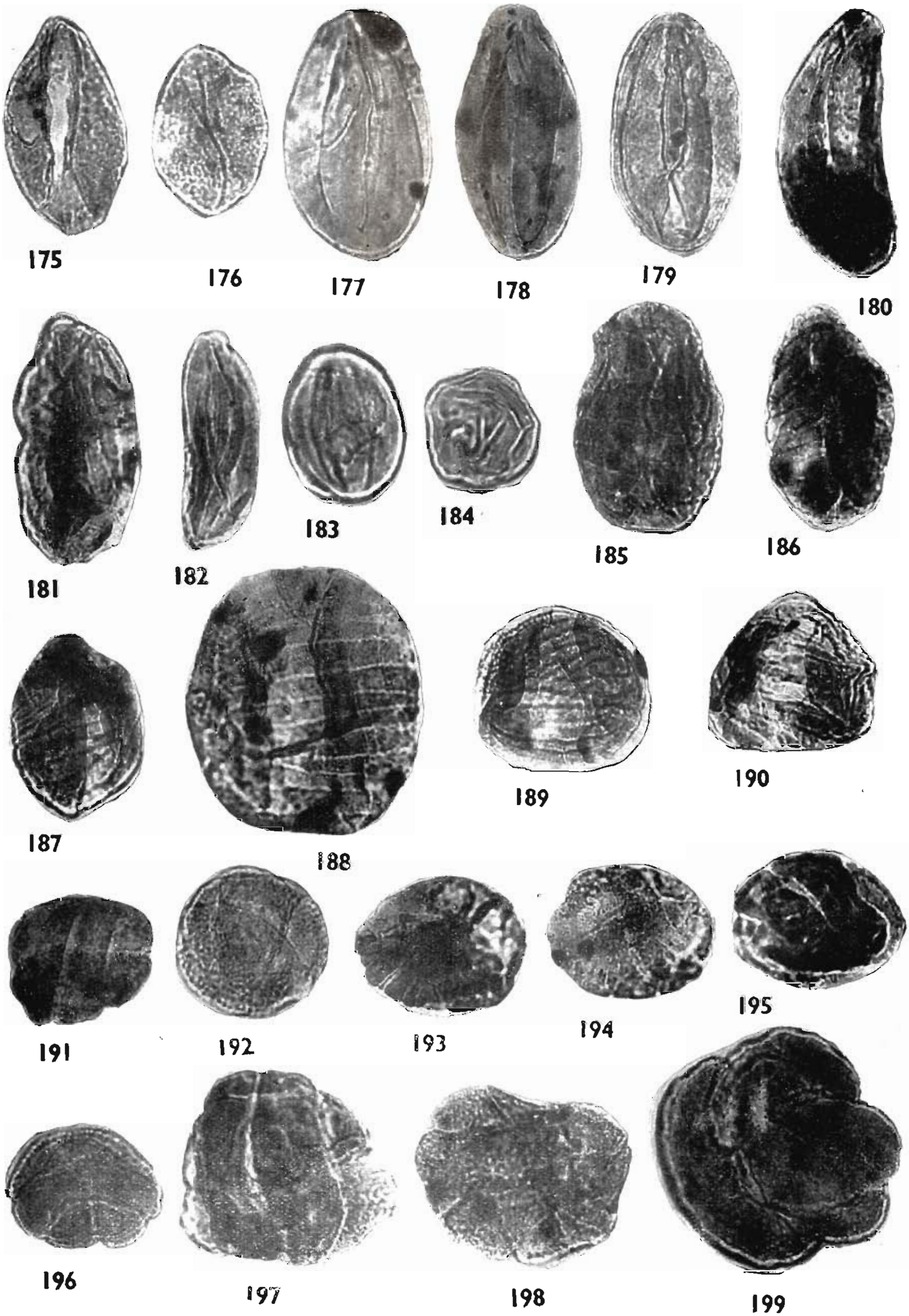

145


146


147


148


149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174


175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199