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 (K₄); Katowake-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 2 to 25 ft. above the Talchir boulder bed, Kathwai; Middle Productus Limestone, Warcha and Jhalewali, 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 Saptukuria, 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.
Coalfied, Bihar. Surange & Lele (1955) reported microflora from the Talchir needle shales (Talchir Stage) of the Giridih Coalfield, Bihar.


Bharadwaj (1962) published an extensive study on the morphology 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' and 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 Ho-haru 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 sub-district (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-mest bed which rests unconformably over the metamorphic rocks. The different rock groups of the area are exposed in the following sequence:

<table>
<thead>
<tr>
<th>Series</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Gondwana</td>
<td>Damuda</td>
</tr>
<tr>
<td></td>
<td>Talchir</td>
</tr>
<tr>
<td></td>
<td>Unconformity</td>
</tr>
<tr>
<td></td>
<td>Metamorphics</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Series</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Gondwana</td>
<td>Mahadeva</td>
</tr>
<tr>
<td></td>
<td>Panchet</td>
</tr>
<tr>
<td>Lower Gondwana</td>
<td>Damuda</td>
</tr>
<tr>
<td></td>
<td>Talchir</td>
</tr>
<tr>
<td></td>
<td>Unconformity</td>
</tr>
</tbody>
</table>
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, i.e.). 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 stratigraphic sections (see Text-Fig. 2).

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

**Exposure No. 4**

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Thickness (in foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse grained, massive sandstone</td>
<td>30’</td>
</tr>
<tr>
<td>Carbonaceous shale ((F_1, F_1A, F_1B))</td>
<td>exact thickness unknown; exposed about 2’</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>32’</td>
</tr>
</tbody>
</table>

**Exposure No. 3**

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Thickness (in foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buff coloured shale ((F_1C))</td>
<td>2’-6”</td>
</tr>
<tr>
<td>Massive sandstone</td>
<td>1’</td>
</tr>
<tr>
<td>Carbonaceous shale ((F_1D))</td>
<td>0’-8”</td>
</tr>
<tr>
<td>Sandstone</td>
<td>0’-8”</td>
</tr>
<tr>
<td>Carbonaceous shale ((F_1E))</td>
<td>6’-0”</td>
</tr>
<tr>
<td>Coarse grained, massive sandstone</td>
<td>2’-0”</td>
</tr>
<tr>
<td>Ferruginous sandstone</td>
<td>1’-6”</td>
</tr>
<tr>
<td>Carbonaceous shale ((F_1F))</td>
<td>0’-8”</td>
</tr>
<tr>
<td>Sandstone</td>
<td>1’-0”</td>
</tr>
<tr>
<td>Buff coloured shale ((F_1G))</td>
<td>0’-10”</td>
</tr>
<tr>
<td>Coarse grained, massive sandstone</td>
<td>1’-6”</td>
</tr>
<tr>
<td>Carbonaceous shale ((F_1H))</td>
<td>exact thickness unknown, exposed about 3’-0”</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>18’-4”</td>
</tr>
</tbody>
</table>

**Exposure No. 2**

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Thickness (in foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massive sandstone</td>
<td>12’-0”</td>
</tr>
<tr>
<td>Carbonaceous shale ((F_1I))</td>
<td>1’-0”</td>
</tr>
<tr>
<td>Massive sandstone</td>
<td>2’-6”</td>
</tr>
</tbody>
</table>
Exposure No. 2

Lithology: Thickness (in foot)

Buff coloured shale (F1J) 0'-6"
Coarse grained sandstone 1'-0"
Fine grained shale (F1K) 1'-0"
Sandstone 2'-0"
Fine grained shale (F2L) 1'-6"
Ferruginous sandstone 4'-0"
Carbonaceous shale (F3M) 1'-0"
Fine grained sandstone 2'-0"
Carbonaceous shale (F3N) 1'-0"
Black, hard, compact, fine grained sandstone 3'-0"
Carbonaceous shale (F3O) 1'-0"
Massive sandstone 4'-0"
Carbonaceous shale (F3P) 4'-0"
Massive sandstone 4'-0"
(coarse grained)
Carbonaceous shale (F3Q) 0'-3"
Sandstone 3'-0"
Carbonaceous shale (F3R) 5'-0"
Massive sandstone 4'-0"
Black, fine grained, compact sandstone 2'-6"
Ferruginous sandstone 4'-0"
Black, fine grained, compact sandstone 0'-9"
Massive sandstone 0'-6"
Carbonaceous shale (F3S) 2'-0"
Coal (F4T, F4U) 10'-0"
Shaly coal (F4V) 1'-0"
Carbonaceous shale (F4X) exact thickness unknown, exposed about 2'-0"
Total 79'-3"

Exposure No. 1

Lithology: Thickness (in foot)

Massive sandstone 16'-0"
Buff coloured shale (F2A) 0'-6"
Sandstone 1'-0"
Buff coloured shale (F2B) 0'-8"
Massive sandstone 15'-0"
Carbonaceous shale (F2C) 5'-0"
Ferruginous sandstone 2'-0"
Carbonaceous shale (F2D) 1'-0"
Sandstone (fine grained) 5'-0"
Carbonaceous shale (F2E, D2F, F2G) 5'-0"
Sandstone (coarse grained) 2'-0"
Carbonaceous shale (F2H) 4'-0"
Fine grained sandstone 1'-6"
Carbonaceous shale 12'-0"
Carbonaceous shale (F4I, F4J) 4'-0"
Sandstone (coarse grained) exact thickness unknown, exposed about 3'-0"
Coal (F4K) 2'-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 PALYNOTOLOGY

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

Genus Leiotritles (Naumova) Potonié & Kremp, 1954

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

Leiotritles sp.

Pl. 1, Figs. 1, 2

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

Comparison — This species is comparable to Leiotritles 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 up to three-fourth the radius of the spore. L. adnatus has possesses straight to slightly convex interapical margins but can be distinguished from Leiotritles sp. by the presence of very well developed, tapering trilete extending up to three-fourth the equator.

Genus Retusotritles Naumova, 1953

Type Species — Retusotritles simplex Naumova, 1953.

Retusotritles sp.

Pl. 1, Figs. 3, 4

Description — Spores circular in polar view. Overall size range 32-41 μ x 33-41 μ.
Trilete distinct, extending up to 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 Rawghanj 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 Venkatachal & Bharadwaj (1964); Calamospora microrugosa Schopf, Wilson & Bentall (1944) and also recorded in the spores recovered from Hüttonia 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 Potonie, 1958

Type Species — Leschikisporis aduncus (Leschik) Potonie, 1958.

Remarks — Leschikisporis was instituted by Potonie (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 Punctatissporites obliquus. The species has further been transferred to Punctatissporites obliquus by Venkatachal & Bharadwaj (1964) and subsequently to Leschikisporis obliquus by Wilson and Venkatachal (in press).

Spores illustrated here as well the ones described by Leschik (1955), Kosanke (1950), Venkatachal & Bharadwaj (1964), Wilson and Venkatachal (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 Punctatissporites and Punctatospirites as suggested by Potonie (1958) and Wilson & Venkatachal (in press). Wilson & Venkatachal (1967) have reviewed the status of Leschikisporis Potonie, 1958 and indicated that Circletissporites Miller, 1966 is a synonym of the former.

Leschikisporis baccatus sp. nov.

Pl. 1, Figs. 23, 24

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

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

Specific Diagnosis — Circular-subcircular, size range 27-41 μ x 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 Potonie compares closely with the present species in size but differs in possessing laevigate to finely granulose exine. Leschikisporis obliquus (Kosanke) Wilson and Venkatachal (1967) is bigger in size with sparsely spaced sculptural elements.

Infraturma — Apiculati (Bennie & Kidston) Potonie, 1956

Genus Verrucosisporites (Ibrahim) Smith et al., 1964

Type Species — Verrucosisporites verrucus Ibrahim, 1933.

Verrucosisporites sp.

Pl. 1, Fig. 5

Description — Spore circular in polar view; 50 x 46 μ. Trilete well marked, rays equal, uniformly broad, extending up to 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 verrucat 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 subtrangular 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 flattened with the result its exact shape can not be determined. Potonié and Kremp (*i.e.*) 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 *Lophotriteles* (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.

**Holotype** — Pl. 1, Fig. 6, size 39 μ x 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. Commisure 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 x 25-36 μ. Apices bluntly rounded, interapical margin straight to convex. Trilete well developed, lips narrow and straight. Commisure 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 conusus** sp. nov.

**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. conusus* distinguishes from other species in possessing prominent trilete apparatus and subcircular to roundly triangular overall shape.
Anapiculisporites sp. B

Pl. 1, Fig. 13

Description — Spore triangular in polar view, 46×46 μ. Trilete prominent, tapering at ends and extending up to 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. virginis and A. granulatus in possessing larger, densely placed coni.

Genus Apiculisporis Potonié & Kremp, 1956

Type Species — Apiculisporis aculeatus Potonié & Kremp, 1955.

Apiculisporis 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 up to 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 Neoaristrikkia Potonié, 1956

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

Neoaristrikkia 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, 46-59 μ×61-64 μ. Trilete well developed, ± equator; raised, apex and vertex high, labra up to 4 μ thick on either side of the suture. Exine up to 4 μ thick, rarely folded. Exine on distal side warty, warts may be pinheaded, bacular or irregular in shape, a few coni can be seen interspersed among the sculptural elements.

Comparison — Anapiculisporites 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 Anapiculisporites is either spinose or conate while in Altitriletes it is warted or verrucoe. Diditectriletes Venkatachala & Kar (1965) is triangular in polar view and characterized by granulose and achinate exine on proximal and distal surface respectively. Lacintriletes Venkatachala & Kar (1965) is distinguished by the presence of granulose to microverrucoe ornamentation on distal side and the trilete is always associated with folds. Apiculisporis Potonié & Kremp is ornamented on both the surfaces.

Derivation of name — The name Altitriletes is derived from the elevated trilete mark. Latin: Altus = high.
Alitritules 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. Trilite raised and well developed. Exine thick, proximally lavedigate and distally warted.

Description — Size range 46-59μ × 61-64 μ. Trilite 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.

Subinfraturna — Varitrilete Venkatachala & Kar, 1965

Remarks — Microbaculispora Bharadwaj, Microfoveolalispora Bharadwaj, Didicirriletes Venkatachala & Kar and Lacinitriletes Venkatachala & Kar, share in common a sub-triangular to triangular shape with well marked trilite 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, size range 32-36 μ × 36-46 μ; trilite up to 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. Trilite well developed, commissure well marked, associated folds in most of specimens up to 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 Didicirriletes Venkatachala & Kar, 1965

Type Species — Didicirriletes horridus Venkatachala & Kar, 1965.

Didicirriletes 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. Trilite associated with folds. Exine proximally lavedigate, distally microverrucose.

Description — Spores found mostly in polar view. Apices acute to bluntly rounded. Interapical margins convex, occasionally constricted at one end. Trilite well developed, extends up to 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.
Infuratma—Murornati Potonié & Kremp, 1954
Genus Dictyotrilites (Naumova) Potonié & Kremp, 1954

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

Dictyotrilites 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 — Dictyotrilites invisus Bharadwaj & Saluja (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 spine cavity outline and bearing a distinct mesh forming muri for its ornamentation. Dictyotrilites 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 Dictyotrilites. For the present due to paucity of material investigated and non-availability of type specimens of several of these species we defer making any emendation of the genus Dictyotrilites.

Turma —Monoletes Ibrahim, 1933
Subturma —Aszononoletes Luber, 1935
Infuratma—Psilamonooler 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 collientes 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.

Infuratma—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, 28-57 μ × 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, sculptural 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 & Saluja (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 microvulvocose 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 microvulvocose.

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 granum and microvulvocae. *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 & Venkatatachala, 1963

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

*Thymospora* sp.

Pl. 2, Fig. 51

Description — Spores bilaterial, 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** — *Sacites* Erdman, 1947

**Subturna** — *Monosaccites* (Chitaley) Potonié & Kremp, 1954

**Infraurma** — *Apertacorpit* 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 & Saluja (1964) and others. Lele (1964) in a study from the Lower Gondwana sediments has instituted two genera *Plicatisporites* and *Virkkipollenites* to accommodate *Nuskoisporites* — like pollen. *Virkkipollenites* appears to be a junior synonym of *Cannanporopollis* Potonié & Sah (1959). The problems need a careful study before the transfer can be effected.

**Infraurma** — *Aletisacrites* 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 verrucose pattern.

**Densipollenites inusus** Bharadwaj & Saluja, 1964

Pl. 4, Figs. 68-73

Holotype — Bharadwaj & Saluja, 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.

*Holotype* — Pl. 4, Figs. 74-77

*Type Locality* — Badam, North Karanpur 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 *Florinates* 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. invius* Bharadwaj & Saluja differ from the present species in having larger size range and presence of folds in the saccus.

Infraturma —*Striasacciti* Bharadwaj, 1962

*Genus Striemosaccites* Bharadwaj, 1962

*Type Species* — *Striemosaccites ovatus* Bharadwaj, 1962.

*Striemosaccites ovatus* Bharadwaj, 1962

*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, inframicoreticulate. Saccus well developed, coarsely infrareticulate, mesh size 2-3 μ, lumina shallow.

Subturma —*Disaccites* Cookson, 1947

Infraturma —*Podocarpoiditi* Potonié, Thomson & Thüergart, 1950

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

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

*Platsaccus sp.*

*Holotype* — 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, micro- verrucose. 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 *Platsaccus* 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. *Platsaccus* 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 *Platsaccus* (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 *Platsaccus* are mostly found in the Permian-Triassic sediments. *Platsaccus* and *Cuneatisporites* share in common a central body devoid of any haptotypic mark or striations. *Platsaccus* and *Cuneatisporites* can be distinguished by the nature of the central body and distal attachment. In *Platsaccus* 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.

*Cuneatisporites* sp.

*Holotype* — 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 sacci to central body equatorial, distal attachment convex. Sacci 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 Jugaspores Leschik, Grebe & Schweitzer (1962) included Limitisporites rectus Leschik, the type species of the very genus as a junior synonym of Illinites delasauccei (Potonié & Klaus) Grebe & Schweitzer along with Jugaspores delasauccei 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 Ulmannia frumentaria (Schloetheim) Goeppert, Grebe & Schweitzer (1962) came to the conclusion that the dispersed spore genera Illinites, Limitisporites and Jugaspores are closely similar to the spores of Ulmannia frumentaria. Potonié (1962), however, opined that Lueckisporites virkkaiae resembles with the spores of U. frumentaria. Lueckisporites is characterized by exo-exinal thickening on the central body and in the opinion of Grebe and Schweitzer (i.e.) this character is not represented in the spores of above mentioned fructification. Klaus (1963) in a recent study has maintained Illinites, Jugaspores 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—Striatitii (Pant) Bharadwaj, 1962

Genus Striatitites (Pant) Bharadwaj, 1962

Type Species — Striatitites swardii (Virkki) Pant, 1955.

Remarks — The genus Striatitites 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 disaccate pollen with microverrucose central body and hemispherical sacci.

Striatites and Lahirites according to Bharadwaj (i.e.) 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):

Striatopinules Sedova, 1956
Striatopites Sedova, 1956
Lueckisporites Potonié & Klaus, 1954 (in parts)
Lunatisporites Leschik, 1956
Protosaccitina Malyavkina, 1953 (in parts)
Striatites Pant, 1956
Taeniasporites Leschik, 1956 (in parts)
Famipollinates Bharadwaj, 1962
Rhytisaccus Naumova, 1939 (in parts)
Striatocordaites ex Abramova and Marchenko, 1960
Striatocoferites ex Abramova & Marchenko, 1960
Striatohaploxypinules ex Abramova & Marchenko, 1960
Pemphygales Lüber and Valts (in parts)
Coniferaletes Andreyeva, 1956 (in parts)
This has made *Protohaploxypinus* a heterogeneous 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 Karanpur basin, Bihar; Barakar Stage (Permian).

**Specific Diagnosis** — Disaccate, diplolynoid 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 & Saluja (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 & Saluja (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 Karanpur basin, Bihar; Barakar Stage (Permian).

**Specific Diagnosis** — Disaccate, diplolynoid 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. Sacchi more than semicircle, infrareticulate, mesh size 1-2 μ, lumina shallow.

**Comparison** — *Striatites lentus*, *S. solitus*, *S. communis* described by Bharadwaj and Saluja (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 Karanpur basin, Bihar; Barakar Stage (Permian).

**Specific Diagnosis** — Disaccate, diplolynoid, 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. Sacchi 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 & Saluja (1964) is having biconvex sulcus. *S. lentus* and *S. solitus* Bharadwaj & Saluja (1964) can be distinguished by the presence of lateral ridges on the central body.
S. lectus can be distinguished by its very narrow sulcus.

Striatites communis Bharadwaj & Saluja, 1964

Pl. 6, Fig. 99

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

Description — Diplolyxylonoid 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, infra-rectulate, 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.

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

Specific Diagnosis — Diplolyxylonoid, bilateral, disaccate pollen grains. 23-32 μ × 50-78 μ. Central body subcircular, minutely microverrucose, proximally horizontally grooved; sacci pitcher shaped infrarectulate, 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 infrarectulate.

Comparison — Verticipollenites gibbosus Bharadwaj & Saluja (1964) also lacks vertical partitions; but can be differentiated by the presence of a thick ridged central body. V. simplex Bharadwaj & Saluja (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 ranigawiensis Bharadwaj, 1962.

Remarks — Bharadwaj (1962) instituted the genus Lahirites to accommodate striated (grooved) bisaccate pollen grains with microverrucose or laevigate sculpture and infrapunctate 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 albus 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 — Diplolyxylonoid, 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 & Saluja (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 & Saluja (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, ± uniformly 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 alutus* can be distinguished from the species described here by its uniformly broad sulcus and sparsely infrapunctate central body. *L. parvus* Bharadwaj & Saluja possesses central body with marginal ridge and coarsely infrapunctate exine. *L. rarus* Bharadwaj & Saluja 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).


_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. alutus* and *L. parvus* are larger in size.

*Lahirites rarus* Bharadwaj & Saluja, 1964
Pl. 7, Figs. 118-120

_Holotype_ — Bharadwaj & Saluja, 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 & Saluja, 1964
Pl. 7, Figs. 121-122

_Holotype_ — Bharadwaj & Saluja, 1964; Pl. 9, Fig. 131.


_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 Karanpur basin, Bihar; Barakar Stage (Permian).

**Specific Diagnosis** — Diploxyloidoon, 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. Sacchi 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 sacchi to central body equatorial, distal attachment close to each other covering most of the central body area leaving a narrow bladder free sulcus. Sacchi ± circular, radial folds sometimes present, infrareticulate, mesh size 1-3 μ, lumina shallow.

**Comparison** — Hindipollenites indicus Bharadwaj (1962) and H. oblongus Bharadwaj & Saluja (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** — Diploxyloidoon, 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 sacchi to central body equatorial, distal attachment straight to slightly convex. Sacchi hemispherical, mesh size 2-3 μ, lumina shallow.

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

**Type Species** — Striatopicelles suchoensis Sedova, 1956.

**Remarks** — Zoricheva and Sedova (1954) proposed the name Striatopicelles without proper generic diagnosis or description. They also did not designate any type species. Sedova (1956), however, validated this genus and included the haploxyloidoon disaccate pollen grains with horizontal striations and finely reticulate (? inframicro-reticulate) 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 Fauntipollenites to include bisaccate, bilateral, haploxyloidoon pollen grains with ill-defined, inframicroreticulate central body having a number of horizontal striations with a distal biconvex sulcus area. Fauntipollenites Bharadwaj (1962) is considered here as a junior synonym of Striatopicelles (Zoricheva & Sedova) Sedova, 1956.

Hart (1964) emended Protohaploxypinus Samoilovich (1952) and included Striatopicelles along with Striatopinities Sedova, Luechisporites Potonie & Klaus (in parts), Lunalisporites Leschik, Striatictes Pant, Taeiaesporites Leschik (in parts), Fauntipollenites Bharadwaj and other genera in it. Protohaploxypinus in the sense defined by Hart (l.c.) is not acceptable to the present authors.

**Striatopicelles minutus** sp. nov.

Pl. 8, Figs. 135-138

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

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

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

**Comparison** — Striatopicelles minutus is distinguished from Fauntipollenites 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 woodhousei Venkatachala & Kar, 1964b.
Schizopolis wodhousei 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.

Schizopolis 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. Sacchi small, half the size of the pollen body, infrareticulate, mesh size 1-2 μ.

Genus Korbapollemites Tiwari, 1964

Type Species — Korbapollemites novus Tiwari, 1964.

Korbapollemites novus Tiwari, 1964
Pl. 9, Figs. 164, 165

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


Remarks — Korbapollemites 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 Korbapollemites 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 radialis Wilson, 1962.

Rhizomaspora sp.
Pl. 9, Figs. 166-167

Description — Bisaccate, bilateral, diploxyylonoid pollen grains. Central body subcircular to vertically oval, ornamented proximally with radiating or diverging grooves; exine of central body upto 2 μ thick, laevigate and infrapunctate. Proximal attachment of sacchi to central body equatorial, distal attachment juxtaposed. Sacchi hemispherical, infrareticulate, 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 sacchi. 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 Polypliphites along with genera like Gnetaceae pollenites and Ephedrites. 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 trilette in the genus Marsupipollenites Balme and Hennelly.
Bharadwaj (1962) restricted Marsupipollenites for trilete forms and transferred the rest to Villatina, considering Villatina as monocolepate with striations on both the surfaces.

Zauer (1960) extensively studied the Villatina group of pollen from Solikamsk basin (Late Permian) and agreed with Luber (1941) that Villatina 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 Villatina 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 Villatina with well drawn test-figures and its subsequent development in others striated bisaccate genera. In her opinion the aperture in Villatina 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 Villatina. Mention should, however, be made here that Samoilovich (1953) did not emphasise these characters and the test-figures given by her also do not reveal the monoradial slit on which Zauer laid much emphasis.

Villatina and allied pollen, have been classed differently by different Palynologists. Jansonius (1962) and Wilson (1962) emended Villatina designating Villatina 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 Villatina.

Jansonius (1962) assumed that exine in Villatina consists of a thin intine 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 Villatina 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 Villatina shows similarity with the pollen grains of Ephetra antisiphilitica (Erdtman, 1957) as both of them possess more or less same exine structure.

Wilson (1962) restricted the genus Villatina for the forms without sacchi 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 Villatina to seed ferns or true ferns.

Villatina lata Wilson, 1962
Pl. 8, Figs. 141-143

Holotype — Wilson, 1962; Pl. 3, Fig. 11.
Description — Oval, 30-35 μ×40-46 μ. Exine thin, occasionally folded, perpendicular to longer axis, infrastructured, horizontal striations 8-12.

Infraturma — Disacciatrileti (Leschik) Potonie
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 μ×50-73 μ. Central body not well defined, exine thin, inframicroreticate. Proximal attachment equatorial; distal attachment closely placed leaving a narrow funnel shaped sulcus, sacchi 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 — Polyplipectes Erdtman, 1952

Genus Gnetaceae pollenites Thiergart, 1938

Type Species — Gnetaceae pollenites ellipticus Thiergart, 1938.

Gnetaceae pollenites sinuosus (Balme & Hennelly) Bharadwaj, 1962

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

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

Description — Elliptical, 32-50 μ x 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.

Gnetaceae pollenites punctatus sp. nov.

Pl. 10, Figs. 178-182

Holotype — Pl. 10, Fig. 178. Size 73 x 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 x 73-78 μ; longitudinal folds almost extend end to end, tapering at ends. Exine about 2 μ thick; infrapunctate, puncta evenly spaced.

Comparison — Gnetaceae pollenites punctatus differs from G. sinuosus 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 Ginkgocycadophytes Samoilovich, 1953

Synonym — Entylissa Naumova, 1937.

Type Species — Ginkgocycadophytes caperatus (Luber) Samoilovich, 1953.

Ginkgocycadophytes 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 x 46-69 μ, exine upto 2 μ thick, infrgranulose. Colpus extending through the whole length of the pollen, funnel shaped.

Subturma — Monopyches (Naumova) Potonié, 1958

Genus Decussisporites Leschik, 1955

Type Species — Decussisporites delineatus Leschik, 1955.

Decussisporites pilus sp. nov.

Pl. 10, Figs. 185-187

Holotype — Pl. 10, Fig. 185. Size 73 x 36 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 x 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 — Decussisporites delineatus is smaller in size with a uniformly broad colpus.

Decussisporites dubius sp. nov.

Pl. 10, Figs 189-190

Holotype — Pl. 10, Fig. 189. Size 55 x 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 x 46-73 μ. Exine 1.5-2.5 μ; thick, infrastructure indistinct. Horizontal striations 10-13, vertical striations 3-6. Colpus distinct with flappy lips.
Comparison — Decussatissporites 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)
Venкатачала, Goubin & Kar, 1967

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

**Emended 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 up to 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 up to 5 per cent in the percentages.

*Exposure No. 1 — Eleven samples (F, K-F2A) 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 Infraturna (*Apiculati* and Subinfraturna *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, Laciniriletes* and *Altitriletes* are subdominant in the assemblage. *Leiotriletes, Laevigatosporites Punctatosporites, Platysaccus, Verteicollinites, Schizopolis, Sulcatisporites, Ginkgocycadophytes, Gnetaceae-pollenites, Decussatisporites* and *Guttulapollenites* are present in less than 2 per cent in the material.

Sample F, H is populated by 29 genera. Among them trilete spore are in overwhelming majority and represents 80 per cent of the whole assemblage. *Microbaculispora, Didectriletes, Laciniriletes* and *Altitriletes* are dominant. *Lophotriletes* and *Apiculatisporis* are subdominant. *Retusotriletes, Verrucosisporites, Leschikisporis, Laevigatosporites, Punctatosporites, Platysaccus, Cuneatisporites, Verteicollinites, Hindipollenites, Stortersporites, Striatopicites, Rhizomaspora, Sulcatisporites, Ginkgocycadophytes, Ephedripites, Decussatisporites, Guttulapollenites* representing less than 2 per cent individually. *Dictyotriletes, Thymospora, Vinkhiplentites, Parasaccites, Striomonosaccites, Densipollenites, Korlapollenites, Hamiapollenites, Vittatina, Vescaspora, Gnetaceae-pollenites* are not met within the counting of 200 specimens.

The sample F, F is populated by 29 genera. Trilete spores are very rich in the assemblage. *Didecitriletes* is the dominant genus in this preparation. *Apiculatisporis, Lophotriletes, Laevigatosporites, Stortersporites* and *Schizopolis* are subdominant. *Retusotriletes, Verrucosisporites, Leschikisporis, Thymospora, Platysaccus, Cuneatisporites, Verteicollinites, Rhizomaspora, Ginkgocycadophytes, Decussatisporites* and *Guttulapollenites* are present (individually less than 2 per cent). *Dictyotriletes, Vinkhiplentites, Plicatipollenites, Parasaccites, Striomonosaccites, Densipollenites, Illinites, Vittatina, Korlapollenites, Hamiapollenites, Vescaspora, Gnetaceae-pollenites and Ephedrripites* are absent within 200 specimens.

Sample F, E contains 26 genera. Trilete genera are well represented. *Altitriletes, Laciniriletes, Didecitriletes, and Microbaculispora* are dominant. *Leiotriletes, Retusotriletes, Verrucosisporites, Laevigato-
sporites, Punctatosporites, Playsaccus, Verticilliferites, Hindipollenites, Rhizospora, Vittatina, Ginkgoceydophytes and Guttulapollenites each present in less than 2 per cent in the assemblage. Leschikisporis, Dictyotrites, Thymospora, Virkhipollenites, Plicatipollenites, Striomonosaccites, Densipollenites, Vittatina, Korbapollenites, Hamiapollenites, Gnetaceapollenites, Ephedripites, Decussatisporites and Guttulapollenites are absent within 200 specimens.

F₂D sample is represented by 26 genera. Trilete genera are most abundant and contributing 62 per cent to the whole assemblage. Lacinitriletes, Didicritriletes, Microbaculispora and Allitriletes are dominant in the assemblage. Anapiculatisporites, Neorastrickia, Laevigatosporites, Punctatosporites, Illinites, Verticipollenites, Hindipollenites, Rhizospora, Ginkgoceydophytes, Ephedripites, Decussatisporites represent less than 2 per cent individually. Leiotoriletes, Retusotriletes, Verrucosisporites, Leschikisporis, Dictyotrites, Thymospora, Virkhipollenites, Plicatipollenites, Parasaccites, Striomonosaccites, Densipollenites, Korbapollenites, Hamiapollenites, Vittatina, Vesicaspora and Gnetaceapollenites are not met within 200 specimens.

F₂C is populated by 22 genera. Lacinitriletes, Didicritriletes, Allitriletes and Microbaculispora are dominant. Schizopolis, Strotersporites, Striatopicite and Striatites are also present in good percentage. Apiculatisporites, Laevigatosporites, Punctatosporites, Playssaccus, Cuneatisporites, Verticipollenites, Hindipollenites, Rhizospora, Ginkgoceydophytes and Decussatisporites present each in less than 2 per cent in the assemblage. Leiotoriletes, Retusotriletes, Verrucopsisporites, Leschikisporis, Anapiculatisporites, Neorastrickia, Dictyotrites, Thymospora, Virkhipollenites, Plicatipollenites, Striomonosaccites, Densipollenites, Illinites, Korbapollenites, Hamiapollenites, Vittatina, Vesicaspora, Cuneatisporites, Ephedripites and Decussatisporites 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 (F₁X, F₁W and F₁V). Monosaccate pollen are very poorly represented. Bisaccate pollen are present in all the samples and dominant in the upper parts (F₁L, F₁K) of the section. Polypllicate and colpute pollen grains are fairly represented in most of the samples.

The Carbonaceous shale sample (F₃X) is the lower most sample and is populated by 22 genera. Lacinitriletes, Didicritriletes, Microbaculispora and Allitriletes are sub-dominant in the assemblage. Leiotoriletes, Verticipollenites, Lahirites, Strotersporites, Striatopicite, Schizopolis, Sutacatisporites, Ginkgoceydophytes and Decussatisporites are represented with less than 2 per cent each. Verrucosisporites, Leschikisporis, Dictyosporites, Thymospora, Virkhipollenites, Plicatipollenites, Striomonosaccites, Densipollenites, Playssaccus, Cuneatisporites, Illinites, Hindipollenites, Rhizospora, Vittatina, Hamiapollenites, Korbapollenites, Vesicaspora, Gnetaceapollenites and Ephedripites are absent within 200 specimens.

The sample F₃W 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. Allitriletes, Didicritriletes and Microbaculispora are also quite dominant. Anapiculatisporites, Neorastrickia, Thymospora, Striatites, Verticipollenites, Hindipollenites, Ginkgoceydophytes, Gnetaceapollenites and Guttulapolollenites each present less than 2 per cent in the assemblage. Leiotoriletes, Retusotriletes, Verrucosisporites, Leschikisporis, Dictyotrites, Virkhipollenites, Plicatipollenites, Striomonosaccites, Densipollenites, Playssaccus, Cuneatisporites, Illinites, Rhizospora, Korbapollenites, Hamiapollenites, Vesicaspora, Ephedripites and Decussatisporites are absent within 200 specimens.

The sample F₃V 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, Didicritriletes and Allitriletes are dominant. Leschikisporis, Thymospora, Verticipollenites, Lahirites, Schizopolis, Vittatina, Sutacatisporites, Ginkgoceydophytes, Gnetaceapollenites, Ephedripites, Decussatisporites and Guttulapol pollenites are each less than 2 per cent in the population. Leiotoriletes, Retusotriletes, Dictyotrites, Virkhipollenites, Plicatipollenites, Striomonosaccites,
Densipollenites, Platysaccus, Cuneatisporites, Illinites, Rhizomaspora, Hamiapollenites and Vesicaspora are not found within 200 specimens.

The sample \( F_{1}O \) has trilete spores in great majority. The assemblage is represented by 30 genera. Lophotriletes and Apiculatisporites are dominant, Verrucosisporites, Leiotiroletes and Microbaculispora are also well represented in the assemblage. Thy- mospora, Densipollenites, Cuneatisporites, Verticipollenites, Striatopicites, Schizopollis, Sulcatisporites, Ephemidites, Decussisporites and Guttulapollenites are less than 2 per cent in the assemblage individually. Dictyotriletes, Virkkipollenites, Plicatipollenites, Striomentosaccites, Platysaccus, Illinites, Hindipollenites, Rhizomaspora, Hamiapollenites, Kornapollenites and Vesicaspora are not present among 200 counted specimens.

The sample \( F_{1}P \) has trilete spore upto 61.5 per cent of the total assemblage. Lophotriletes and Apiculatisporites are dominant. Verrucosisporites, Anapliculatisporites and Laevigatosporites are subdominant. Leiotiroletes, Altitriroletes, Thymospora, Densi- pollenites, Verticipollenites, Lahirites, Schizopollis, Sulcatisporites, Gnetaceae pollenites and Guttulapollenites are less than 2 per cent individually. Dictyotriletes, Virkkipollenites, Plicatipollenites, Striomentosaccites, Platysaccus, Cuneatisporites, Illinites, Hindipollenites, Kornapollenites, Rhizomaspora, Hamiapollenites and Vesicaspora are not found within 200 specimens.

The sample \( F_{1}O \) shows an overwhelming majority of the trilete spores. In all there are 30 genera. Lophotriletes and Apiculatisporites are dominant contributing 16 and 14 per cent respectively. Anapliculatisporites, Microbaculispora, Laevigatosporites and Striatites are also common in the assemblage. Densipollenites, Verticipollenites, Hindipollenites, Schizopollis, Sulcatisporites, Gnetaceae pollenites and Decussisporites contribute less than 2 per cent individually. Thymospora, Virkkipollenites, Pli- catipollenites, Striomentosaccites, Platysaccus, Cuneatisporites, Illinites, Kornapollenites, Rhizomaspora, Hamiapollenites and Vesi- caspora are not found within 200 specimens.

The sample \( F_{1}N \) has 34 genera. Trilete ones contribute 46 per cent of the total assemblage. Lophotriletes and Apiculatis- sporites are dominant and contributing 19 and 11 per cent respectively. Leiotiroletes, Retusotriletes, Verrucosisporites, Leschi- kisporites, Lacinitriletes, Altitriroletes, Tymospora, Striomentosaccites, Densipollenites, Platysaccus, Cuneatisporites, Verticipollenites, Hindipollenites, Schizopollis, Rhizomaspora are present less than 2 per cent in the assemblage individually. Dictyotriletes, Virkkipollenites, Plicatipollenites, Illinites, Korn- apollenites, Hamiapollenites, Vesicaspora are not present within 200 specimens that have been counted.

The carbonaceous shale designated \( F_{1}M \) 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 Apiculatisporites are dominant. Lei- triroletes, Lacinitriletes and Striatites are also quite common. Retusotriletes, Verrucosisporites, Altitriroletes, Thymospora, Stri- monosaccites, Densipollenites, Platysaccus, Cuneatisporites, Verticipollenites, Hindipollenites, Stroterisporites, Schizopollis and Sulcatisporites are present less than 2 per cent individually in the assemblage. Virkkipollenites, Plicatipollenites, Illinites, Kornapollenites, Rhizomaspora, Hamiapollenites and Vesi- caspora are not met within 200 specimens.

The sample \( F_{1}L \) contains trilete, monolete, bisaccate and colpate spores and pollen classified into 38 genera, bisaccate pollen contributing 50 per cent to the assemblage. Schizopollis, Striatites, Stroterisporites and Striatopicites are dominant. Lophotriletes, Laevigatosporites, Verticipollenites and Hindipollenites are subdominant. Verrucosisporites, Leschiquisporites, Microbaculis-pora, Didecitriletes, Lacinitriletes, Altitriroletes Striomentosaccites, Densipollenites, Platysaccus, Cuneatisporites, Illinites, Kornapat- pollenites, Hamiapollenites, Vesicaspora, Sulcatisporites and Ginkgocycadophytes are less than 2 per cent individually. Dictyotriletes, Virkkipollenites and Plicatipollenites are absent among 200 specimens counted.

The sample \( F_{1}K \) is populated by 34 genera. Bisaccate pollen contribute 59.5 per cent to the assemblage. Striatites and Lahirites are dominant. Apiculatisporites, Laevigato- sporites, Verticipollenites and Stroterisporites are subdominant. Retusotriletes, Leschi- kisporites, Neoaristrichia, Microbaculispora, Didecitriletes, Lacinitriletes, Altitriroletes, Thymospora, Striomentosaccites, Platysaccus,
Illinites, Schizopolis, Villatina, Korhapollenites, Ginkgocycadophytus, Ephedrites and Guttulapollenites contribute less than 2 per cent individually. Dictyotriletes, Virkhipollenites, Plicatipollenites, Rhizomaspora, Hamiapollenites, Vesicaspora and Gnetaceae pollenites are not found within 200 specimens.

Exposure No. 3 — Six samples (F_H-F_C) 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_H represents 34 genera. Bisaccate is very common and contributes 65.5 per cent to the assemblage. Striatites and Lahirites are dominant. Lophotritules, Verticopollenites, Strotersporites and Striatopicites are subdominant. Retusotriletes, Verrucosporites, Neorastrichia, Didectritules, Lacintriletes, Allitriletes, Laevigatosporites, Punctatosporites, Striomenosaccites, Platysaccus, Cuneatisporites, Hindipollenites, Schizopolis, Villatina, Korhapollenites, Rhizomaspora, Ginkgocycadophytus, Gnetaceae pollenites, Ephedrites, Decussatisporites and Guttulapollenites represent less than 2 per cent each. Dictyotriletes, Thymospora, Virkhipollenites, Plicatipollenites, Illinites, Hamiapollenites and Vesicaspora are not found within 200 counted specimens.

The sample F_C shows an enormous development of bisaccate pollen contributing 75.5 per cent to the whole assemblage. Striatites and Lahirites are again in dominance. Verticopollenites, Strotersporites and Striatopicites are subdominant. Leiotriletes, Retusotriletes, Verrucosporites, Leschikisporis, Anapliculatisporites, Lophotriletes, Neorastrichia, Microbaculispora, Didectritules, Lacintriletes, Allitriletes, Laevigatosporites, Punctatosporites, Striomenosaccites, Platysaccus, Illinites Schizopolis, Ginkgocycadophytus, Gnetaceae pollenites, Ephedrites and Decussatisporites each contribute less than 2 per cent. Dictyotriletes, Thymospora, Virkhipollenites, Plicatipollenites, Korhapollenites, Rhizomaspora, Hamiapollenites and Vesicaspora are not found within 200 counted specimens.

The sample F_H is represented by 31 genera. Bisaccate pollen are very rich contributing 81.5 per cent to the assemblage. Striatites and Lahirites are dominant. Verticopollenites, Strotersporites and Striatopicites are also quite common. Leiotriletes, Apicalatisporis, Anapliculatisporites, Neorastrichia, Microbaculispora, Didectritules, Lacintriletes, Laevigatosporites, Punctatosporites, Thymospora, Srimono-saccites, Densipollenites, Hindipollenites, Schizopolis, Korhapollenites, Rhizomaspora, Sulcatisporites, Ginkgocycadophytus, Gnetaceae pollenites, Ephedrites, Decussatisporites and Guttulapollenites contribute less than 2 per cent individually in the assemblage. Retusotriletes, Verrucosporites, Leschikisporis, Altitriletes, Dictyotriletes, Virkhipollenites, Plicatipollenites, Illinites, Hamiapollenites and Vesicaspora are absent within 200 counted specimens.

The sample F_E represents 37 genera. Bisaccate pollen are in the majority and contribute 54.5 per cent to the assemblage. Striatites, Lahirites and Strotersporites are dominant. Lophotritules, Verticopollenites and Striatopicites are subdominant. Leiotriletes, Retusotriletes, Verrucosporites, Leschikisporis, Neorastrichia, Didectritules, Lacintriletes, Altitriletes, Thymospora, Srimono-saccites, Platysaccus, Cuneatisporites, Hindipollenites, Korhapollenites, Hamiapollenites, Villatina, Vesicaspora, Ginkgocycadophytus and Gnetaceae pollenites are present less than 2 per cent individually in the assemblage. Dictyotriletes, Virkhipollenites, Plicatipollenites and Illinites are not found within 200 counted specimens.

The sample F_D is represented by 35 genera. Bisaccate contributes 53.5 per cent to the assemblage. Striatites and Lahirites are dominant. Densipollenites, Verticopollenites, Strotersporites and Striatopicites are subdominant. Leiotriletes, Retusotriletes, Verrucosporites, Anapliculatisporites, Neorastrichia, Microbaculispora, Altitriletes, Thymospora, Platysaccus, Cuneatisporites, Illinites, Schizopolis, Korhapollenites, Rhizomaspora, Ginkgocycadophytus, Gnetaceae pollenites and Decussatisporites are present in less than 2 per cent individually in the assemblage. Dictyotriletes, Virkhipollenites, Plicatipollenites, Hamiapollenites, Vesicaspora and Guttulapollenites are not found within 200 counted specimens.

The sample F_C represents 35 genera. Bisaccate is in great majority and contributes up to 71 per cent to the assemblage. Striatites and Lahirites are dominant.
TEXT-FIG. 3a—Histograms illustrating relative abundance of fossil spores-pollen groups.
Text-fig. 3b - Histograms illustrating abundance of trilete, monolete, monosaccate, bisaccate, polyplicate and colpate spore-pollen groups (arranged according to the sections studied).
Densipollenites, Verticipollenites, Strotersporites and Sulcatisporites are also quite common in the assemblage. Leiotriletes, Retusotriletes, Verrucosisporites, Lechikisporis, Anaplicatulapollenites, Neospathiceras, Microbalus spora, Didactylites, Laciniriletes, Altitriteles, Stromonosaccites, Platysaccus, Rhizomaspora, Viitaitama, Hamiapollenites and Sulcatisporites are less than 2 per cent individually in the assemblage. Densipollenites, Verticipollenites, Strotersporites, Altitriteles, Stromonosaccites, Platysaccus, Rhizomaspora, Viitaitama, Hamiapollenites and Sulcatisporites are less than 2 per cent individually in the assemblage. Densipollenites, Verticipollenites, Strotersporites, Altitriteles, Stromonosaccites, Platysaccus, Rhizomaspora, Viitaitama, Hamiapollenites and Sulcatisporites are less than 2 per cent individually in the assemblage.

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 (F1, F1A and F1B) 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. Trilette spores are poorly represented while monosaccate, polyplcitc and colpate pollen are represented as subdominant and accessory types respectively.

The samples F1, F1A, F1B represent 35 genera. Bisaccate contributes 76 per cent to the assemblage. Striatites and Lahirites are dominant. Densipollenites, Verticipollenites, Strotersporites and Striatopiceites are subdominant. Lohotriletes, Retusotriletes, Lecihiisporis, Anaplicatulapollenites, Neospathiceras, Microbalus spora, Didactylites, Laciniriletes, Altitriteles, Lervigatosporites, Punctatosporites, Stromonosaccites, Cuneatisporites, Ilimites, Schizopollis, Viitaitama, Korlapollenites, Rhizomaspora, Vesicaspora, Sulcatisporites, Ginkgocladophytes, Gneteaceapollenites, 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 F2K-F2C) and three lowermost samples (F1X, F1W and F1V) of the second exposure (see Text-Fig. 2). This zone is dominated by trilette spores. Among these Microbalus spora, Didactylites and Laciniriletes representing the group Varitriteles outnumber the other group of trilette spores represented by the groups Apiculati and Lervigati. Lohotriletes, Apiculatisporites are found in good number in the two lowermost samples (F2K and F2H) of the first exposure; their percentage, however, decrease in the upper most samples studied (F1W and F1V). The Lervigati group represented by Leiotriletes and Retusotriletes are present in small number of lowermost samples (F2K-F2E), but not encountered in the uppermost samples (F1W and F1F) of this zone.

Monolete spores represented by Lervigatosporites and Punctatosporites form a minor percentage in the assemblage. Thymospora is only found in two uppermost samples (F1W and F1V) of this zone. Monosaccate pollen are not recorded from this zone.

Platysaccus, Cuneatisporites and Ilimites of the nonstrate group are either absent or poorly represented in this zone.

Sulcatisporites, Ginkgocladophytes and Guttulapollenites are represented but is only second in position to the group Apiculati. Leiotriletes and Retusotriletes of the Lervigati 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 (F1Q, F1P, F1O) and found in poor percentage in the uppermost sample (F1N and F1M) of this zone.

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

Table 1 - Showing the Three Different Zones

<table>
<thead>
<tr>
<th>Zone</th>
<th>Trilete</th>
<th>Monolete</th>
<th>Monosaccate</th>
<th>Nonstriated</th>
<th>Striated</th>
<th>Polyplicate and Colpate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Rare or accessory</td>
<td>Absent or rare</td>
<td>Absent or rare</td>
<td>Rare or accessory</td>
<td>Dominant</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Rare or accessory</td>
<td>Absent or rare</td>
<td>Subdominant</td>
<td>Rare or accessory</td>
<td>Subdominant</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Rare or accessory</td>
<td>Subdominant</td>
<td>Subdominant</td>
<td>Rare or accessory</td>
<td>Subdominant</td>
<td></td>
</tr>
</tbody>
</table>

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 Lacinirites 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 aperture, were the dominant type of vegetation in Zone A. The dominance of the group \textit{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 Chlamydo spermaeous 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.

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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.


**EXPLANATION OF PLATES**

(All magnifications x 500)

**PLATE 1**

3-4. Retusotriletes sp. Photo Nos. 53/20, 54/6.
5. Verrucosospories sp. Photo No. 47/1.
6-7. Anapiciulatisporites vertitas sp. nov. Photo Nos. 50/18, 46/30.
8-10. Anapiciulatisporites sp. A Photo Nos. 49/9, 53/21, 53/25.
11-12. Anapiciulatisporites consorus sp. nov. Photo Nos. 54/21, 57/14.
20-22. Aciulatisporites sp. Photo Nos. 51/22, 51/1, 48/12.
28-32. Microcalulispora minutus sp. nov. Photo Nos. 55/9, 55/25, 55/2, 55/21, 55/7.

**PLATE 2**

33-37. Lacinitrites minutus sp. nov. Photo Nos. 54/19, 70/9. 70/10, 70/12, 48/18.
38-42. Alitritutes densis gen. et sp. nov. Photo Nos. 54/15, 54/30, 57/17, 54/18.
43-44. Dicyotritutes sp. Photo No. 54/22.
45-50. Laevigatisporites collinsect (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**

57-63. Punctatotritulates morosus sp. nov. Photo Nos. 48/6, 52/12, 53/17, 57/23, 52/5, 49/9, 52/21.
64. Virkihipollotes sp. Photo No. 45/30.

**PLATE 4**


**PLATE 5**

78-80. Strionomosaccites ovatus Bharadwaj, Photo Nos. 55/27, 53/18, 55/17.
81-82. Platvaccites sp. Photo Nos. 57/24, 53/7.
83-84. Cunealisporites sp. Photo Nos. 50/21, 48/21.
85. Illinites sp. Photo No. 57/8.
86-90. Striates orrlntus sp. nov. Photo Nos. 46/2, 46/34, 47/2, 48/27, 46/26.

**PLATE 6**

91-95. Striates 02dus sp. nov. Photo Nos. 46/14, 45/2, 50/11, 47/20, 45/5.
96-98. Striates &ctus sp. nov. Photo Nos. 51/24, 54/16, 49/4.
100-103. Verticiscopiates dehils sp. nov. Photo Nos. 45/8, 51/13, 47/7, 54/12.
104-106. Lahriites altatus sp. nov. Photo Nos. 49/8, 49/13, 45/26.

**PLATE 7**

113-117. Lahriites minutus sp. nov. Photo Nos. 55/4, 57/30, 52/17, 47/4, 45/25.
118-120. Lahriites varius Bharadwaj & Saluja. Photo Nos. 45/29, 55/23, 46/32.
121-122. Lahriites varius Bharadwaj & Saluja. Photo Nos. 50/14, 47/26.
123-127. Hindipollotes formosus sp. nov. Photo Nos. 45/13, 47/11, 45/27, 45/15, 47/34.
131. Striatopicites 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.
140. *Homapollenites* sp. Photo No. 50/6.
144-146. *Schizopollis wodehousei* Venkatachala & Kar. Photo Nos. 52/7, 51/28, 55/24.

Plate 9
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.

Plate 10
178-182. *Gnetaceae-pollenites punctatus* sp. nov. Photo Nos. 54/28, 46/33, 54/27, 50/28, 46/7.
188. *Decussatisporites* sp. Photo No. 50/30.
189-190. *Decussatisporites dubius* sp. nov. Photo Nos. 57/25, 50/26.
191-199. *Gnetapollenites hamonicus* (Goubin) Venk. Goubin & Kar. Photo Nos. 55/1, 46/19, 51/5, 50/24, 50/27, 54/1, 49/6, 50/32, 45/32.