PALYNOLOGY OF THE NORTH KARANPURA BASIN, BIHAR, INDIA—2. BARAKAR EXPOSURES NEAR LUNGATOO, HAZARIBAGH DISTRICT

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

ABSTRACT

The present paper deals with the palynological investigation of Barakar exposures near Lungatoo, Hazaribagh District, Bihar, India. 34 spore-pollen genera and 62 species have been recovered from the sediments, out of which 11 species are new. The new species have been described and illustrated. The present assemblage is comparable to "Zone C" of the Barakar assemblage described by the authors (1968a).

INTRODUCTION

THE material for the present investigation was collected from a rivulet (nala) near the bend joining the main Lungatoo — Burkagaon river near Pukra-Buruadeeh colliery about two miles north-east of Burkagaon Police Station (TEXT-FIG. 1). The material was collected on both sides of the rivulet. The exposure on the west side of the rivulet is thicker than the east. The lithology of the exposures is as follows:

Exposure on the west side of the rivulet
(Exposure no. 2)

		Sample Nos.
Alluvium	3-4′	
Buff coloured shale rich in mica peridotite	6′-6″	C14
Fine grained sandstone	1′	
Buff coloured shale rich in mica peridotite	3′-6″	C15
Blackish silt stone	1′	
Coaly shale exposed	2′-3′	C16 &
Rivulet bed	(thickness unknown)	C17

Exposure on the east side of the rivulet
(Exposure no. 3)

Alluvium	3-4′	
Fine grained sandstone	2′-6″	
Coaly shale	1′	C13
Coal exposed	1′ (thickness unknown	C12
Rivulet bed		

Exposure on the east side of the rivulet
(Exposure no. 1)

Carbonaceous shale	1′-2′	C8 & C8A
Medium grained sandstone	2′-3′	
Carbonaceous — coaly shale	1′-2′ (thickness unknown)	C9
Rivulet bed		

About 25 grams of material was treated with commercial Nitric acid (40 per cent) for 2-8 days followed by a treatment of Potassium hydroxide solution (5 per cent) for 3-5 minutes. Siliceous elements in the macerates were eliminated by treating with Hydrofluoric acid (40 per cent) for 3-6 days. The macerate after several washings in water was dried on the cover glass with Polyvenyl alcohol and finally mounted in Canada balsam. The slides, photomicrographs and unused material are preserved at the repository of the Birbal Sahni-Institute of Palaeobotany, Lucknow, India.

SYSTEMATIC PALYNOLOGY

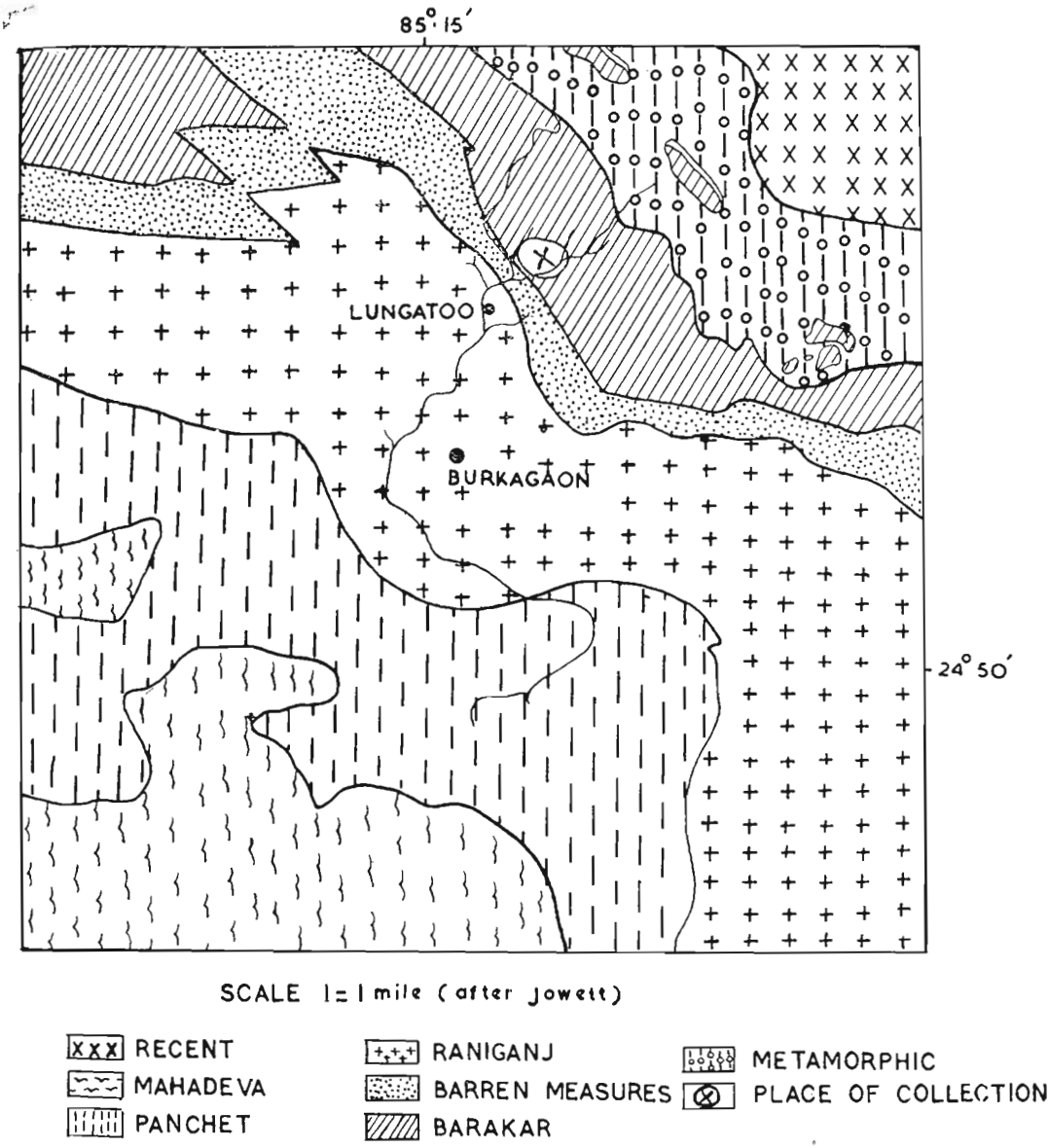
Anteturma — *Sporites* H. Potonié, 1893
Turma — *Triletes* (Reinsch) Potonié & Kremp, 1954
Subturma — *Azonotriletes* Luber, 1935
Infraturma — *Laevigati* (Bennie & Kidston) Potonié, 1956

Genus *Punctatisporites* (Ibrahim) Potonié & Kremp, 1955

Species recorded here:

1. *Punctatisporites gretensis* Balme & Hennelly, 1956.

*Present address — Palynology Laboratory, Research & Training Institute, Oil and Natural Gas Commission, Kaulagarh Road, Dehra Dun (U.P.).



TEXT-FIG. 1

2. *Punctatisporites* sp. (Pl. 1, Fig. 1).

Description — Spores oval — subcircular, 50-60 μ × 54-78 μ. Exine 1·5-2·5 μ thick, intrapunctate. Trilete well developed, rays ± uniformly broad, extending upto equator, associated with strongly developed folds. Commissure well marked.

Comparison — *Punctatisporites gretensis* Balme & Hennelly (1956b) resembles the present species in its general shape and size range but is differentiated in the absence of folds in association with the trilete mark. *Punctatisporites* sp. described by Kar (1968) from the Barren Measures Sequence is subcircular in shape, with prominent trilete mark extending upto three-fourths of radius and also devoid of the associated fold-system.

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

Genus *Apiculatisporis* Potonié & Kremp, 1956

Species recorded here:
Apiculatisporis cornutus Høeg & Bose, 1960.

Genus *Anapiculatisporites* Potonié & Kremp, 1954

Species recorded here:
1. *Anapiculatisporites veritas* Venkatachala & Kar, 1968a.
2. *Anapiculatisporites consonus* Venkatachala & Kar, 1968a.

Infraturma — *Varitrileti* Venkatachala & Kar, 1965

Genus *Microbaculispora* Bharadwaj, 1962

Species recorded here:
Microbaculispora minutus Venkatachala & Kar, 1968a.

Genus *Didecitriletes* Venkatachala & Kar, 1965

Species recorded here:
1. *Didecitriletes horridus* Venkatachala & Kar, 1965.
2. *Didecitriletes bellus* sp. nov. (Pl. 1, Fig. 3).
Holotype — Pl. 1, Fig. 3.
Type Locality — Lungatoo, North Karanpura basin, Bihar; Barakar Stage (Permian).
Diagnosis — Spores triangular-subtriangular in polar view, cordate in lateral compression. 65-75 μ × 75-85 μ. Trilete extending upto equator, associated with fold system. Exine thick, proximally ± laevigate — sparsely granulose, distally ornamented mostly with thickly set grana.
Description — Spores mostly triangular in polar view, laterally compressed specimens are also frequently met with. Apices acutely — bluntly triangular, interapical margins straight to slightly convex. Exine 1·5-2·5 μ thick, granulose, grana widely placed proximally and evenly distributed on the distal side, interspersed with bulbous spines. Trilete well developed, rays tapering at ends, extending upto equator, associated fold system also well developed.
Comparison — *Didecitriletes horridus* Venkatachala & Kar (1965) resembles *D. bellus* in size and general organization but is distinguished in having distal bulbous spines. *D. ericianus* (Balme & Hennelly) Venkatachala & Kar (*l.c.*) is differentiated in the presence of distinct spines. *D. dentatus* (Balme & Hennelly) Venkatachala & Kar (*l.c.*) is much smaller in size and ornamented with thin spines.

Genus *Lacinitriletes* Venkatachala & Kar, 1965

Remarks — The holotype of *Lacinitriletes* will be Pl. 1, Fig. 8 and not Pl. 1, Fig. 7, (Venkatachala & Kar, 1965).

Species recorded here:
1. *Lacinitriletes badamensis* Venkatachala & Kar, 1965.
2. *Lacinitriletes minutus* Venkatachala & Kar, 1966.

Infraturma — *Murornati* Potonié & Kremp, 1954

Genus *Cyclofoveolatispora* Venkatachala & Kar, 1968

Species recorded here:
Cyclofoveolatispora minutus sp. nov. (Pl. 1, Fig. 8).
Holotype — Pl. 1, Fig. 8.
Type Locality — Lungatoo, North Karanpura basin, Bihar; Barakar Stage (Permian).
Diagnosis — Circular-subcircular spores in polar view, 20-25 μ × 22-30 μ. Exine thin, proximally laevigate, distally microfoveolate. Trilete, ill-developed, rays not clearly seen.
Description — Spores mostly circular in polar view. Exine 1-1·5 μ thick, occasionally irregularly folded, proximally laevigate, microfoveolate on distal side, foveola ± 0·5 μ in diameter, closely and evenly distributed. Trilete, ill-developed, rays hardly perceptible, commissure ill-defined.
Comparison — *Cyclofoveolatispora caecus* Venkatachala & Kar (1968b) is comparable to the present species in possessing weakly developed trilete rays and similar sculptural elements but can easily be distinguished by its larger size. *C. plicatus* Venkatachala & Kar (*l.c.*) is also larger in size and has thinner, much folded exine.

Infraturma — *Perinotrileti* Erdtman, 1947

Genus *Valemisporites* Bharadwaj & Venkatachala, 1962

Species recorded here:
Valemisporites pukraensis sp. nov. (Pl. 1, Figs. 4-6).

Holotype — Pl. 1, Fig. 4.

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

Diagnosis — Spores circular in polar view, 68-76 μ × 68-82 μ. Exine thick, enveloped uniformly by a perisporal covering forming rugose-vermiculate to pseudoreticulate pattern. Trilete well developed, rays extending three-fourths the radius of the spore body.

Description — Spores mostly circular in polar view. Exine about 2 μ thick, laevigate, perisporal covering may be intact or torn leaving remnants in the form of grana or ramifying processes sticking to the body margin, while intact perisporal covering renders the spores appear rugose-vermiculate, sometime a pseudoreticuloid pattern is seen in some parts. Trilete well developed on the spore exine, rays mostly straight but may be sinuous in some cases, uniformly broad or slightly tapering at ends. Commissure distinct.

Comparison — *Valemisporites rugosus* Bharadwaj & Venkatachala (1962) resembles the present species in possessing well developed trilete rays and rugose perisporal covering but is distinguished by its larger size range. *V. descretus* Bharadwaj & Venkatachala (*l.c.*) is also comparable to the present species in the extension of the trilete rays upto three-fourth the radius but is differentiated by its larger size range and laevigate perisporal coat.

Turma — *Aletes* Ibrahim, 1933
Subturma — *Azonaletes* (Luber) Potonié & Kremp, 1954
Infraturma — *Reticulonapiti* (Erdtman) ex Vimal, 1952, Bose & Kar, 1967

Genus *Greinervillites* Bose & Kar, 1967

Species recorded here:

Greinervillites undulatus Bose & Kar, 1967.

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

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

Species recorded here:

1. *Laevigatosporites colliensis* (Balme & Hennelly) Venkatachala & Kar, 1966.

2. *Laevigatosporites punctatus* sp. nov. (Pl. 1, Fig. 7).

Holotype — Pl. 1, Fig. 7.

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

Diagnosis — Spores oval-subcircular in polar view, 56-65 μ × 86-100 μ. Exine punctate, puncta ± 0·5 μ in diameter, unevenly distributed. Monolete well developed, extending three-fourths of longitudinal axis.

Description — *Laevigatosporites colliensis* (Balme & Hennelly) Venkatachala & Kar (1968a) is comparable in size range and shape to the present species but can be differentiated in the presence of ± laevigate exine.

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

Genus *Plicatipollenites* Lele, 1964

Species recorded here:

Plicatipollenites indicus Lele, 1964.

Genus *Virkkipollenites* Lele, 1964

Species recorded here:

Virkkipollenites obscurus Lele, 1964.

Infraturma — *Triletesacciti* Leschik, 1955

Genus *Barakarites* Bharadwaj & Tiwari, 1964

Species recorded here:

1. *Barakarites indicus* Bharadwaj & Tiwari, 1964.

2. *Barakarites glabrus* sp. nov. (Pl. 1, Figs. 10-11).

Holotype — Pl. 1, Fig. 11.

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

Diagnosis — Monosaccate, circular-subcircular in overall shape, 72-88 μ × 74-88 μ. Central body circular, well defined; exine thick, imperfectly intramicroreticulate. Trilete well developed, rays extending half of central body. Saccus ill-developed, subsaccate, intrapunctate.

Description — Pollen grains mostly circular, central body comparatively large, 72-78 μ × 74-78 μ; incipient inner body may be present in some specimens. Exine 2-2·5 μ thick, subsaccate, ± laevigate-imperfectly intramicroreticulate. Trilete rays mostly well developed, rays ± equal, uniformly broad or slightly tapering at ends extending not more than half radius of central body. Proximal attachment of saccus to central body equatorial, distal

attachment subequatorial. Saccus subsaccate, ill-developed, mostly intrapunctate.

Comparison — *Barakarites indicus* Bharadwaj & Tiwari (1964) is comparable to the present species in general shape and size range but can easily be differentiated by the presence of pseudoreticuloid grooves on central body in the former. *B. crassus* Tiwari (1965) is distinguished by its roundly subtriangular overall shape and central body with pseudoreticuloid grooves and distinct inner body. *B. implicatus* Tiwari (*l.c.*) and *B. densicorpus* Tiwari (*l.c.*) resemble the present species in the extension of the trilete rays but can be differentiated by the presence of distinct polygonal meshes and inner body. *B. dubius* Venkatachala & Kar (1968b) is larger in size range, central body possessing pseudoreticuloid grooves and ill-developed trilete rays.

Remarks — Venkatachala & Kar (1968b) observed that the saccus in *Barakarites* Bharadwaj & Tiwari (1964) is not distinctly intrareticulate but mostly intrapunctate to imperfectly intrareticulate. Thus, it shares in common the saccus structure in *Schizopollis* Venkatachala & Kar (1964). The specimen studied (*B. glabrus* & *B. dubius*) from the present material also show that the saccus in *Barakarites* is subsaccate and intrapunctate, the attachment zone of saccus to central body is also not clear in most specimens and they sometime form a girdle around that region. The saccus in *Barakarites* appears to be more a pseudosaccus. After a restudy of *Endosporites* Bharadwaj (1965) placed this genus under the turma *Zonales* (Bennie & Kidston) Potonié (1956) and infraturma *Saccizonati* Bharadwaj (1965) concluding that saccus in *Endosporites* is not a true one. Perhaps, the saccus in *Barakarites* with its subsaccate intrapunctate — imperfectly intrareticulate saccus is also closely related.

Infraturma — *Aletisacciti* Leschik, 1956

Genus *Densipollenites* Bharadwaj, 1962

Species recorded here:

Densipollenites invisus Bharadwaj & Salujha, 1964.

Genus *Divarisaccus* Venkatachala & Kar, 1966b

Species recorded here:

Divarisaccus rimosus (Venkatachala & Kar, 1968b) comb. nov. (Pl. 1, Fig. 13).

Synonym — *Parasaccites rimosus* Venkatachala & Kar, 1968b.

Holotype — Venkatachala & Kar, 1968b; Pl. 3, Fig. 31.

Diagnosis — Monosaccate, elliptical-oval in overall shape, 87-146 μ × 96-194 μ. Central body elliptical — oval, comparatively smaller in size than saccus, 60-120 μ × 87-146 μ, intramicroreticulate. Proximal attachment of saccus to central body ± equatorial, distal attachment bilateral. Saccus intrareticulate.

Description — Pollen grains sometimes upto 200 μ. Central body well defined, mostly confronting with the general contour of the pollen grains, lighter than saccus. Exine 2-2·5 μ thick, intramicroreticulate. Attachment zone of saccus to central body well defined; proximally equatorially and distally bilaterally attached, distally saccus covering major part of central body, bilateral distal attachment may be associated with longitudinal folds. Sulcus distinct, ± rectangular. Saccus coarsely intrareticulate, mesh size 1·5-3 μ, lumina shallow.

Comparison — *Divarisaccus lelei* Venkatachala & Kar (1966a) closely resembles the present species in size range and general organization; however, the central body is proportionately larger in *D. lelei* while in *D. rimosus* the saccus is considerably larger than the central body.

Infraturma — *Amphisacciti* Lele, 1965

Genus *Parasaccites* Bharadwaj & Tiwari, 1965

Species recorded here:

1. *Parasaccites korbaensis* Bharadwaj & Tiwari, 1965.
2. *Parasaccites bokaroensis* Tiwari, 1965.
3. *Parasaccites bellus* Venkatachala & Kar, 1968b.

Infraturma — *Vesiculomonoradites* (Pant) Bhardwaj, 1955

Genus *Potonieisporites* (Bhard.) Bharadwaj, 1964

Species recorded here:

Potonieisporites sp. A. Bharadwaj, 1964.

Infraturma — *Striasacciti* Bharadwaj, 1962

Genus *Striomonosaccites* Bharadwaj, 1962

Species recorded here:

Striomonosaccites sp. (Pl. 2, Fig. 17).

Description — Monosaccate, subcircular in overall shape, 90 × 108 μ. Central body dark, subcircular, 48 × 52 μ; exine about 3 μ thick, ± laevigate. Horizontal grooves 10 in number, strongly developed, occasionally branched, extending from one end to other. Vertical striations numerous, not so strongly developed as horizontal ones. Proximal attachment of saccus to central body equatorial, distal attachment not traceable. Saccus unequally broad, coarsely intrareticulate, mesh-size 2-3 μ, lumina shallow.

Comparison — *Striomonosaccites ovatus* Bharadwaj (1962) is comparable to the present species in shape and size range and general organization but is distinguished in possessing less number of horizontal grooves on central body. *S. circularis* Bharadwaj & Salujha (1964) shares similar size range with the present species but is differentiated by its ill-developed horizontal grooves. *Striomonosaccites* sp. described here is conspicuous by its presence of well developed, branched, horizontal and numerous vertical partitions on the thick, dark central body.

Remarks — The presence of vertical partitions on the central body of *Striomonosaccites* Bharadwaj (1962) has not been recorded by earlier authors.

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

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

Species recorded here:

Platysaccus sp. (Pl. 2, Fig. 22).

Description — Bisaccate, bilaterally symmetrical pollen grain, 44 × 108 μ. Central body circular, 44 × 46 μ; exine 2·5 μ thick, ± laevigate. Proximal attachment of sacci to central body equatorial, distal attachment straight, covering major part of central body. Sulcus narrow, rectangular. Sacci unequal in size, more than hemisphere, coarsely intrareticulate, mesh-size 1·5-2 μ, lumina shallow.

Remarks — The present specimen possesses ± equally broad central body and sacci. *Platysaccus papilionis* Potonié & Klaus (1954), the type species of the genus is characterized by very broad sacci in comparison to central body so as to provide it a butterfly-like appearance.

Infraturma — *Striatiti* (Pant) Bharadwaj, 1962

Genus Striatites (Pant) Bharadwaj, 1962

Species recorded here:

1. *Striatites solitus* Bharadwaj & Salujha, 1964.
2. *Striatites communis* Bharadwaj & Salujha, 1964.
3. *Striatites ornatus* Venkatachala & Kar, 1968a.
4. *Striatites alius* Venkatachala & Kar, 1968a.
5. *Striatites lectus* Venkatachala & Kar, 1968a.

Genus *Verticipollenites* Bharadwaj, 1962

Species recorded here:

1. *Verticipollenites secretus* Bharadwaj, 1962.
2. *Verticipollenites debilis* Venkatachala & Kar, 1968a.

Genus *Lahirites* Bharadwaj, 1962

Species recorded here:

1. *Lahirites rarus* Bharadwaj & Salujha, 1964.
2. *Lahirites parvus* Bharadwaj & Salujha, 1964.
3. *Lahirites alutas* Venkatachala & Kar, 1966.
4. *Lahirites angustus* Venkatachala & Kar, 1966.
5. *Lahirites lungatooensis* sp. nov. (Pl. 2, Figs. 18-19).

Holotype — Pl. 2, Fig. 18.

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

Diagnosis — Bisaccate, diploxylonoid, bilaterally symmetrical pollen grains. Central body horizontally oval, exine thick, intrapunctate, 4-10 horizontal grooves, distal attachment closely placed. Sacci subsaccate, thick, intrapunctate to imperfectly intrareticulate.

Description — Medium sized pollen grains, 50-60 μ × 86-114 μ, constricted in middle on both sides. Central body distinct, 40-52 μ × 52-58 μ, exine 2-4 μ thick, intrapunctate structure weakly developed; horizontal striations occasionally branched, extending from one end of central body to other. Proximal attachment of sacci to central body equatorial, distal attachment straight, very

closely placed to each other. Sulcus absent. Sacci hemispherical, thick, strongly built, leathery, intrapunctate, puncta closely placed and evenly distributed, obscured in some specimens.

Comparison — *Lahirites rotundus* Bharadwaj & Salujha (1964) and *Lahirites parvus* Bharadwaj & Salujha (1964) are comparable to the present species in the presence of only horizontal striations but can easily be distinguished by their subcircular — vertically oval central body. *L. bokaroensis* Tiwari (1965) is also distinguished by its subcircular central body and intrareticulate sacci. *L. alutas* Venkatachala & Kar (1968a) is smaller in size range. *L. angustus* Venkatachala & Kar (1968b) is characterized by vertically oval body and intrareticulate sacci. *L. naviculus* Venkatachala & Kar (1968a) is characterized by a thick, subcircular, central body and boat shaped sulcus. *L. lungatooensis* is characterized by its strongly horizontal central body, leathery and intrapunctate sacci.

Genus *Hindipollenites* Bharadwaj, 1962

Species recorded here:

1. *Hindipollenites oblongus* Bharadwaj & Salujha, 1962.
2. *Hindipollenites formosus* Venkatachala & Kar, 1968a.

Genus *Strotersporites* Wilson, 1962

Species recorded here:

1. *Strotersporites decorus* Venkatachala & Kar, 1964.
2. *Strotersporites diffusus* Venkatachala & Kar, 1964.
3. *Strotersporites lentisaccatus* Kar, 1967.

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

Species recorded here:

1. *Striatopiceites minutus* Venkatachala & Kar, 1968a.
2. *Striatopiceites digredius* Kar, 1968.
3. *Striatopiceites rimosus* sp. nov (Pl. 2, Figs. 23-24).

Holotype — Pl. 2, Fig. 23.

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

Diagnosis — Pollen grains bisaccate but monosaccoid in constriction, subcircular-circular in overall shape. Central body ill-defined, intramicroreticulate, horizontal striations 5-10. Attachment zone ill-defined. Sacci hemispherical, coarsely intrareticulate.

Description — Bisaccate, bilaterally symmetrical pollen grains. Pollen grains seems to be monosaccoid due to subcircular-circular overall shape and diffused nature of the distal attachment. Size range 120-134 μ × 130-146 μ. Central body not traceable, seems to be subcircular — horizontally oval; exine 2-2·5 μ thick, intramicroreticulate. Horizontal striations well developed, occasionally branched and converging at ends. Proximal attachment of sacci to central body seems to be equatorial, distal attachment hardly perceptible in most cases. Sacci distinct, mesh-size 1·5-3 μ, lumina broad.

Comparison — *Striatopiceites minutus* Venkatachala & Kar (1968a) resembles the present species in possessing ill-defined central body and horizontal striations. *S. minutus* can, however, be distinguished by its smaller size and typically bisaccate condition. *S. digredius* Kar (1968) is characterized by horizontally oval central body and distinct distal attachment forming unequally broad sulcus. *S. granulatus* Kar (1968) is distally granulose.

Genus *Schizopollis* Venkatachala & Kar, 1964

Species recorded here:

1. *Schizopollis disaccoidis* Venkatachala & Kar, 1964.
2. *Schizopollis extremus* Venkatachala & Kar, 1964.
3. *Schizopollis rugosus* sp. nov. (Pl. 2, Figs. 20-21).

Holotype — Pl. 2, Fig. 20.

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

Diagnosis — Pollen grains circular-subcircular, polysaccate, apparently monosaccate by cohesion of sacci margins. Central body circular, comparatively larger than individual sacci, microverrucose, grooves parallel to each other, strongly developed. Sacci ill-developed, sub-saccate, intrapunctate, crumpled and deformed at the area of distal attachment.

Description — Pollen grains mostly circular, 50-55 μ × 55-65 μ. Central body generally confronting with general shape of pollen grains; exine 1·5-2 μ thick, microverrucae ill-developed and scantily represented.

Grooves 8-12 in number, parallel to each other. Proximal attachment of sacci to central body equatorial; distal attachment subequatorial, ill-defined, sacci crumpled before attachment to central body. Sacci 7-10 in number, joined with each other, intrapunctate, ill-developed, margin wavy.

Comparison — *Schizopollis wodehousei* Venkatachala & Kar (1964) closely resembles the present specimens in size range, number of sacci and general organization. *S. wodehousei* can, however, be distinguished by the presence of pseudoreticuloid grooves on central body. *S. disaccoides* Venkatachala & Kar (1964) is apparently bisaccoid in construction and also possesses pseudoreticulate or brick-work like pattern on central body. *S. extremus* Venkatachala & Kar (1964) is monosaccate in construction with a horizontally oval to subcircular central body possessing parallel grooves.

Genus *Corisaccites* Venkatachala & Kar, 1966b

Species recorded here:

1. *Corisaccites alutas* Venkatachala & Kar, 1966b.
2. *Corisaccites distinctus* sp. nov. (Pl. 1, Fig. 15).

Holotype — Pl. 1, Fig. 15.

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

Diagnosis — Bisaccate, bilaterally symmetrical pollen grains, 40-50 μ × 55-65 μ. Central body distinct, horizontally oval with a single, prominent, longitudinal furrow, exine thin, microverrucose; distal attachment concave, sulcus well defined, boat shaped. Sacci leathery, intrapunctate.

Description — Pollen grains mostly oval in overall shape with slight middle constriction. Central body well defined, 40-45 μ × 43-50 μ, lighter than sacci, longitudinal furrow unequally broad extending from one end to other; exine about 1·5 μ thick, microverrucae ill-developed. Proximal attachment of sacci to central body equatorial, distally sacci covering major part of central body, attachment full. Sacci semicircular, leathery, intrapunctate, structure unevenly distributed.

Comparison — *Corisaccites alutas* Venkatachala & Kar (1968a) closely resembles the present species in size range and a single longitudinal furrow on central body, but is distinguished by its ill-defined central body and subcircular shape. *C. vanus* Venkatachala & Kar (1968a) is monosaccoid in construction and larger in size range. *C. distinctus* sp. nov. can be distinguished from the other species by its distinct, horizontally oval central body and boat shaped sulcus.

Genus *Rhizomaspora* Wilson, 1962

Species recorded here:

Rhizomaspora costa Venkatachala & Kar, 1968b.

Genus *Hamiapollenites* Wilson, 1962

Species recorded here:

1. *Hamiapollenites saccatus* Wilson, 1962.
2. *Hamiapollenites incestus* Venkatachala & Kar, 1968b.

Genus *Vittatina* (Luber) Wilson, 1962

Species recorded here:

1. *Vittatina subsaccata* Samoilovich, 1953.
2. *Vittatina lata* Wilson, 1962.

Infraturma — *Disacciatrileti* (Leschik) Potonié, 1958

Genus *Sulcatisporites* (Leschik) Bharadwaj, 1962

Species recorded here:

Sulcatisporites ovatus Bharadwaj, 1962.

Turma — *Polyplicates* Erdtman, 1952

Genus *Gnetaceaepollenites* Thiergart, 1938

Species recorded here:

Gnetaceaepollenites punctatus Venkatachala & Kar, 1968a.

Turma — *Monocolpates* Iversen & Troels-Smith, 1950

Subturma — *Intortes* (Naumova) Potonié, 1958

Genus *Ginkgocycadophytus* Samoilovich, 1953

Species recorded here:

Ginkgocycadophytus magnus sp. nov. (Pl. 2, Fig. 26).

Holotype — Pl. 2, Fig. 26.

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

Diagnosis — Pollen grains monocolpate, elongated oval with rounded ends, 50-60 μ × 90-115 μ. Exine laevigate and intrapunctate. Colpus extending from one end to

other, narrow in middle region and broad at ends.

Description — Pollen grains large in size with smooth margin. Exine 1·5-2 μ thick, intrapunctate structure closely and evenly distributed, puncta ± 0·5 μ in diameter, occasionally irregularly folded. Colpus present on distal surface, well defined, unequally broad.

Comparison — *Ginkgocycadophytus cymbatus* (Balme & Hennelly) Potonié & Lele (1961) is comparable to the present species in the shape of the colpus but can be distinguished by its smaller size and granulose exine. *G. vetus* Balme & Hennelly (1956a) is smaller in size range. *G. korbaensis* Tiwari (1965) resembles in intrapunctate exine but can be differentiated by its smaller size range and uniformly broad colpus. *G. microreticulatus* Kar (1968) has a smaller size range, imperfectly intramicroreticulate exine and uniformly broad colpus. *G. magnus* is distinguished from all known species by its larger size, intrapunctate exine and unequally broad colpus.

Subturma — *Monoptyches* (Naumova) Potonié, 1958

Genus *Striasulcites* Venkatachala & Kar, 1968

Species recorded here:

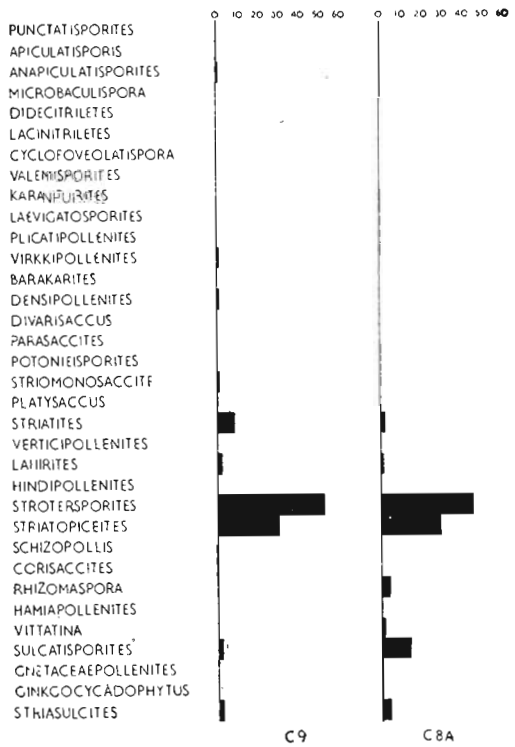
1. *Striasulcites tectus* Venkatachala & Kar, 1968b.
2. *Striasulcites ovatus* Venkatachala & Kar, 1968b.

DISCUSSION

Palynological Composition — Samples were collected from each lithological unit and macerated (*see* p. 2). 200 fossils were counted for each sample having a sizeable palynological assemblage. Check counts were taken to ensure correct results.

Exposure no. 1: Three samples (C8, C8A & C9) were collected at close intervals (*see* p. 258) and out of which, C9 and C8A yielded a good number of spores-pollen grains. The samples show a overwhelming majority of striate bisaccate pollen represented mostly by *Strotersporites* and *Striatopiceites* (TEXT-FIG. 2).

Ten genera are encountered in sample C9. Striate bisaccate pollen grains are dominant contributing 92 per cent of the assemblage. *Strotersporites* and *Striatopiceites* contribute 52 per cent and 30 per cent respectively while *Striatites* represents 8 per cent and *Lahirites* 2 per cent in the assemblage. The non-striate bisaccate pollen are represented by *Sulcatisporites* (2%) in the assemblage. Trilete spores are very few and only represented by *Anapiculatisporites* (1%). Monosaccate pollen grains contribute 3 per cent to the assemblage and equally shared by *Virkkipollenites*, *Densipollenites* and *Striomonosaccites*. Monocolpate pollen represent 2 per cent of the assemblage and is represented by *Striasulcites*.



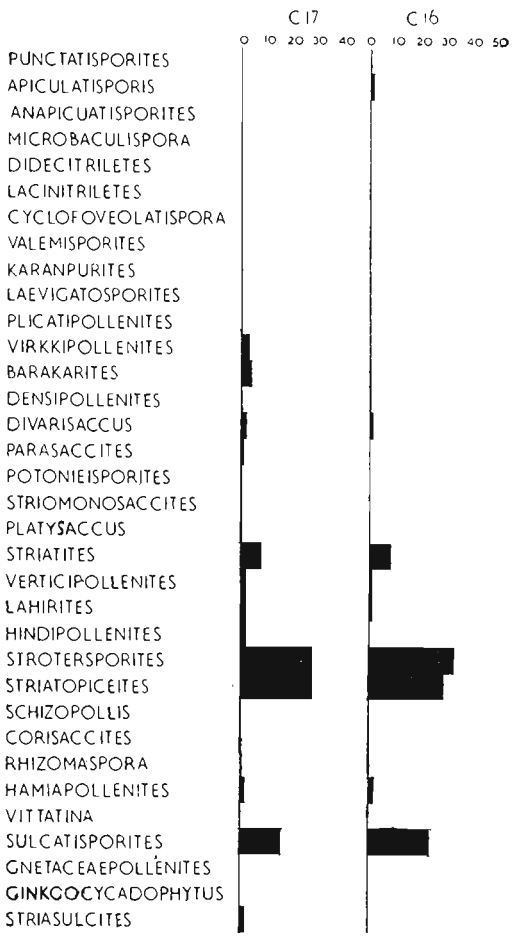
TEXT-FIG. 2

The sample C8A is populated by 8 genera is also dominated by striate bisaccate pollen. This striate bisaccate pollen contribute upto 82 per cent in the assemblage. *Strotersporites* and *Striatopiceites* are dominating and contribute 45 and 29 per cent in the assemblage. *Corisaccites* is represented by 4 per cent while *Striatites* by 2 per cent; *Lahirites* and *Vittatina* each 1 per cent in the assemblage. Among the non-striate bisaccate pollen, *Sulcatisporites* is very common and forms 14 per cent of the assemblage. Trilete spores and monosaccate

pollen grains are not met within the counts. *Striasulcites* is represented by 4 per cent of the total assemblage and is the only representative of the monocolpate pollen grains.

Exposure no. 2. Out of four samples (C14-C17), C17 and C16 were very rich in spore-pollen assemblages. Both the samples, however, are predominated by bisaccate pollen grains (TEXT FIG. 3).

The sample C17 is represented by 13 genera in the count. *Strotersporites* and *Striatopiceites* are dominating and each contributes 28 per cent in the assemblage. *Striatites* represents 8 per cent while *Verticipollenites, Lahirites, Hindipollenites* and *Hamiapollenites* each shares 2 per cent. The non-striate bisaccate pollen is only represented by *Sulcatisporites* (16 per cent)



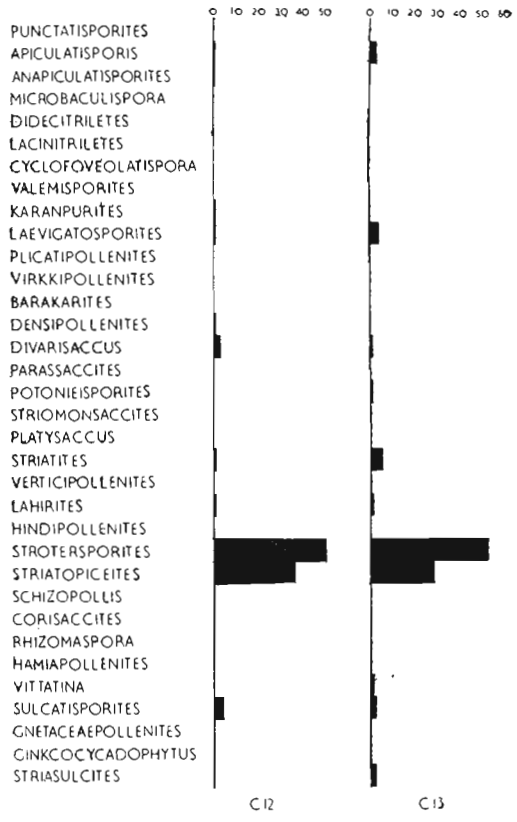
TEXT-FIG. 3

in the assemblage. Trilete spores do not come within the count. Among the monosaccate pollen *Barakarites* and *Virkkipollenites* are represented by 4 and 3 per cent respectively while *Divarisaccus* and *Parasaccites* are represented by 2 and 1 per cent respectively. Polyplicate and monocolpate pollen are represented by *Striasulcites* forming 2 per cent of the assemblage. The sample C16 is exceptionally rich in bisaccate pollen and they represent upto 98 per cent in the assemblage. Among the striate pollen *Strotersporites* and *Striatopiceites* represent 33 and 29 per cent respectively. *Striatites* is represented by 8 per cent while *Hamiapollenites* by 2 per cent. *Verticipollenites* and *Hindipollenites* each are represented by 1 per cent in the assemblage. *Sulcatisporites* is represented by 24 per cent and is the only genus among the non-striate bisaccate pollen encountered in the count. Among the trilete spores *Apiculatisporis* forms 1 per cent while *Divarisaccus* represents the monosaccate pollen by contributing 1 per cent. Polyplicate and monocolpate pollen are not met within the count.

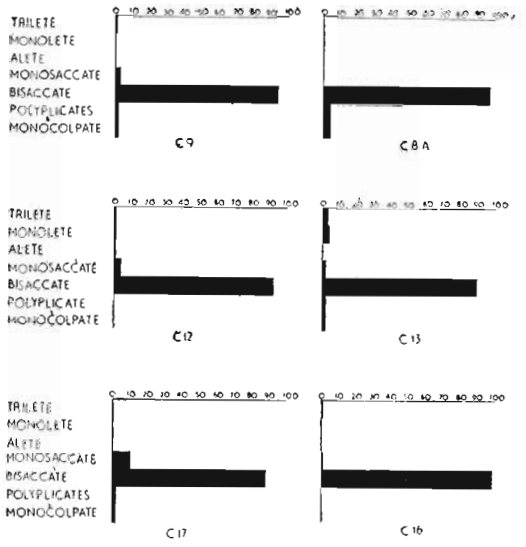
Exposure no. 3. Sample C13 and C12 are very rich in bisaccate pollen, while the other groups of spores and pollen are meagrely represented (TEXT-FIG. 4).

The sample C13 has 11 genera and is overwhelmingly dominated by bisaccate pollen (92%) in the assemblage. *Strotersporites* alone contributes 50 per cent in the assemblage, while *Striatopiceites* is represented by 36 per cent. *Striatites* and *Lahirites* are represented by 1 per cent only. Among the non-striate bisaccate pollen *Sulcatisporites* contributes 4 per cent. Among the trilete spores genera *Apiculatisporis* and *Anapiculatisporites* each is represented by 1 per cent. *Greinervillites* and *Laevigatosporites* also represent 1 per cent each in the assemblage. The monosaccate pollen are represented by *Divarisaccus* and *Densipollenites* contributing 3 and 1 per cent respectively. Polyplicate — monocolpate pollen though present are not met within the count.

The sample C13 has 11 genera in the count. Bisaccate pollen contribute to the major bulk forming 89 per cent in the assemblage. *Strotersporites* is found in 28 per cent. *Striatites* shares 5 per cent while *Lahirites* and *Vittatina* each contributes 1 per cent in the assemblage. Among the



TEXT-FIG. 4



TEXT-FIG. 5

non-striate bisaccate pollen *Sulcatisporites* contributes 2 per cent. *Apiculatisporis* is the only trilete spore genus found in the count. Monolete spore is represented by *Laevigatosporites* (4%). Among the monosaccate pollen *Divarisaccus* and *Potonieisporites* each found in 1 per cent. *Striasulcites* is the only genus found among the polyplicate — monocolpate pollen and it contributes 2 per cent in the assemblage.

Palynological Comparison—The three sections studied here are all exceptionally rich in bisaccate pollen; among them, the striate pollen mostly represented by *Strotersporites* and *Striatopiceites* are dominant. *Sulcatisporites* among the non-striate pollen is, however, well represented in most of the samples studied here. The trilete, monosaccate, monolete, alete and polyplicate — monocolpate spore-pollen are poorly represented throughout (*see* TEXT-FIG. 5). This assemblage is closely comparable to "Zone C" of the Barakar assemblage described by Venkatachala and Kar (1968a) where the striate bisaccate pollen are dominant and the other groups are rare or accessory in the assemblage.

REFERENCES

For references on Systematic Palynology see Venkatachala & Kar (1968a & 1968b).

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

Idem (1964). *Potonieisporites* Bhard., iher Morphologie, Systematik und Stratigraphie. *Fortschr. Geol. Rheinld Westf.* **12**: 45-54.

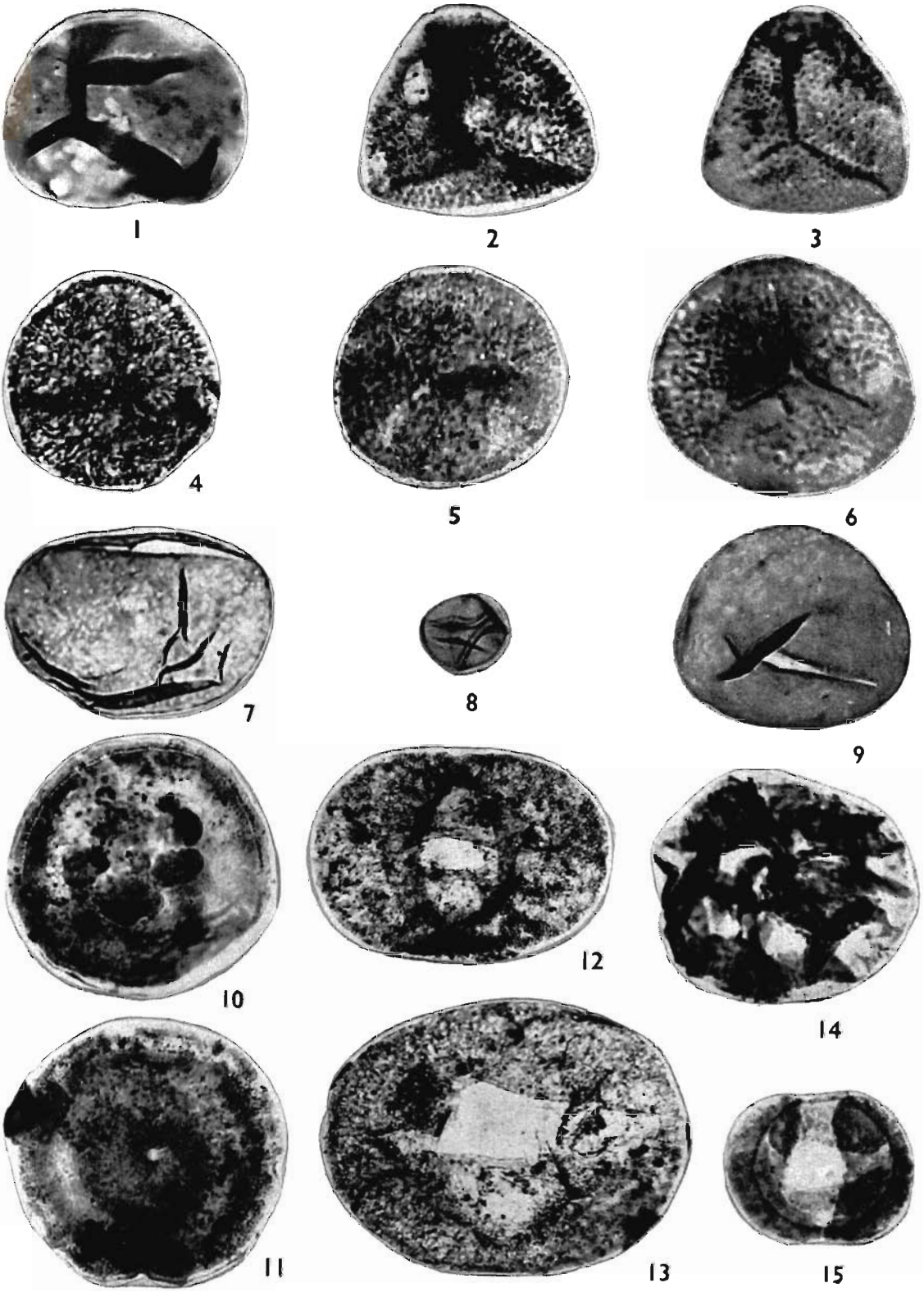
Idem (1965) On the organization of *Spenceri-sporites* Chaloner and *Endosporites* Wilson & Coe with remarks on their systematic position. *Palaeobotanist* **13**(1). 85-88, 1964.

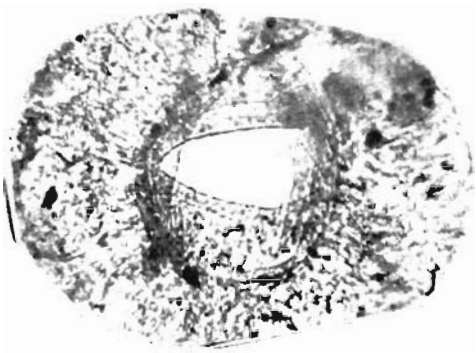
BHARADWAJ, D. C. & VENKATACHALA, B. S. (1962). Spore assemblage out of a Lower Carboniferous shale from Spitzbergen. *Ibid.* **10**(1 & 2): 18-47, 1961.

COOKSON, I. C. (1947). Plant microfossils from the lignites of Kerguelen Archipelago. *Rep. B.A.N.Z. antarct. Res. Exped. Ser. A*, **2**: 127-142.

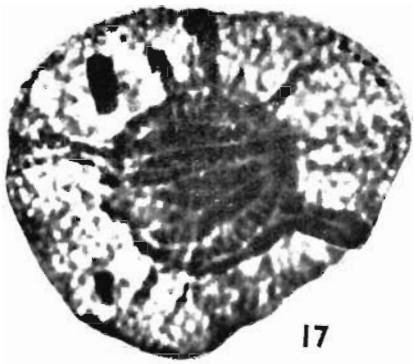
KAR, R. K. (1968). Palynology of the Barren Measures Sequence from Jharia coalfield, Bihar, India. 2. General Palynology. *Palaeobotanist.* **16**(2): 115-140, 1967.

SAMOILOVICH, S. R. (1953). Pollen und Sporen der permischen Ablagerungen von Tscherdin O,


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15



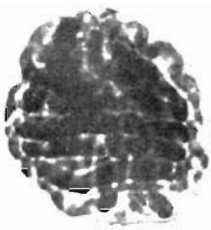
16



17

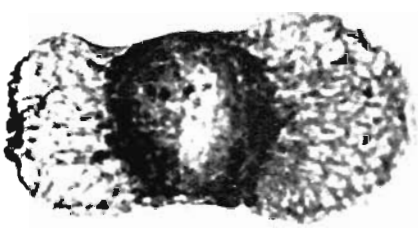
18

19

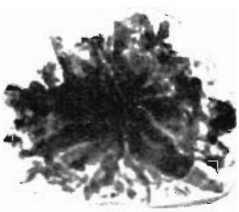


20

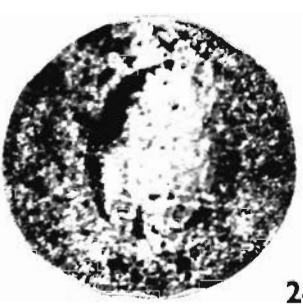
23



22

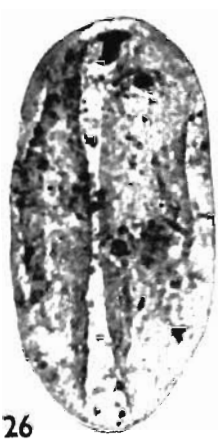


21



24

25



26

Aktjubinsk im Vorwial. *Arbeit. Erdöl. geol. Inst. U.S.S.R. N.S.* **75**: 5-57 (Translation Okla. Geol. Surv. Cir. 56, 1961).

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

SEDOVA. M. A. (1956). "The definition of 4 genera of disaccate striatiti" in material of Palaeontology: new families and genera. *VSEGEI*; *New Series*. 12: 246-249. Hart Palynol. Transl. 1. 1-10.

THIERGART, F. (1938). Die Pollen Flora der Niederlausitzer Braunkohle. *Jb. preuss. geol.* **58**: 282-351.

TIWARI, R. S. (1964). New miospore genera in the coals of Barakar Stage (Lower Gondwana) of India. *Palaeobotanist.* **12**(3). 250-259, 1963.

Idem (1965). Miospore assemblage in some coals of Barakar Stage (Lower Gondwana) of India. *Ibid.* **13**(2) 168-214, 1964.

VENKATACHALA, B. S. & KAR, R. K. (1966a). *Divarisaccus* gen. nov. a new saccate pollen genus from the Permian sediments of India. *Ibid.* **15**(1 & 2): 102-106.

Idem (1966b). *Corisaccites* Venkatachala & Kar, a new pollen genus from the Permian of Salt Range, W. Pakistan. *Ibid.* **15**(1 & 2): 107-109.

Idem (1968a). Palynology of the North Karanpura basin, Bihar, India. 1. Barakar exposures near Badam, Hazaribagh district. *Ibid.* **16**(1): 56-90, 1967.

Idem (1968b). Palynology of the Kathwai shales, Salt Range, West Pakistan. 1. Shales 25 ft. above the Talchir Boulder bed. *Ibid.* **16**(2): 156-166, 1967.

VIMAL, K. P. (1952). Spores and pollen from Tertiary lignites from Dandot, West Punjab (Pakistan). *Proc. Indian Acad. Sci.* **36**: 135-147.

EXPLANATION OF PLATES

(All photomicrographs are enlarged *ca.* × 500 unless otherwise mentioned)

PLATE 1

1. *Punctatisporites* sp. Slide no. 2492.
2. *Didecitriletes horridus* Venkatachala & Kar. Slide no. 2497.
3. *Didecitriletes bellus* sp. nov. Slide no. 2489.
4-6. *Valemisporites pukraensis* sp. nov. Slide nos. 2486, 2489, 2487.
7. *Laevigatosporites punctatus* sp. nov. Slide no. 2506.
8. *Cyclofoveolatispora minutus* sp. nov. Slide no. 2496.
9. *Laevigatosporites colliensis* (Balme & Hennelly) Venkatachala & Kar. Slide no. 2487.
10-11. *Barakarites glabrus* sp. nov. Slide nos. 2509, 2507.
12. *Potonieisporites* sp. A. Bharadwaj. Slide no. 2519 (× 250).
13. *Divarisaccus rimosus* Venkatachala & Kar. Slide no. 2488 (× 250).
14. *Greinervillites undulatus* Bose & Kar. Slide no. 2505.
15. *Corisaccites distinctus* sp. nov. Slide no. 2508.

PLATE 2

16. *Potonieisporites* sp. A Bharadwaj. Slide no. 2489 (× 250).
17. *Striomonosaccites* sp. Slide no. 2487.
18-19. *Lahirites lungatooensis* sp. nov. Slide nos. 2495.
20-21. *Schizopollis rugosus* sp. nov. Slide nos. 2510, 2508.
22. *Platysaccus* sp. Slide no. 2508
23-24. *Striatopiceites rimosus* sp. nov. Slide nos. 2490, 2489 (× 250).
25. *Striasulcites ovatus* Venkatachala & Kar. Slide no. 2488.
26. *Ginkgocycadophytus magnus* sp. nov. Slide no. 2508.