

CARBONIFEROUS SPORES AND POLLEN FROM THE CALARETI ZONE OF THE MOESIAN PLATFORM, RUMANIA

B. S. VENKATACHALA¹, D. BEJU² & R. K. KAR³

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The present paper deals with the systematic description of spores and pollen from 3 shale samples of a boring in Calareti zone situated S.E. of Bucharest, Rumania. The palynological fossils have been assigned to 44 genera and 75 species of dispersed spores and pollen.

INTRODUCTION

THE present paper deals with the systematic description of the spores and pollen recovered from 3 carbonaceous shales from a boring in the Calareti zone situated S. E. of Bucharest, Rumania. The Calareti zone is a part of the Moesian platform and is delimited by the pre-carpatic and prebalkan depressions.

Venkatachala and Beju (1962) have assigned uppermost Namurian age to the assemblages recovered from these samples. The palynological composition and their comparison with other assemblages have also been discussed by the same authors.

SYSTEMATIC PALYNOLOGY

Anteturma — *Sporites* H. Pot. 1893

Turma — *Triletes* (Rein.) Pot. & Kr. 1954

Subturma — *Azonotriletes* Lub. 1935

Infraturma — *Laevigati* (Benn. & Kidst.) Pot. 1956

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

Type Species — *Leiotriletes sphaerotriangulus* (Loose) Pot. & Kr. 1954.

Leiotriletes adnatoides Pot. & Kr. 1954

Pl. 1, Fig. 1

Remarks — Spore triangular in polar view, 36 μ . Apices rounded, interapical margins straight-slightly convex. Trilete distinct, rays narrow, $\pm$ uniformly broad extending

upto three-fourths the radius; commissure well defined. Exine $\pm 2 \mu$ thick, laevigate.

Leiotriletes tumidus Butterw. & Will. 1958

Pl. 1, Fig. 2

Remarks — The specimens described here are smaller in size than those described by Butterworth and Williams (1958) from the Lower Carboniferous of Scotland.

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

Type Species — *Calamospora hartungiana* Schopf in Schopf, Wils. & Bent. 1944.

Calamospora cf. *C. mutabilis* (Loose) Schopf, Wils. & Bent. 1944

Pl. 1, Fig. 3

Remarks — Spores subcircular, 58 μ . Trilete prominent, rays equal, tapering at ends, extending upto half the radius. A central distinct circular area delimited confirming to the contact area. Exine upto 1.5 μ thick, laevigate, irregularly folded.

Comparison — *C. mutabilis* has a very faintly defined contact area. *C. cf. mutabilis* Venkat. & Bharad. (1964) has a darkened contact area.

Calamospora microrugosa (Ibr.) Schopf, Wils. & Bent. 1944

Pl. 1, Fig. 4

Remarks — Playford (1962) has pointed out the cosmopolitan distribution of this species as it has been reported from Russia (LUBER & WALTZ, 1938, 1941; ISCHENKO, 1952; NAUMOVA, 1953); Europe (HORST 1943; PLAYFORD, 1962); China (IMGRUND,

Present address — 1. Palynology Laboratory, Research and Training Institute, Oil and Natural Gas Commission, Dehra Dun.

2. Geological Institute, Ministry of Petroleum & Chemicals, Bucharest, Rumania.

3. Birbal Sahni Institute of Palaeobotany, Lucknow.

1952) and America (SCHOPF, WILSON & BENTALL, 1944; KOSANKE, 1950). This species is known mostly from the Pennsylvanian sediments.

Calamospora pedata Kos. 1950

Pl. 1, Fig. 6

Genus — *Punctatisporites* (Ibr.) Pot. & Kr. 1954

Type Species — *Punctatisporites punctatus* Ibr. 1933.

Punctatisporites sp.

Pl. 1, Fig. 7

Description — Spore roundly triangular, 42 μ . Trilete distinct, rays equal, $\pm$ uniformly broad extending upto equator; commissure prominent. Exine $\pm$ 3.5 μ thick, laevigate and intrapunctate.

Comparison — The known species of *Punctatisporites* are all much bigger in size. The specimen recorded here is distinguished by roundly triangular amb, which necessitates the placement in *Punctatisporites*.

Genus — *Cadiospora* (Kos.) Venkat. & Bharad. 1964

Type Species — *Cadiospora magna* Kos. 1950.

Cadiospora sp.

Pl. 1, Fig. 5

Description — Roundly triangular, Y-mark distinct, upto three-fourths radius, ending in a darkened mond. Exine laevigate, irregularly thickened on distal side with a mottled appearance, proximally smooth.

Comparison — The three thickened areas at ray ends allow the specimen illustrated here, to be placed in *Cadiospora*. *C. aggera*, *C. obsoluta* and *C. laminata* described by Venkatachala and Bharadwaj (1964) show various trends in the development and specialization of the thickened ray ends. Cf. *Cadiospora* sp. described by the above authors comes closest to the specimens studied here.

Infraturma — *Apiculati* (Benn. & Kids.) Pot., 1956

Genus — *Granulatisporites* (Ibr.) Pot & Kr. 1954

Type Species — *Granulatisporites granulatus* Ibr. 1933.

Granulatisporites politus Hoffm., Stap. & Mall. 1965

Pl. 1, Fig. 8

Granulatisporites cf. *G. granulatus* Ibr. 1933

Pl. 1, Fig. 9

Description — Spore triangular, 30 μ . Apices rounded, interapical margins concave. Trilete well defined, rays equal, $\pm$ uniformly broad extending upto three-fourths the radius. Exine 1.5 μ thick, granulose, grana about 1 μ high, closely placed, uniformly distributed, about 37 grana on the margins.

Comparison — The specimens studied here are closely comparable to the ones described by Butterworth and Williams (1958, Pl. 1, Figs. 16 & 17).

Genus — *Cyclogranisporites* Pot. & Kr. 1954

Type Species — *Cyclogranisporites leopoldi* (Kr.) Pot. & Kr. 1954.

Cyclogranisporites sp.

Pl. 1, Fig. 10

Description — Spores circular, 30-40 μ . Trilete mostly well developed, rays $\pm$ equal, tapering at ends extending upto three-fourths the radius. Exine 2-2.5 μ thick, granulose, grana not more than 1 μ high, uniformly distributed and closely placed.

Cyclogranisporites cf. *C. aureus* (Loose) Pot. & Kr. 1954

Pl. 1, Fig. 11

Description — Spore subcircular, 64 μ . Trilete, rays distinct, slightly elevated, tapering at ends extending half of the radius. Exine $\pm$ 2.5 μ thick, granulose, grana densely placed, $\pm$ overlapping, 1-2 μ high; individual elements can be distinctly seen along the amb.

Comparison — *C. aureus* has finer sculptural elements.

Genus — *Apiculatisporis* (Ibr.) Pot. & Kr. 1956

Type Species — *Apiculatisporis aculeatus* Ibr. 1933.

Apiculatisporis variocorneus Sull. 1964

Pl. 1, Fig. 13

Genus — *Planisporites* (Knox) Pot. & Kr. 1956

Type Species — Planisporites granifer (Ibr.) Knox, 1956.

Planisporites sp.

Pl. 1, Fig. 14

Description — Spore subcircular, 100 μ . Exine $\pm 2.5 \mu$ thick, conii $\pm 1 \mu$, uniformly distributed. Trilete, rays well developed, extending not more than three-fourths the radius; commissure well recognisable.

Genus — *Ibrahimisporis* Art. 1957

Type Species — Ibrahimisporis microhorridus Art. 1957.

Ibrahimisporis sp.

Pl. 1, Fig. 17

Description — Spores subcircular in polar view, mostly folded. Trilete indistinct in obliquely flattened specimens. Sculptured with sharp tipped 4-8 μ long spines, sometimes interspersed with conii.

Comparison — *I. microhorridus* Art. is larger in size and ornamented with bigger spines. *I. brevispinosus* Neves (1964) and *I. magnificus* Neves (1964) have hollowed pointed spines for their ornamentation. *I. spitzbergensis* Bharad. & Venkat. (1962) has solid, shorter, broad based spines for its ornamentation.

Cf. Ibrahimisporis

Pl. 1, Fig. 16

Description — Spore originally seems to be subcircular, much folded. Exine 2.5 μ thick, sculptured elements sparse, uniformly distributed. Bacula 4-6 μ long, sometimes interspersed with spines.

Remarks — The specimen is badly preserved and hence has only been tentatively compared with *Ibrahimisporis*.

Genus — *Schopfites* Kos. 1950

Type Species — Schopfites dimorphus Kos. 1950.

Schopfites cf. *S. angustus* Playf. 1963

Pl. 1, Fig. 18

Description — Spore circular, 65 μ . Trilete, rays not distinct as the specimen illustrated here shows the distal face with ornamentation. Exine about 2.5 μ thick, possesses irregularly distributed verrucae with rounded ends, interspersed with sharp conii, sculptural elements are concentrated in the centre of the spore.

Comparison — *S. angustus* has projections of diverse sizes and shapes as compared to the specimen described here.

Genus — *Lophotriletes* (Naum.) Pot. & Kr. 1954

Type Species — Lophotriletes gibbosus (Ibr.) Pot. & Kr. 1954.

Lophotriletes microsaetosus (Loose) Pot. & Kr. 1954

Pl. 1, Fig. 19

Lophotriletes sp.

Pl. 1, Fig. 22

Description — Spores triangular in polar view, 20-30 μ , apices rounded, markedly concave interapical margins. Trilete, rays narrow, $\pm$ uniformly broad extending upto the margin. Exine upto 2 μ thick, sculptured with $\pm 1 \mu$ high, closely placed and evenly distributed conii.

Comparison — The present species is distinguished from *Lophotriletes microsaetosus* (Loose) Pot. & Kr. (1954) by its more concave interapical margins.

Genus — *Acanthotriletes* (Naum.) Pot. & Kr. 1954

Type Species — Acanthotriletes ciliatus (Knox) Pot. & Kr. 1954.

Acanthotriletes cf. *A. splendidus* Neves, 1961

Pl. 1, Fig. 23

Description — Spores $\pm$ subtriangular in polar view, 76 μ . Trilete, rays not very clearly seen, obscured by the ornamentation, extending upto two-thirds the radius; commissure ill-defined. Exine about 2 μ thick, spinose, spines 4-10 μ long and 2-5 μ broad

at base; blunt, closely placed and evenly distributed, about 40 spines on the margins.

Comparison — *A. splendidus* has comparatively smaller, sparsely arranged spines and *A. horridus* Hacq. (1957) has longer, densely placed ornamentation.

Acanthotriletes baculatus Neves 1961

Pl. 1, Figs. 24-25

Remarks — Spores triangular in polar view, 30-40 μ . Trilete, rays ill-developed not extending more than three-fourths the radius. Exine 2-2.5 μ thick, spinose, spines blunt, 4-10 μ long and 2-4 μ broad, occasionally curved, sparsely distributed, 15-25 elements on the margins, exine laevigate in between the spines.

Acanthotriletes sp.

Pl. 1, Fig. 15

Description — Spore subtriangular, 29 μ . Exine 2.5 μ thick, spinose, spines 2-5 μ long, sometimes interspersed with bacula. Trilete, rays ill-developed, extending not more than three-fourths the radius.

Comparison — The present specimen is smaller than the earlier described species.

Neoraistrickia Pot. 1956

Type Species — *Neoraistrickia truncatus* (Cook.) Pot. 1956.

Neoraistrickia inconstans Neves 1961

Pl. 1, Fig. 20

Remarks — *Neoraistrickia*, *Lophotriletes* and *Acanthotriletes* are hard to distinguish from one another. The shape of all the three genera is triangular with varied concavity of the interapical regions of the amb which sometimes project as three arms. The ornamentation varies from grana in *Lophotriletes* to spines in *Acanthotriletes* and to broad or narrow bacula in *Neoraistrickia*.

Neoraistrickia sp.

Pl. 1, Fig. 31

Description — Mostly triangular in polar view, sometimes subtriangular. Trilete ill-developed, rays not traceable in most of

the specimens. Exine 2-3 μ long, baculate, bacula mostly straight, sometimes curved; tip generally blunt or pinheaded.

Remarks — Only one specimen is recovered.

cf. *Neoraistrickia* sp.

Pl. 1, Fig. 21

Description — Spore triangular, 40 μ . Apices broad, interapical margins $\pm$ straight. Exine $\pm$ 3 μ thick, densely beset with knob-headed pila. Sculptural elements 4-6 μ long. Trilete, rays obscured by pila.

Remarks — The present specimen is conspicuous by the presence of knob-headed sculptural elements. In *Neoraistrickia* the bacula may be curved but not knob-headed; hence it has only been compared with *Neoraistrickia*.

Genus — *Raistrickia* (Schopf. Wils. & Bent.)
Pot. & Kr. 1954

Type Species — *Raistrickia grovensis* Schopf in Schopf, Wils. & Bent. 1944.

Raistrickia microhorrida (Horst) Pot. & Kr. 1955

Pl. 1, Figs. 26-28

Remarks — Spores subcircular, 35-40 μ (excluding the sculptural elements). Trilete, generally obscured by the ornamentation. Exine 2-2.5 μ thick, baculate, bacula 8-20 μ long, 4-10 μ broad, sometime with lacerated tips.

Raistrickia sp.

Pl. 1, Fig. 30

Description — Spore circular, 30 μ . Trilete, rays ill-developed. Exine 2.5 μ thick, baculate, bacula 3-6 μ long, sparsely placed, $\pm$ uniformly distributed, tips blunt or minutely lacerated.

Comparison — The present species differs from *Raistrickia microhorrida* (Horst) Pot. & Kr. (1955) by its smaller size and sculptural elements.

Genus — *Convolutispora* Hoffm., Stap. & Mall.
1955

Type Species — *Convolutispora florida* Hoffm., Stap. & Mall. 1955.

Convolutispora florida Hoffm., Stap. & Mall. 1955
Pl. 2, Fig. 37

Convolutispora punctatimura Stap. 1960
Pl. 2, Fig. 38

Convolutispora cerebra Butterw. & Will. 1958
Pl. 2, Fig. 39

Convolutispora tesellata Hoffm., Stap. & Mall. 1955
Pl. 1, Figs. 12, 29

Remarks — The present specimens are smaller in size range than those originally described by Hoffmeister, Staplin & Malloy (1955) from the Hardinsburg formation of Illinois and Kentucky.

Infraturma — *Murornati* Pot. & Kr. 1954

Genus — *Camptotriletes* Naum. 1937

Type Species — *Camptotriletes corrugatus* (Ibr.) Pot. & Kr. 1954.

Camptotriletes sp.

Pl. 2, Fig. 40

Description — Spore subcircular in polar view, 40 μ . Trilete, rays well developed, one arm is generally shorter than two; commissure well recognisable. Exine about 2.5 μ , slightly rugose, muri tips found distinctly on equatorial margin. Muri 2-3 μ broad, forming irregular ridges.

Genus — *Microreticulatisporites* (Knox) Pot. & Kr. 1954

Type Species — *Microreticulatisporites lacunosus* (Ibr.) Knox 1950.

Remarks — Bharadwaj (1955) emended *Microreticulatisporites* to include only spores with a triangular shape in polar view. This suggestion is laudable as triangular as well as circular spores cannot be put together under the same taxon. By acceptance of this suggestion a host of species possessing a circular shape in polar view get eliminated from *Microreticulatisporites*.

Microreticulatisporites sp.

Pl. 2, Fig. 43

Description — Spores triangular in polar view with straight to convex sides, 36-40 μ .

Trilete, rays hardly perceptible in most of the specimens as covered by the muri, ray-arms while perceptible reach upto equator. Exine upto 3 μ thick, muri forming $\pm$ 4 μ high ridges enclosing $\pm$ 2 μ wide lacuna.

Comparison — *M. fistulosus* (Ibrahim) Knox (1950) and *M. novicus* Bharadwaj (1955) though comparable do not possess as high muri as seen in the specimen illustrated here.

Microreticulatisporites cf. *M. concavus* Butterw. & Will. 1958

Pl. 2, Fig. 42

Description — Roundly triangular with concave sides and rounded apices in polar view, 40 μ . Y-mark distinct reaching upto three-fourths the radius. Muri flat enclosing less than 2 μ wide lacuna, lacuna uniformly distributed. Equatorial margin notched due to the presence of muri.

Comparison — *Microreticulatisporites concavus* Butterw. & Will. (1958) differs from the present species in possessing broader angles and notched equatorial margin, suggesting high muri.

Vestispora (Wils. & Hoffm.) Wils. & Venkat. 1963

Type Species — *Vestispora profunda* Wils. & Hoffm. 1956.

Vestispora sp.

Pl. 3, Fig. 85

Description — Spore circular, 102 μ . Operculum distinct, ornamented with muri, irregularly anastomosing forming incomplete meshes. The specimens studied are not well preserved.

Genus — *Propriporites* Neves 1958

Type Species — *Propriporites rugosus* Neves 1958.

Propriporites rugosus Neves 1958

Pl. 2, Fig. 52

Propriporites laevigatus Neves 1962

Pl. 2, Fig. 53

Infraturma — *Perinotrileti* Erdt. 1947

Velamisporites Bharad. & Venkat. 1961

Type Species — *Velamisporites rugosus* Bharad. & Venkat. 1962.

Remarks — Circular, folded, 104 μ . Y-mark present on the spore body but obscured by the granulose, densely folded perisporial coat.

Comparison — The specimen closely compares with *V. rugosus* except for their size.

Turma — *Zonales* (Benn. & Kids.) Pot. 1956

Subturma — *Auritotriteles* Pot. & Kr. 1954

Infraturma — *Auriculati* (Schopf) Pot. & Kr. 1954

Genus — *Triquitrites* Wils. & Coe 1940

Type Species — *Triquitrites arcuatus* Wils. & Coe 1940.

Triquitrites bransonii Wils. & Hoffm. 1956

Pl. 3, Fig. 57

Triquitrites cf. *T. tendoris* Hacque. & Brass 1957

Pl. 3, Fig. 59

Description — Spore triangular, 41 μ . Apices broadly rounded, interapical regions concave. Apices having cushion like thickening which also extends towards interapical margins. Trilete distinct, rays extending three-fourths the radius. Exine $\pm$ laevigate.

Triquitrites golatensis (Stap.) Bharad. & Venkat. 1962

Pl. 3, Fig. 60

Triquitrites minutus sp. nov.

Pl. 3, Figs. 61-62

Holotype — Pl. 3, Fig. 61, size 30 μ .

Type Locality — Calareti zone, Lower Carboniferous, Moesian Platform, Rumania.

Diagnosis — Spores triangular, 20-30 μ . Apices acutely rounded, interapical margins concave. Auriculae thickened, mostly parate, completely covering the apices. Trilete extending upto the equator.

Description — Spores mostly triangular in polar view. Apices covered with auriculae; they are branched either in two or four parts in each apices. Trilete distinct, rays slightly elevated, uniformly broad extending upto the equator. Commissure well defined. Exine 2-2.5 μ thick, laevigate.

Comparison — *Triquitrites tendoris* Hacque. & Brass (1957) is comparable to the

present species somewhat in size range but can easily be distinguished by its extension of the cushion like thickening towards the interapical margins. *T. golatensis* (Stap.) Bharad. & Venkat. (1962) is also comparable to *T. minutus* in the presence of dissected auriculae in some specimens but can easily be differentiated by its larger size range. *T. inusitatus* Kos. (1950) (also referred to as *Mooreisporites* Neves) is larger in size and the auricular processes are long and looking like bacula. *T. minutus* is distinguished from all of the known species of this genus by its smaller size, extension of the trilete upto the equator and thin auriculate processes which divide into 2-4 parts in each apices.

Genus — *Tripartites* (Schem.) Pot. 1956

Type Species — *Tripartites vetustus* Schem. 1950.

Tripartites ianthina Butter. & Will. 1958

Pl. 3, Fig. 63

Mooreisporites Neves 1958

Type Species — *Mooreisporites fustis* Neves 1958.

Mooreisporites fustis Neves 1958

Pl. 3, Fig. 58

Infraturma — *Crassiti* Bharad. & Venkat. 1962

Genus — *Crassispora* Bharad. 1957

Type Species — *Crassispora ovalis* (Bharad.) Bharad. 1957.

Crassispora sp.

Pl. 2, Fig. 34

Description — Spores circular in polar view, 40-50 μ . Trilete ill-developed, rays hardly traceable in most of the specimens. Exine 2.5-5 μ thick, scabrate. Equatorial crassitudo $\pm$ 8 μ broad, distinct.

Comparison — *C. spitzbergensis*, *C. vestita* described by Bharad. and Venkat. (1962) are distinctly conate. *C. sp.* B. described by the same authors has granulose ornamentation but differs in its larger size.

Subturma — *Zonotriletes* Waltz 1935
Infraturma — *Cingulati* Pot. & Kl. 1954

Genus — *Stenozonotriletes* (Naum.) Pot. 1958

Type Species — *Stenozonotriletes conformis* Naum. 1953.

Stenozonotriletes clarus Isch. 1958

Pl. 3, Fig. 66

Remarks — *S. clarus* is a rare species described by Ischenko from the Lower Carboniferous of U.S.S.R. The spore is circular in polar view, 39 μ . Inner body well defined, circular. Trilete distinct, rays equal, extending upto margin of the central body; exine of the inner body intrapunctate. Cingulum prominent, uniformly broad, $\pm 4 \mu$ broad.

Remarks — The present specimen is somewhat smaller in size than those described by Ischenko (1958) and Playford (1962).

Stenozonotriletes perforatus Playf. 1962

Pl. 3, Fig. 67

Stenozonotriletes spectandus Naum. 1953

Pl. 3, Fig. 68.

Genus — *Murospora* Som. 1952

Type Species — *Murospora kosankei* Som. 1952.

Murospora kosankei Som. 1952

Pl. 3, Fig. 64

Murospora sp.

Pl. 3, Fig. 65

Description — Spores triangular in polar view. Central body generally confronting with the overall shape. Trilete, rays ill-developed, hardly traceable in some specimens; exine of the inner body laevigate to granulose. Cingulum broad, thick, cleft to form verrucae — bacula like projections; otherwise exine of the cingulum psilate.

Comparison — *Murospora kosankei* Som. (1952) is comparable to the present species in general shape but is distinguished by its comparatively smaller size, prominent trilete rays and uniformly thick cingulum without any pseudosculptural elements. *M.*

aurita (Waltz) Playf. (1962) and *M. friendii* Playf. (1962) are differentiated from the present species by their larger size range, prominent trilete rays and laevigate, $\pm$ uniformly broad cingulum.

Genus — *Savitrisorites* Bharad. 1955

Type Species — *Savitrisorites triangulus* Bharad. 1955.

Savitrisorites nux (Butterw. & Will.) Sull. 1964

Pl. 3, Fig. 69

Genus — *Bellisporis* Art. 1957

Type Species — *Bellisporis bellus* Art. 1957.

Bellisporis bellus Art. 1957

Pl. 3, Fig. 70

Genus — *Rotaspora* Schem. 1950

Type Species — *Rotaspora fracta* Schem. 1950.

Rotaspora knoxi Butterw. & Will. 1958

Pl. 3, Fig. 72

Genus — *Cingulizonates* (Dyb. & Jach.) Stap. & Jans. 1964

Type Species — *Cingulizonates tuberosus* Dyb. & Jach. 1957

Cingulizonates capistratus (Hoffm., Stap. & Mall.) Stap. & Jans. 1964

Pl. 3, Figs. 71 & 73

Cingulizonates loricatus (Loose) Butterw. & Smith in Butterw. 1963

Pl. 3, Fig. 76

Cristatisporites cf. *C. bellus* Bharad. & Venkat. 1962

Pl. 3, Fig. 74

Remarks — The specimens described here are smaller in size range than those originally described by Bharadwaj and Venkatachala (1962) from the Carboniferous shale from Spitzbergen.

Densosporites (Berry) Bharad. & Venkat. 1962

Type Species — *Densosporites covensis* Berry 1937

Densosporites sp. 1

Pl. 3, Fig. 75

Description — Roundly triangular, 42 μ . Central body scabrate. Y-mark distinct, apex and vertex high, tecta raised, cingulum upto 8 μ broad, uniform, irregularly thickened, laevigate.

Genus — *Lycospora* (Schopf, Wils. & Bent.) Pot. & Kr. 1956

Type Species — *Lycospora micropapillata* (Wils. & Coe) Schopf, Wils. & Bent. 1944.

Lycospora adornatus (Art.) comb. nov.

Pl. 3, Fig. 77

Synonym — *Densosporites adornatus* Art. 1957.

Holotype — Art., 1957, pl. 4, fig. 40.

Description — Spore subtriangular, 39 μ ; central body confronting with the overall shape. Proximal surface of the body punctate. Trilete prominent, rays raised, apex and vertex high, labra broad, raised, ray arms almost extending upto the equator. Cingulum 6-8 μ broad.

Remarks — In view of the similarity in morphology of this species to *Lycospora* in possessing a thin papery cingulum and the nature of the central body we consider it necessary to transfer this species to *Lycospora*.

Infraturma — *Zonati* Pot. & Kr. 1958

Genus — *Procoronaspora* Butter. & Will. 1958

Type Species — *Procoronaspora ambigua* Butterw. & Will. 1958.

Procoronaspora sp. 1

Pl. 2, Fig. 32

Description — Spore triangular in polar view, 36 μ . Apices rounded, interapical regions slightly convex. Trilete, rays distinct, narrow, uniformly broad extending three-fourths the radius; commissure well developed. Exine $\pm$ 2.5 μ thick; conied at the distal surface; interradsial parts of the

proximal surface are also conied. Coni $\pm$ up to 3 μ long, about 30 coni on the margins.

Remarks — The interradsial ornamentations of the exine can be considered as an incipient corona. The equatorial nature of this ornamentation allows these specimens to be placed under infraturma *Zonati*.

Procoronaspora sp. 2

Pl. 2, Fig. 33

Description — Spore triangular, 30 μ . Apices acutely rounded, interapical margins straight. Trilete, rays distinct, extending almost upto the equator; commissure well defined. Exine 2 μ thick, conied distally and on contact area proximally. Coni 3-5 μ long.

Comparison — *Procoronaspora* sp. 2 is distinguished from *P.* sp. 1 by its more triangular shape, smaller size but longer coni.

Genus — *Reinschospora speciosa* (Loose) Schopf, Wils. & Bent. 1944

Reinschospora fimbriata Art. 1957

Pl. 3, Fig. 78

Genus — *Reticulatisporites* (Ibr.) Neves 1964

Type Species — *Reticulatisporites reticulatus* Ibr. 1933.

Reticulatisporites sp.

Pl. 2, Fig. 44

Description — Spore circular, 40 μ . Trilete rays narrow, uniformly broad extending upto the equator. Exine about 2.5 μ thick, muri raised forming large reticulation, lacuna wide. Zona narrow, upto 6 μ wide.

Genus — *Knoxisporites* (Pot. & Kr.) Neves 1961

Type Species — *Knoxisporites hageni* Pot. & Kr. 1954.

Knoxisporites triradiatus Hoffm., Stap. & Mall. 1955

Pl. 2, Fig. 47

Knoxisporites sp. 1

Pl. 2, Fig. 46

Description — Spore subcircular, 52 μ . Trilete, rays poorly developed. Muri raised

forming broad polygonal area. Zona upto $6\ \mu$ broad.

Genus — *Tendosporites* Hacque. 1957

Type Species — Tendosporites subalatus Hacque. & Brass 1957.

Tendosporites cf. *T. subalatus* Hacque. 1957

Pl. 2, Fig. 49

Description — Spore subcircular, $50\ \mu$. Trilete, rays ill-developed not extending upto the margin of the central body. Central body roundly triangular. Cingulum well developed, upto $14\ \mu$ broad, radially thickened ribs present, margins slightly thin.

Tendosporites sp. 1

Pl. 2, Fig. 54

Description — Circular, $45\ \mu$. Central body finely ornamented with verrucae of different sizes and shapes. Cingulum $\pm 14\ \mu$ wide and uniform. The distinct compressional folds running across the spore can be mistaken for muri such as seen in *Knoxisporites*.

Comparison — *T. subalatus* has laevigate spore body. *T. subcrenatus* is characterized by plications on the spore body and *T. rotulus* has thickened cingulum.

Tendosporites sp. 2

Pl. 2, Fig. 50

Description — Spore subcircular — subtriangular, $50-64\ \mu$. Trilete, extending upto the margin of the spore body. Cingulum distinct, uniformly broad, irregularly thickened.

Comparison — The specimens grouped under here are distinguished in possessing a non-ornamented central body and a very massive cingulum.

Genus — *Clavisporis* Bharad. & Venkat. 1962

Type Species — Clavisporis spitzbergensis Bharad. & Venkat. 1962.

Clavisporis sp.

Pl. 2, Fig. 51

Description — Spore $\pm$ oval, $70\ \mu$, margin undulated. Central body $\pm$ subcircular.

Trilete, rays ill-developed not extending upto the margin of the central body. Cingulum well defined, $\pm$ broadly cleft to produce very broad projections in the form of large warts.

Comparison — *Clavisporis spitzbergensis* Bharad. & Venkat. (1962) is distinguished from the present species by its larger size and well developed trilete mark. *Clavisporis boletus* (Stap.) Bharad. & Venkat. (1962) is roundly triangular in shape with prominent haptotypic mark and pilate cingulum.

Genus — *Canthospora* Wins. 1962

Type Species — Canthospora patula Wins. 1962.

Canthospora sp.

Pl. 2, Fig. 45

Description — Circular, $70\ \mu$. Y-mark distinct, labra prominent, apex slightly raised, rays reaching upto the limit of the spore body. Cingulum upto $8\ \mu$ broad. Central body beset with a circular knob at the distal pole, distal annular ring upto $18\ \mu$ broad, irregular, in between the distal exine appears to be covered by fine mud-crack like, scabrate exine.

Comparison — *Canthospora patula* and *C. cracens* are both from the Devonian rocks. They are larger in size and lack the conspicuous distal annular ring present here.

Turma — *Monoletes* Ibr. 1933

Subturma — *Axonomonoletes* Lub. 1935

Infraturma — *Psilamonoleti* V.D.Ham. 1955

Genus — *Laevigatosporites* Ibr. 1933

Type Species — Laevigatosporites vulgaris (Ibr.) Ibr. 1933.

Laevigatosporites ovalis Kos. 1950

Pl. 3, Fig. 79

Laevigatosporites medius Kos. 1950

Pl. 3, Fig. 80

Genus — *Punctatosporites* Ibr. 1933

Type Species — Punctatosporites minutus Ibr. 1933.

Punctatosporites minutus Ibr. 1933

Pl. 3, Figs. 81-82

Anteturma — *Pollenites* Pot. 1931Turma — *Saccites* Erdt. 1947Subturma — *Monosaccites* (Chit.) Pot. & Kr. 1954Infraturma — *Triletesacciti* Les. 1955Genus — *Florinites* Schopf, Wils. & Bent. 1944*Type Species* — *Florinites antiquus* Schopf 1944.*Florinites visendus* (Ibr.) Schopf, Wils. & Bent. 1944

Pl. 3, Fig. 83

Genus — *Schulzospora* Kos. 1950*Type Species* — *Schulzospora rara* Kos. 1950.*Schulzospora rara* Kos. 1950

Pl. 3, Fig. 84

Incertae Sedis

Genus — *Grandispora* Hoffm. Stap. & Mall. 1955*Type Species* — *Grandispora spinosa* Hoffm., Stap. & Mall. 1955.*Grandispora spinosa* Hoffm. Stap. & Mall. 1955

Pl. 2, Fig. 36

Remarks — The specimens referred here to *Grandispora spinosa* are of the same size as originally described by Hoffmeister, Staplin & Malloy (1955); but the sculptural elements are longer and the inner body is also comparatively inconspicuous.

REFERENCES

- ARTÜEZ, S. (1957). Die *Sporae dispersae* der Türkischen Steinkohle von Zonguldak — Gebiet (mit besonderer Beachtung der neuen Arten und Genera). *Istanb. Üniv. Fen Fak. Mecd. Ser. B22* (4): 239-263.
- BERRY, W. (1937). Spores from the Pennington Coal, Rhea County, Tennessee. *Am. Midl. Nat.* **18**: 155-160.
- BHARADWAJ, D. C. (1955). The spore genera from the Upper Carboniferous coals of the Saar and their value in stratigraphical studies. *Palaeobotanist.* **4**: 119-149.
- BHARADWAJ, D. C. & VENKATACHALA, B. S. (1962). Spore assemblage out of a Lower Carboniferous shale from Spitzbergen. *Ibid.* **10** (1 & 2): 18-47, 1961.
- Idem (1968). Suggestions for a morphological classification of *Sporae dispersae*. *Rev. Palaeobot. Palynol.* **6**: 41-59.
- BUTTERWORTH, M. A. & WILLIAMS, R. W. (1958). The small spore floras of coals in the Limestone coal group and Upper Limestone group of the Lower Carboniferous of Scotland. *Trans. R. Soc. Edinb.* **63** (2): 353-392.
- BUTTERWORTH, M. A. *et al.* (1964). *Densosporites* (Berry) Potonié & Kremp and related genera. *C.r.5. Start. geol. Congr. Carbon.* **3**: 1049-1057.
- DYBOVA, S. & JACHOWICZ, (1957). Microspores of the Upper Silesian Coal Measures. *Prace. Inst. geol.* **23**: 1-328.
- ERDTMAN, G. (1947). Suggestions for the classification of fossil and recent pollen grains and spores. *Svensk bot. Tidskr.* **41** (1): 104-114.
- HACQUEBARD, P. A. (1957). Plant spores in coal from the Horton group (Mississippian) of Nova Scotia. *Microfaleontology.* **3** (4): 301-324.
- HACQUEBARD, P. A. & BRASS, M. S. (1957). A Carboniferous spore assemblage in coal from the south Nahanni river area northwest territories. *Bull. geol. Surv. Can.* **40**: 1-63.
- HAMMEN, V. D. (1955). Principios para la Nomenclatura Palinologica sistemática. *Inst. Geol. Nac. Colombia, Bot. Geol.* **2** (2): 1-21.
- HOFFMEISTER, W. S., STAPLIN, F. L. & MALLOY, R. E. (1955). Mississippian plant spores from the Hardinsburg formation of Illinois and Kentucky. *J. Paleont.* **29** (3): 372-399.
- HORST, U. (1943). Mikrostratigraphischer Beitrag zum Vergleich des Namur von West-Oberschlesien und Mährisch-Ostrau. Die Mega- und Mikrosporen der hauptsächlichen Flöze beider Reviere. *Diss. Tech. Hochschule. Berlin.*
- IBRAHIM, A. C. (1932). Beschreibung von Sporenformen aus Flöz Ägir — in R. Potonié, Sporenformen aus den Flozen Ägir und Bismarck des Ruhrgebietes. *Neues Jb. Miner. geol. Paläont. Beil. Bd.* **67** B: 447-449.
- IMGRUND, R. (1952). Die Sporites des Kaipingbeckens, ihre paläontologische und stratigraphische Bearbeitung im Hinblick auf eine Parallelisierung mit dem Ruhrkarbon und dem Pennsylvanian von Illinois. *Diss. Tech. Hochschule. Aachen:* 1-96.
- ISCHENKO, A. M. (1952). Atlas of microspores and pollen of the Middle Carboniferous of the western part of the Donets basin. *1-2 Akad. NaukUkr. S.S.R.:* 1-83.
- Idem (1958). Spore-pollen analysis of lower coal layer of Dnepr-Don confluence. *Stratigraphy and Palaeontology series. Ukr. Acad. Sci.:* 1-186.
- KOSANKE, R. M. (1950). Pennsylvanian spores of Illinois and their use in correlation. *Bull. Illinois geol. Surv.* **74**: 1-128.
- KNOX, E. M. (1950). The spores of *Lycopodium*, *Phylloglossum*, *Selaginella* and *Isoetes* and their

- value in the study of microfossils of Palaeozoic age. *Trans. Proc. bot. Soc. Edinb.* **35**: 209-357.
- LUBER, A. A. & WALTZ, I. E. (1938). Classification and stratigraphical value of spores of some Carboniferous coal deposits in the U.S.S.R. *Trav. Inst. géol. S.S.S.R.* **105**: 1-45.
- Idem (1941). Atlas of microspores and pollen grains of the Palaeozoic of the U.S.S.R. *Trans. All-Un. sci. Res. Inst. geol. (VSEGEI)* **139**: 1-107.
- NAUMOVA, S. N. (1939). Spores and pollen of the coals of the U.S.S.R. *Int. geol. Cong., Moscow.* (1937) **1**: 353-364.
- Idem (1953). Spore-pollen complexes of the Upper Devonian of the Russian platform and their stratigraphical significance. *Trans. Inst. Sci. géol. S.S.S.R.* **143**: 1-154.
- NEVES, R. (1961). Namurian plant spores from the Southern Pennines, England. *Palaeontology.* **4**: 247-279.
- Idem (1964). *Knoxisporites* (Potonié & Kremp) Neves 1961. *C.r. 5 Congr. Strat. Géol. Carbon.* **3**: 1063-1069.
- PLAYFORD, G. (1962). The Lower Carboniferous microfloras of Spitsbergen. *Palaeontology.* **5** (3): 550-618.
- POLONIÉ, R. & KREMP, G. (1954). Die Gattungen der paläozoischen *Sporae dispersae* und ihre Stratigraphie. *Geol. Jb.* **69**: 111-194.
- Idem (1955). Die *Sporae dispersae* des Ruhrkarbons ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. Teil. 1. *Palaeontographica.* **98B**: 1-136.
- Idem (1956). Die *Sporae dispersae* des Ruhrkarbons ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. Teil. 2. *Ibid.* **99B**: 85-191.
- 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.
- SOMERS, G. (1952). A preliminary study of the fossil spore content of the Lower Jubilee seam of the Sydney coalfield, Nova Scotia. *Nova Scotia Res. Found.*: 1-30.
- STAPLIN, F. L. (1960). Upper Mississippian plant spores from the Golata formation, Alberta, Canada. *Palaeontographica.* **107** (B): 1-40.
- SULLIVAN, H. J. (1964). Miospores from the Drybrook Sandstone and associated measures in the forest of Dean basin, Gloucestershire. *Palaeontology.* **7** (3): 351-392.
- VENKATACHALA, B. S. & BEJU, D. (1961). Studii palinologice in paleozoicul platformei moesice. Aspura prezentei Devonianului in fundamentul zonei calarasi. *Petrol Gaze.* **12** (11): 494-495.
- Idem, (1962). Cerecari microfloristice in paleozoicul platformei moesice. Aspura prezentei carboniferului in fundamentul zonei Calareti. *Ibid.* **13** (4): 145-151.
- VENKATACHALA, B. S. & BHARADWAJ, D. C. (1964). Sporological study of the coals from Falkenburg (Faulquemont) colliery, Lothringen (Lorraine), France. *Palaeobotanist.* **11** (3): 159-207, 1962.
- WILSON, L. R. & HOFFMEISTER, W. S. (1956). Plant microfossils of the Croweburg coal. *Circ. Okla. geol. Surv.* **32**: 1-57.
- WILSON, L. R. & VENKATACHALA, B. S. (1963). An emendation of *Vestispora* Wilson & Hoffmeister, 1956. *Okla. Geol. Notes* **23** (4): 94-100.
- WINSLOW, M. R. (1962). Plant spores and other microfossils from Upper Devonian and Lower Mississippian rocks of Ohio. *U.S. geol. Surv. Prof. Paper* **364**: 1-93.

EXPLANATION OF PLATES

(All photographs are enlarged ca. $\times 500$. The slides are preserved at the Institute of Petroleum Geology, M.I.P.C., Bucharest, Rumania)

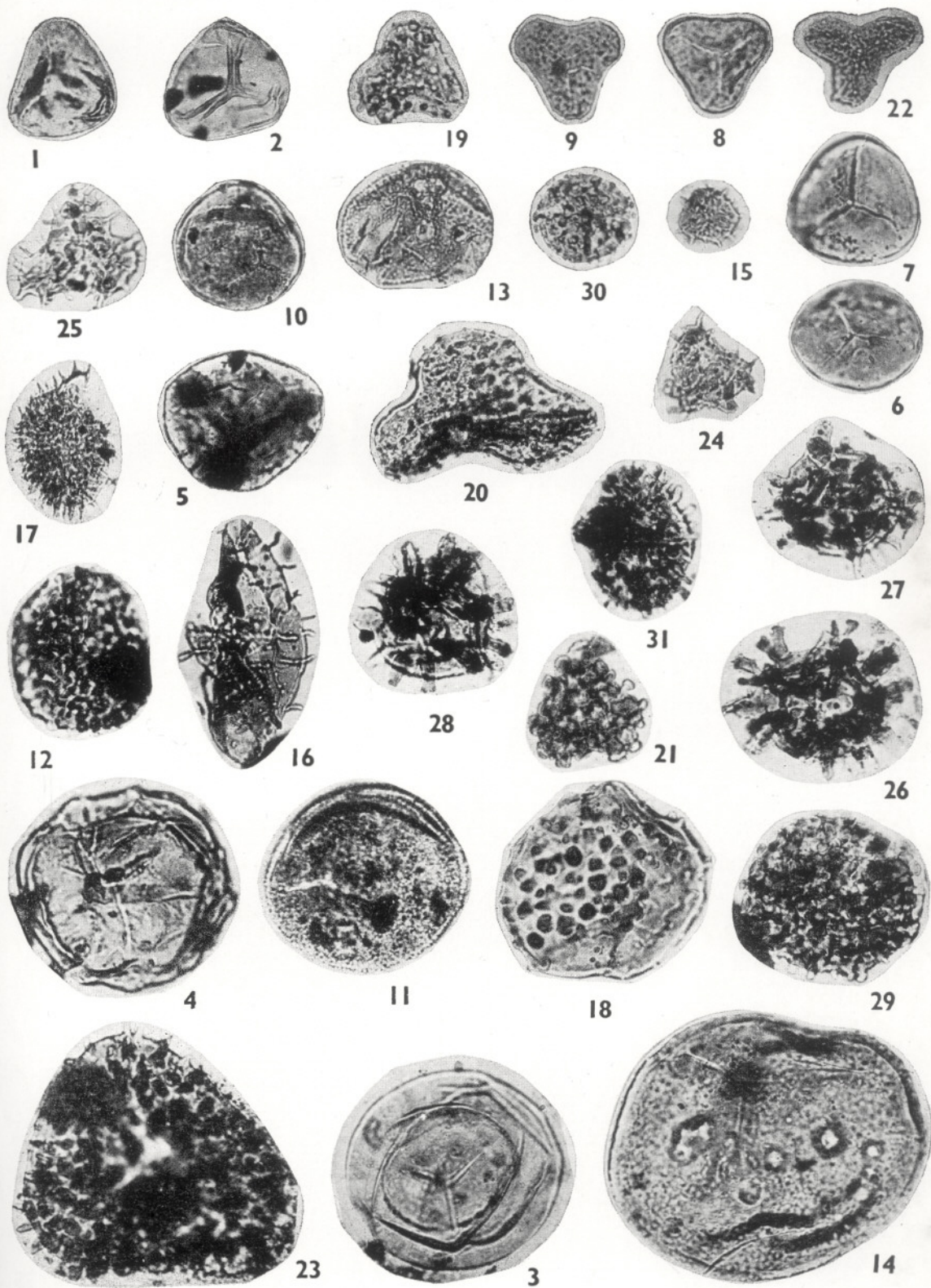
PLATE 1

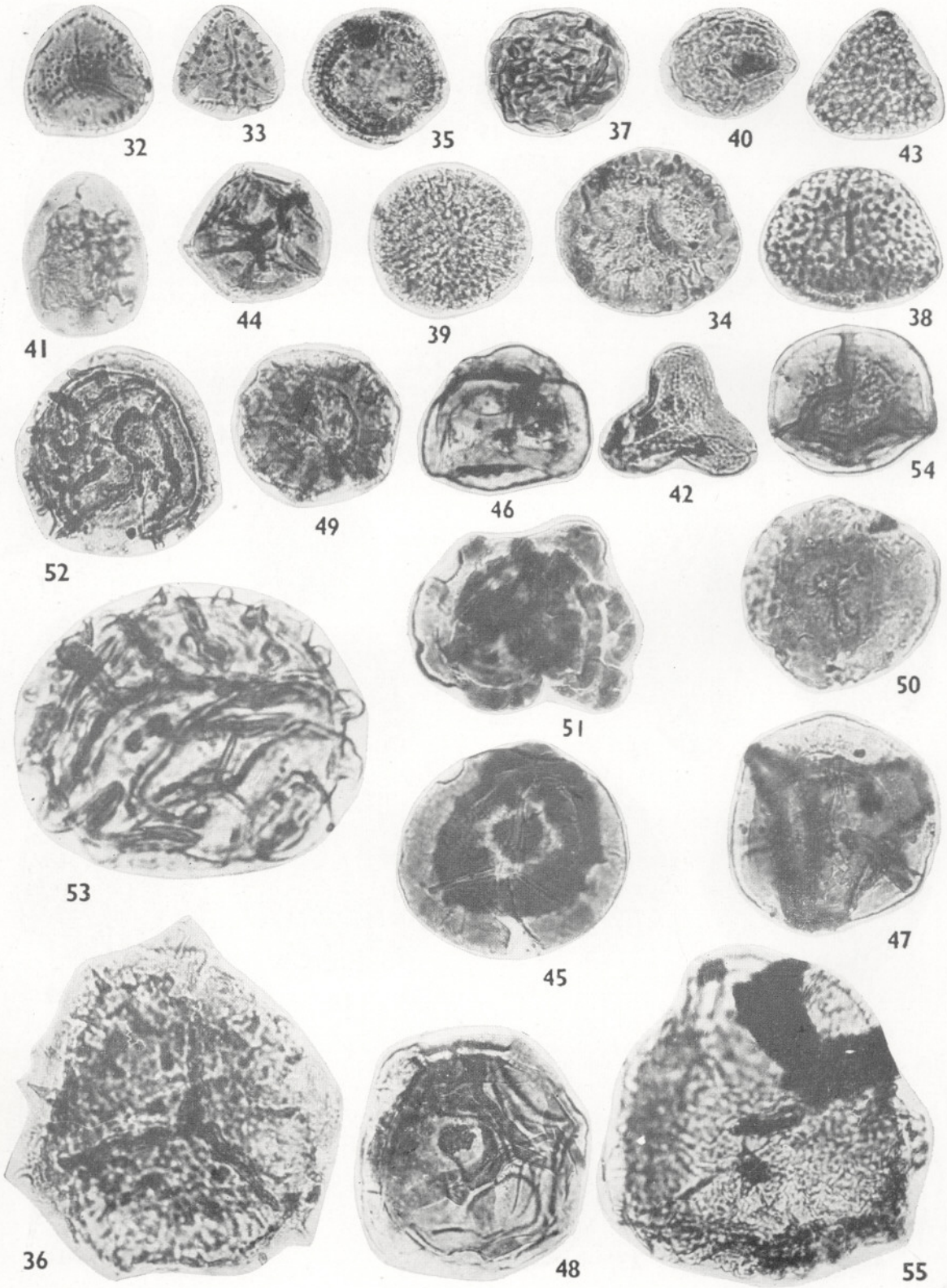
1. *Leiotriletes adnatoides*.
2. *Leiotriletes tumidus*.
3. *Calamospora* cf. *C. mutabilis*.
4. *Calamospora microrugosa*.
5. *Cadiospora* sp.
6. *Calamospora pedata*.
7. *Punctatisporites* sp.
8. *Granulatisporites politus*.
9. *Granulatisporites* cf. *G. granulosus*.
10. *Cyclogranisporites* sp.
11. *Cyclogranisporites* cf. *C. aureus*.
12. *Convolutispora tesellata*.
13. *Apiculatisporis variocorneus*.
14. *Planisporites* sp.
15. *Acanthotriletes* sp.
16. Cf. *Ibrahimisporis* sp.
17. *Ibrahimisporis* sp.
18. *Schopfites* cf. *S. angustus*.
19. *Lophotriletes microsaetosus*.
20. *Neoraistrickia inconstans*.
21. Cf. *Neoraistrickia* sp.

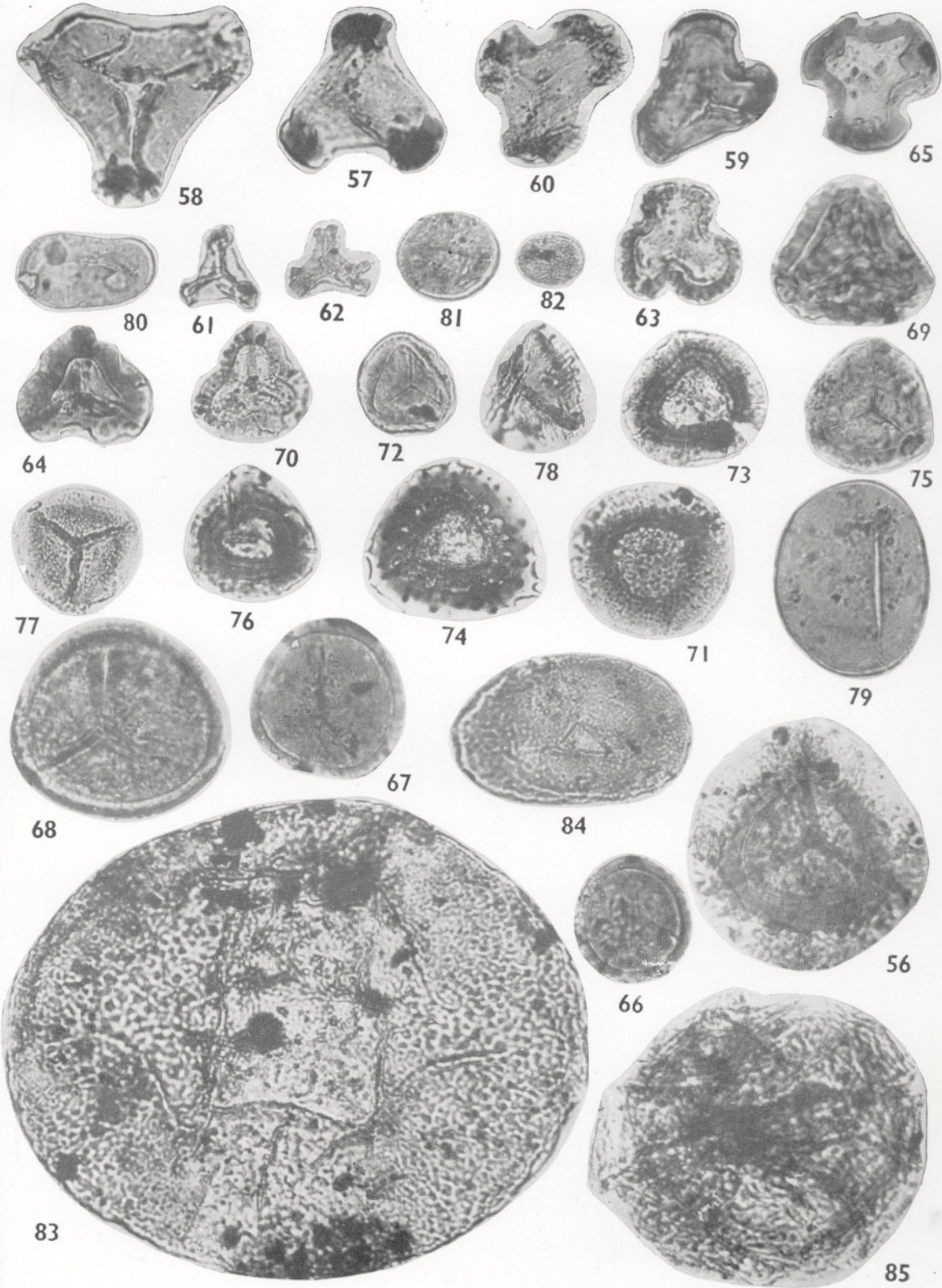
22. *Lophotriletes* sp.
23. *Acanthotriletes* cf. *A. splendidus*.
- 24-25. *Acanthotriletes baculatus*.
- 26-28. *Raistrickia microhorrida*.
29. *Convolutispora tesellata*.
30. *Raistrickia* sp.
31. *Neoraistrickia* sp.

PLATE 2

32. *Procoronaspora* sp. 1.
33. *Procoronaspora* sp. 2.
34. *Crassispora* sp.
35. Spore type 1.
36. *Grandispora spinosa*.
37. *Convolutispora florida*.
38. *Convolutispora punctatimura*.
39. *Convolutispora cerebra*.
40. *Camptotriletes* sp.
41. *Hystrichosphaerid* type 1.
42. *Microreticulatisporites* cf. *M. concavus*.
43. *Microreticulatisporites* sp.
44. *Reticulatisporites* sp.







- 45. *Canthospora* sp.
- 46. *Knoxisporites* sp. 1.
- 47. *Knoxisporites* *triradiatus*.
- 48. ? *Knoxisporites* sp.
- 49. *Tendosporites* cf. *T. subalatus*.
- 50. *Tendosporites* sp. 2.
- 51. *Clavisporis* sp.
- 52. *Proprisporites* *rugosus*.
- 53. *Proprisporites* *laevigatus*.
- 54. *Tendosporites* sp. 1.
- 55. *Velamisporites* sp.

PLATE 3

- 56. *Cingulizonates* sp.
- 57. *Triquitrites* *bransonii*.
- 58. *Mooreisporites* *fustis*.
- 59. *Triquitrites* cf. *T. tendoris*.
- 60. *Triquitrites* *golatensis*.
- 61-62. *Triquitrites* *minutus* sp. nov.

- 63. *Tripartites* *ianthina*.
- 64. *Murospora* *kosankei*.
- 65. *Murospora* sp.
- 66. *Stenozonotriletes* *clarus*.
- 67. *Stenozonotriletes* *perforatus*.
- 68. *Stenozonotriletes* *spectandus*.
- 69. *Savitrisporites* *nux*.
- 70. *Bellisporis* *bellus*.
- 71, 73. *Cingulizonates* *capistratus*.
- 72. *Rotaspora* *knoxii*.
- 74. *Cristatisporites* cf. *C. bellus*.
- 75. *Densosporites* sp. 1
- 76. *Cingulizonates* *loricatus*.
- 77. *Lycospora* *adornatus* comb. nov.
- 78. *Reinschospora* *fimbriata*.
- 79. *Laevigatosporites* *ovalis*.
- 80. *Laevigatosporites* *medius*.
- 81-82. *Punctatosporites* *minutus*.
- 83. *Florinites* *visendus*.
- 84. *Schulzospora* *rara*.
- 85. *Vestispora* sp.