LOWER AND MIDDLE DEVONIAN SPORES
OF NORTH AND CENTRAL VESTSPITSBERGEN

by K. C. ALLEN

ABSTRACT. From the Devonian succession in North and Central Vestspitsbergen, seven hundred rock-specimens collected by the author and over three hundred collected by previous Expeditions have been examined microscopically; two hundred and fifty of these were prepared for microscopic investigation. These included specimens from every Spitsbergen formation, and consisted typically of medium to fine-grained elastic sediments. Eighty-two dispersed spore species are recorded, of which forty-eight new species are systematically described. Five new genera (Bulbulosporites, Craspelopora, Cyphosporites, Aulicosporites, and Cladosporites) are proposed, and another genus (Archaeosporesporites) is amended. Twenty-five morphologically complex species were sectioned, in order to elucidate and interpret their structure. Consideration is given to corrosion and preservation of the spore exine.

This paper describes only the preparation and systematics of the dispersed spores from the Devonian succession of North and Central Vestspitsbergen. In a later paper the microfloral assemblages and their stratigraphical applications will be discussed.

The study of the dispersed spores from the Devonian succession of Spitsbergen was undertaken at the joint suggestion of Mr. N. F. Hughes and Mr. W. B. Harland. An initial study by Dr. P. F. Friend and Mrs. M. Mortimer had shown the presence of spores from horizons in the Mimer Valley Series.

All the samples studied were collected by members of various Spitsbergen Expeditions organized from the Sedgwick Museum, although prior to 1959 few samples were collected for this purpose; samples for palynological preparation and examination were collected by Dr. P. F. Friend and Dr. D. J. Gobbett in 1959, and by the author in 1961.

The spore genera and species are based solely on morphological criteria, their botanical affinities are for the most part unknown.

The Devonian succession in Spitsbergen is confined to the island of Vestspitsbergen, where the Devonian outcrops over a large area (Friend 1961, p. 79, fig. 1). It consists of about six thousand metres of predominantly Old Red Sandstone facies. Numerous sections were collected for palynological study throughout the area by the author, in the hope of producing a stratigraphical succession based on dispersed spores. Well-localized samples collected by previous Cambridge Spitsbergen Expeditions were also used. For general stratigraphy and stratigraphical nomenclature, I have followed Friend (1961) throughout.

Acknowledgements. The writer expresses his sincere gratitude to Mr. N. F. Hughes for constant advice and encouragement throughout the course of this study. The investigation was made possible through the fieldwork of members of various Cambridge Spitsbergen Expeditions. The writer is particularly indebted to Mr. W. B. Harland who organized most of these Expeditions, and who jointly with Mr. Hughes suggested the research topic; to Dr. P. F. Friend who led the 1961 Cambridge Spitsbergen Expedition and who in 1959 with Dr. D. J. Gobbett, collected many of the samples investigated. Grateful acknowledgement is extended to Professor O. M. B. Bulman, F. R. S., for the use of research facilities of the Sedgwick Museum, Cambridge, where the study was carried out. The writer also

thanks Dr. M. E. Dettmann for helpful discussions, and Mr. A. Barlow for kindly assisting with much of the photography.

Through the courtesy of Professor O. A. Haeg, of the University of Oslo, the writer was able to examine collections of Devonian plants from Spitsbergen housed in the Palaeontological Museum, Oslo.

The writer is indebted to the Shell International Petroleum Company Limited for financial assistance during the tenure of one of their Postgraduate Studentships.

PREPARATION AND EXAMINATION OF SAMPLES

Specimens were examined macroscopically, and information on colour, grain-size, calcareous and micaceous content, plant fragments, and any weathering was recorded. A representative selection of two hundred and fifty specimens, comprising a variety of lithological types ranging from coals to coarse-grained sandstones, and all of probable continental origin, were prepared for microscopic examination. Red oxidized shales and sandstones failed to produce any spores, but all other lithological types, though not all other samples, produced spores; the grey and green siltstones yielded the best preserved and most diverse assemblages.

Although the same basic technique was used throughout, with such a variety of lithologies every sample required individual attention and timing at each stage of its preparation. The macroscopic record of each sample prepared was studied, so that any constant reaction might perhaps be related to some visible feature, thus helping to improve the selection of suitable samples. Each specimen for microscopic investigation was scrubbed in distilled water to remove any Recent contamination. About 3 gm. of sediment were broken up with a hammer into approximately 3-5 mm. fragments. To avoid any contamination, the specimen was crushed within sheets of newspaper on an anvil, both the hammer and anvil surfaces being washed after each crushing. If the specimen was superficially weathered, care was taken to use only the central part.

Calcareous samples were treated with 20-30 per cent. hydrochloric acid, and left for at least 2 hours (and frequently overnight). All clastic samples were then treated with cold 50-60 per cent. hydrofluoric acid for 2-14 days; the remaining sediment was then transferred to a nickel crucible to which fresh hydrofluoric acid was added and boiled for 30-40 minutes.

Insoluble fluorides resulting from the previous treatment were removed in warm 10-30 per cent. hydrochloric acid in a water-bath. Frequently as many as ten of these 5-minute treatments were needed to remove all the fluorides.

To the washed residue in 10 cc. of distilled water were added 2-3 drops of 50 per cent. Stergine (or other non-ionic detergent). This was then subjected to a 5-20 second treatment with an ultrasonic disintegrator (1:1 end ratio steel probe vibrating at 20 kilocycles per second). This disaggregated clumps of organic and mineral matter. The residue was then washed in distilled water until the top fluid remained clear.

Oxidation of the humic material was then carried out in Schulze solution. Maceration time varied from 10 minutes to 5 hours, with different samples.

Frequently, further clearing and concentration with an alkali was necessary, and a few drops of 5 per cent. potassium hydroxide, sodium hydroxide, or ammonium hydroxide were used, the latter seemingly gave the best results. The residue was left in alkali for about 15 seconds.
Often minerals which survived the HF treatments were in such concentration that they required removal by a heavy liquid separation. Acidified zinc bromide (S.G. 2.2) was used, the preparation being centrifuged for 20 minutes at 1,800 revolutions per minute.

Only two coals are present in the Spitsbergen Devonian succession; these were crushed and then macerated in Schulze solution for 24-48 hours, thereafter following the preparation technique for clastic sediments.

From these residues at least two strew-slides were prepared for each productive sample, the residue being mounted in unstained glycerine jelly on standard glass slides, and covered with No. 0 coverslips. The slide was tapped lightly, to encourage the residue to settle in one plane, and after allowing the glycerine jelly at least three days to set, the coverslips were sealed with gold size. Single megaspore and microspore mounts were made of several species. Single spores were also separated from residues for serial sectioning, following the embedding and sectioning techniques of Wigglesworth (1959) and Hughes, Dettmann, and Playford (1962). From one to four specimens of twenty-three species were sectioned at 2-3 μ intervals, perpendicular to the equatorial plane, mounted in glycerine jelly and sealed as before. From unproductive samples, one slide was usually prepared as a negative record of the sample. Surplus residue was stored in polythene-stoppered glass tubes, in 50 per cent. glycerine containing a few drops of phenol to prevent fungal growth.

All the strew-slides were first surveyed at ×125 magnification. However, after all productive samples had been studied, the interpretation of morphological features and specific identification was completed at magnifications of ×500 and ×1250, using as many well-preserved specimens as possible and the sections where available. After the specific descriptions were complete, a quantitative estimation was made of the species present, by counting under high power 200 specimens from each sample yielding a sufficient number of well-preserved spores.

**Dispersed Spore Systematics**

*Nomenclature and Classification.* The nomenclature of the described Spitsbergen Devonian spores follows the rules of priority and typification of the International Code of Botanical Nomenclature (1961, Montreal). No botanical affinities are implied with generic designations, which relate to form genera based solely on their morphological features. The nomenclature of suprageneric categories is the artificial classification proposed by Potonié and Kremp (1954), later amplified by them (1955, 1956a) and by Potonié (1956, 1958, 1960), and subsequently revised in part by Dettmann (1965).

*Terminology.* In the systematic section, the descriptive terms used are for the most part those which have been well defined, clearly understood, and widely accepted by previous authors. An effort has been made to keep the number of terms to a minimum.

The author uses the terms intextine and exoexine (Potonié and Kremp 1955) to denote respectively the inner and outer layers of a two-layered spore wall (exine). Where the exoexine is stratified (occasionally separate, but never truly caviate), for example in *Cirratrilocitites arius* sp. nov. (Pl. 99, fig. 11), the terms outer exoexine and inner exoexine are used. In Spitsbergen Devonian species referred to the genus *Perotritites* (Erdtman)
ex Couper 1953, the exact nature of the outermost layer is unknown; it may be a true perine, or it may be an outer exoccine, and the non-committal term outer sculptine is used.

The term cavate (Dettmann 1961) is used for asaccate spores in which the spore wall layers are separated from each other by a cavity, the width of which is at least 20 per cent. of the total spore radius, or if less, then the outer layer is thinner and loosely enveloping, as for example in Peroirillites panasus sp. nov. (Pl. 102, fig. 14). This excludes Densosporites and Anulatisporites which, as demonstrated by Smith (1960, pl. 20, figs. 1-8), occasionally have a small cavity between the intine and exine, and Geniosporites in which the intine sometimes separates wholly or partially from the exocine.

Equatorial flange is used for what appears in proximo-distal aspect to be a membranous zona, but proves from sections to be a sharply tapering cingulum.

Granulate pseudosculpture is used where corrosion of the infra-granulate structure of a spore wall has resulted in an upstanding ‘ornament’ of granules.

A crumina is defined as a separation and extension of the outer part of the exine (or exoccine). This may occur primarily in the distal region, as for example in Hystiricosporites monosaccus (Archangelskaya) comb. nov. (Pl. 96, figs. 1, 2), where it is a separation of the outer exoccine; or in the equatorial region as in Labiodensites fimbriatus (Waltz) Haquehagard & Barss 1957, see Dettmann and Playford 1963 (pl. 96, figs. 1, 2), where the outer part of the exine is separated and extended.

Miosporite is used for dispersed spore species, in which the mean diameter is less than 200 μ, and megasporites for dispersed spore species in which the mean diameter is more than 200 μ.

New species have been erected only where fifteen or more adequately preserved specimens were available for study. Assignment to previously described species is made only when there is reasonable evidence for identity from published illustrations and descriptions. Frequently, however, descriptions are short and illustrations poor, and although the Spitsbergen specimens may appear similar, I cannot be certain that their construction is identical. In most of these cases I have erected new species, recording in my comparisons where conspecificity may occur; in the event of a re-examination of poorly described species, any conspecificity may be easily located. All type and other figured specimens here described, are housed in the Sedgwick Museum, Cambridge, and referred to by a preparation slide number, followed by the ‘east–west’ and ‘north–south’ mechanical stage readings, and then by the Sedgwick Museum Spitsbergen Species number and a Sedgwick Museum number. In single mount preparations, the slide number is prefixed ‘M’, with sections the slide number is prefixed ‘S’. The stage readings are from the Leitz Dialux microscope No. 3 (serial no. 526724) in the Sedgwick Museum, Cambridge.

Anteturma sporites H. Potonié 1893
Turrma triletes (Reinsch) Dettmann 1963
Supersubturma acavatetritetes Dettmann 1963
Subturma azonotritetes (Luber) Dettmann 1963
Infraturma laevigata (Bennie and Kidston) H. Potonié 1956
Genus leiotritetes (Naumova) Potonié and Kremp 1954

Type species. Leiotritetes sphaerotriangulat (Loose) Potonié and Kremp 1954.
K. C. Allen: Lower and Middle Devonian Spores

Leiotriletes parvus Naumova 1953

Dimensions. (Twenty specimens) Equatorial diameter 16-24 μ (mean 19 μ).

Occurrence. Fraenkelyngen Division, and Lower Reuterskioldfjellet Sandstone; Gedinnian and Siegenian.

Leiotriletes pyramidalis (Luber) comb. nov.

1941 Azonotriletes pyramidalis Luber, in Luber and Waltz, p. 54, pl. 12, fig. 182.
1955 Filicotriletes pyramidalis Luber, p. 60, pl. 3, fig. 70.

Dimensions. (Eighteen specimens) Equatorial diameter 54-95 μ (mean 70 μ). Elevated lips, individually 2-3 μ wide, 4-9 μ high.

Remarks. Filicotriletes lacks type species designation, and embraces within it spores of several previously well-established genera (Potonié 1958, p. 35).

Occurrence. Reuterskioldfjellet Sandstone and Mimer Valley Series; Siegenian to Eifelian.

Comparison. Leiotriletes palvereus Balme and Hassell 1962 (p. 5, pl. 1, fig. 182) has a larger size range, weaker lip development, and is punctuate. L. tumidus Butterworth and Williams 1958 (p. 359, pl. 1, figs. 5, 6) has a smaller size range and is tumid. L. ornatus Ishchenko 1956 (p. 22, pl. 2, figs. 18-21) is smaller and has thicker lips.

Leiotriletes pagius sp. nov.

Plate 94, figs. 1, 2

Diagnosis. Miospores trilete; amb convexly triangular with broadly rounded apices. Laesurae distinct, simple, straight, almost reaching the equatorial margin. Exine 2-5-4 μ thick, homogeneous, laevigate.

Dimensions. (Twenty-two specimens) Equatorial diameter 46-63 μ (mean 54 μ).

Holotype. Preparation KA 251/9, 21/5 94 8, K905, N231.

Locus typicus. South Mimeralen, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Siegenian.

Description. Holotype diameter 58 μ. Exine 4 μ thick.

Comparison. Leiotriletes dissimilis McGregor 1960 (p. 27, pl. 11, fig. 1) has punctate contact areas, low distinct lips and a thinner exine. Leiotriletes confertus McGregor 1960 (p. 27, pl. 11, fig. 2) also has distinct lips and a thinner exine, and the only difference between these two McGregor species is the punctate contact area and open commisure in L. dissimilis, which might be the result of preservation. Leiotriletes devonicus Naumova 1953 (p. 22, pl. 1, fig. 5) and L. trivialis Naumova 1953 (p. 45, pl. 5, fig. 14) are both considerably smaller. Naumova (1953) in describing L. devonicus states 'exine dense, thick, spore margin thickened'. This thick wall might be misinterpreted as a cingulum, unless seen in broken specimens or in oblique aspect, and many form species included within Stenozonotriletes, may in fact be thick-walled representatives of Leiotriletes or Punctatisporites. If Stenozonotriletes simplex Naumova 1953 (p. 36, pl. 3, fig. 17; p. 69, pl. 10, fig. 3; and p. 130, pl. 19, figs. 16, 17) should prove to have a thick wall and not a cingulum, then Leiotriletes pagius sp. nov. would be synonymous with it.

Occurrence. Lower Reuterskioldfjellet Sandstone; Siegenian.
Genus *Punctatisporites* (Ibrahim) Potonié and Kremp 1954

*Type species.* *Punctatisporites punctatus* Ibrahim 1933.

**Punctatisporites glaber** (Naumova) Playford 1962

*Dimensions.* (Twenty specimens) Equatorial diameter 29–44 μ (mean 38 μ).

*Occurrence.* Throughout the Lower and Middle Devonian succession.

**Punctatisporites laevigatus** (Naumova) comb. nov.

1953 *Stenozonotriletes laevigatus* Naumova, p. 70, pl. 10, figs. 9, 10.

*Dimensions.* (Twenty specimen) Equatorial diameter 51–71 μ (mean 61 μ). Exine 3.5–6 μ thick.

*Remarks.* Variation in length of laesurae frequently occurs within a single specimen. Naumova (1953, p. 70) in her description, records ‘a thick exine’, and the narrow border to which she refers (which is approximately 4 μ thick in her illustration) is probably an optical section through this thick exine, rather than a cingulum as suggested by her generic placing; the species is therefore more appropriately placed within *Punctatisporites*.

*Comparison.* *Punctatisporites aerarius* Butterworth and Williams 1958 (p. 360, pl. 1, figs. 10, 11) is larger and has a thinner exine. *Stenozonotriletes faciilis* Ishchenko 1956 var. *faciilis* (p. 73, pl. 14, figs. 162–4) may be conspecific, but it is not clear from the description whether the otochicha (5 μ wide) is a cingulum or the optical section of a thick wall.

*Occurrence.* Frenkelfjøygen Division, Dicksonfjorden Sandstone, Reuterskioldfjellet Sandstone, and Minner Valley Series; Gedinnian to Givetian.

**Punctatisporites flavus** (Kosanke) Potonié and Kremp 1955

1950 *Calamospora fava* Kosanke, p. 41, pl. 9, fig. 2.

1955 *Punctatisporites flavus* (Kosanke) Potonié and Kremp, p. 42.

*Dimensions.* (Twenty-two specimens) Equatorial diameter 95–152 μ (mean 120 μ).

*Occurrence.* Lower Minner Valley Series and probable Upper Reuterskioldfjellet Sandstone, Emsian and Eifelian.

**Genus Calamospora** Schopf, Wilson, and Bentall 1944

*Type species.* *Calamospora hartmanni* Schopf, in Schopf, Wilson and Bentall 1944.

*Calamospora micronugosu* (Ibrahim) Schopf, Wilson, and Bentall 1944

*Synonym.* See Playford 1962, p. 579.

*Dimensions.* (Twenty specimens) Equatorial diameter 50–110 μ (mean 86 μ). Exine 2 μ or less thick.

*Occurrence.* Kapp Kjeldsen Division, Dicksonfjorden Sandstone, Reuterskioldfjellet Sandstone, and Minner Valley Series; Siegenian to Givetian, more common in the Givetian.
Calamospora nigrata (Naumova) comb. nov.

1953 Leiotritites nigratus Naumova, p. 23, pl. 1, fig. 9.
1958 Leiotritites nigratus Ishchenko, p. 35, pl. 1, fig. 5; non Naumova 1953.

Dimensions. (Twenty-six specimens) Equatorial diameter 60–80μ (mean 76μ). Exine 1μ or less thick.

Remarks. The short læsurae, and thin folded exine suggest correct inclusion within Calamospora. Naumova (1953) quotes dimensions of 60–70μ, and Ishchenko (1958) 90–110μ. Neither author states the number of spores measured. Naumova's readings are probably two equatorial axes of the same spore. The Spitsbergen spores are of intermediate size. In some specimens there is a tetrad impression of narrow arcuate folds (the curvaturae and curvaturae imperfectae of Potonié and Kremp 1955).

Comparison. Leiotritites atatus Naumova 1953 (p. 23, pl. 1, fig. 8) is smaller and lacks folding. Calamospora sauriana Bhardwaj 1957 (p. 81, pl. 22, figs. 13–15) is also smaller and possesses lips.

Occurrence. Present in the majority of well-preserved samples; Gedinnian to Givetian, most common in the Emsian.

Calamospora wilneyana Chaloner 1963

Dimensions. (Fifteen specimens) Equatorial diameter 116–212μ (mean 151μ).

Occurrence. Reuterskioldfjellet Sandstone and Lower Mimer Valley Series; Siegenian and Emsian.

Genus Triletes (Erdtman 1945, 1947) ex Potonié 1956

Type species. Triletes (al. Trilletes) sparius (Dijkstra) Potonié 1956.

Triletes oxfordiensis Chaloner 1963

Dimensions. (Twenty specimens) Equatorial diameter 186–530μ (mean 290μ).

Occurrence. Dicksonfjorden Sandstone, Reuterskioldfjellet Sandstone and Mimer Valley Series; Siegenian to Givetian.

Infraturnera aculati (Bennie and Kidston) R. Potonié 1956

Genus Granulatisporites (Ibrahim) Potonié and Kremp 1954

Type species. Granulatisporites granulatus Ibrahim 1933.

Granulatisporites munninensis sp. nov.

Plate 94, figs. 3–5

Diagnosis. Miospores trilete; amb triangular with straight to slightly convex sides and rounded apices. læsurae straight, length two-thirds to full spore radius, accompanied by smooth, raised lips, individually up to 2μ wide. Exine 1μ thick, homogeneous to infragranulate, contact areas laevigate, proximo-equatorial and distal surfaces sculptured with evenly spaced granules.

Dimensions. (Twenty specimens) Equatorial diameter 24–30μ (mean 27μ).

Holotype. Preparation KA 293/1, 56-7105-1, K556, N233.

R. 8012 Z Z
Locus tripicus. East Munindalen, Central Dicksonland, Vestspitsbergen; Planteklafth Conglomerate, probably Givetian.

Description. Holotype triangular with straight sides, diameter 25 μ. Laeversae four-fifths spore radius, accompanied by lips individually 1 μ wide, slightly separating equatorially. Slight curvaturae ridges in radial regions.

Remarks. The lips are frequently imperturate, and are sometimes separated equatorially. Slight curvaturae are occasionally present in the radial regions.

Comparison. Gramulatisporites triconvexus Staplin 1960 (p. 15, pl. 3, figs. 11, 12) is larger, more finely granulose, the lips are less prominent and there is no suggestion of laevesque contact areas. Gramulatisporites planiusculus (Luber) Playford 1962 (p. 533, pl. 79, fig. 18) is larger, has a thinner exine and lacks the laevesque contact areas. Archaeozonotriletes parvibasilaris Naumova var. triangulatus Chibrikova 1959 (p. 71, pl. 11, fig. 5) has a thicker exine and sculptured contact areas. Anaplicateisporites devonicus var. azonatus (Chibrikova) Vigran 1964 (p. 13; pl. 1, figs. 21–23) differs only in having a sculpture of coni.

Occurrence. Present in most productive samples; Gedinnian to Givetian, most common in the Givetian.

Genus Cyclogranisporites Potonié and Kremp 1954

Type species. Cyclogranisporites leopoldi (Kremp) Potonié and Kremp 1954.

Cyclogranisporites rotundus (Naumova) comb. nov.

1953 Lophotriletes rotundus Naumova, p. 58, pl. 7, fig. 19; p. 108, pl. 16, fig. 34.
1953 Lophotriletes rotundus Naumova var. minor, p. 96, pl. 15, fig. 10; p. 108, pl. 16, figs. 29, 30. No type designated.

Dimensions. (Twenty-five specimens) Equatorial diameter 29–45 μ (mean 35 μ).

Remarks. Lophotriletes rotundus Naumova var. minor, lacks both holotypic designation and description. Its separation from L. rotundus Naumova is made on its slightly smaller

EXPLANATION OF PLATE 94

All figures × 500 unless otherwise stated; from unretouched negatives.

Figs. 1. 2. Loxotriletes paginae sp. nov. 1, Holotype, sectional focus; KA 251/9, 21-5 94-8, K905, N231. 2. Proximal surface; KA 251/7, 23-4 96-9, K905, N232.

Figs. 3–5. Gramulatisporites minutissimus sp. nov. 3, 4, Holotype, proximal and distal surfaces respectively; KA 293/1, 36-7 105-1, K556, N233. 5, Holotype, ×1000; distal surface, showing granules.

Figs. 6–9. Cyclogranisporites pleuriscus sp. nov. 6, Holotype, KA 258/3, 56-4 100-1, K922, N234. 7, Showing curvaturae; KA 258/2, 49-4 91-4, K922, N235. 8–9, Specimens showing variation in size of granules. 8, KA 258/4, 35-1 91-2, K922, N236. 9, KA 258/2, 49-1 91-6, K922, N237.

Figs. 10–18. Gymnospora spp. 10–11. G. tuberculata (Kedo) comb. nov. 10, Proximal surface; KA 229/3, 22-1 89-4, K550, N238. 11, Distal surface; KA 225/2, 41-3 87-5, K760, N239. 12–16. G. avicularis (Vigran) comb. nov. 12, Distal surface, showing intestines; KA 255/2, 48-2 93-5, K760, N240. 13, 14, Proximal and distal surfaces respectively; KA 243/2, 35-8 91-5, K767, N241. 15, Distal surface; KA 243/2, 47-0 97-2, K767, N242. 16, Section, showing lips and uniformly thick exine; KA 286/2, 52-5 94-9, K773, N243. 17–18, G. spinosa sp. nov. Holotype, proximal and distal surfaces respectively; KA 243/1, 30-4 107-3, K767, N244.

Figs. 19–20. Acathotriletes rupiensis sp. nov. Holotype, proximal and distal surfaces respectively; KA 258/3, 47-0 108-7, K922, N245.
size. However, as only two specimens of *L. rotundus* var. *minor* were measured and as the Spitsbergen specimens span the size range of both, the variety is included within the synonymy. Its circular amb and granulose sculpture indicate more appropriate inclusion within *Cyclogranisporites*.

*Occurrence.* Upper Mimer Valley and Wijde Bay Series; Givetian.

*Cyclogranisporites plicatus* sp. nov.

Plate 94, figs. 6–9

*Diagnosis.* Miospores trilete, originally spherical; amb circular to subcircular. Laesurae distinct to discernible, straight, length \( \frac{1}{2} \) spore radius, simple, or accompanied by smooth often sinuous lips, individually 0.5–2 \( \mu \) wide. Exine thin, 1 \( \mu \) or less, homogeneous, supporting a granulose ornament of variable density. Low, narrow curvaturae or curvaturae imperfectae are present in approximately one-third specimens. Major compression folds always present.

*Dimensions.* (Forty-five specimens) Equatorial diameter 51–82 \( \mu \) (mean 66 \( \mu \)).

*Holotype.* Preparation KA 25/3, 50-1 100-1, K922, N234.

*Locus typicus.* Minerdaalen, Central Dicksonland, Spitsbergen; \(?\) Reuterskioldfjellet Sandstone, Emsian.

*Description.* Holotype subcircular, diameter 53 \( \mu \). Laesurae simple, length two-thirds spore radius. Exine less than 1 \( \mu \) thick, densely sculptured. Three compression folds.

*Remarks.* Variation in size and density of ornament is demonstrated in Plate 94, figs. 8, 9. Curvaturae imperfectae seen in Plate 94, fig. 7.

*Comparison.* *Lophotriletes rugosus* Naumova 1950 (pl. 2, fig. 6) var. *rugosus* Naumova 1953 (p. 27, pl. 2, fig. 1 and p. 54, pl. 7, fig. 1), is smaller, and may have a sculpture of cones. *Cyclogranisporites lastus* (Waltz) Playford 1962 (p. 585, pl. 79, figs. 19, 20) has more distinct laesurae and a thicker exine. *Retractotriletes verruculosus* Naumova 1953 (p. 29, pl. 2, fig. 10) is smaller, and is roundly triangular. *R. punctatus* Chibrikova 1959 (p. 52, pl. 5, fig. 7) is also smaller and roundly triangular. Miospores recorded from *?Enigmophyton superbum* fructification Hoeg 1942 (p. 118, pl. 49, figs. 9–11) appear to be very similar, but are probably laevigate.

*Occurrence.* Present in most well-preserved samples, but extremely common in the Reuterskioldfjellet Sandstone and Lower Mimer Valley Series; Gedinnian to Givetian.

**Genus Geminospora** Balme 1962

*Type species.* *Geminospora lestrani* Balme 1962.

*Discussion.* Although the type species has a slightly thicker distal surface (a feature common to many Devonian spores), the difference is not appreciable and the genus cannot be regarded as truly patinate. Although the species described below do not show this feature, they are regarded as being of similar construction, and are included within this genus.
Geminospora tuberculata (Kedo) comb. nov.

Plate 94, figs. 10, 11

1955 Archaeozonotriletes tuberculatus Kedo, p. 35, pl. 5, figs. 6, 7.

Description of specimens. Miospores trilite; amb roundly triangular to subcircular. Laesurae straight, length two-thirds to full spore radius, simple, or rarely accompanied by narrow, sharp lips, individually 0.5–1 μ wide. Exine two-layered; intine very thin, 1 μ or less, homogeneous, separated at least in part from the exoexine; exoexine 2–3 μ thick, finely infragranulate. Proximal surface laevigate, distal surface sculptured with granules and small cones 1 μ or less high. Major folding common, frequently the intine is more strongly folded.

Dimensions. (Twenty specimens) Equatorial diameter 40–65 μ (mean 56 μ).

Remarks. Chibrikova (1959, p. 58), includes Geminospora tuberculata (Kedo) in synonymy with Archaeozonotriletes neovincianus Naumova nom. nud. The latter, however, lacks both holotypic designation and description.

Comparison. Archaeozonotriletes plicatus Naumova nom. nud. in Chibrikova 1959 (p. 64, pl. 8, fig. 10) is very similar, and may prove to be conspecific.

Occurrence. Upper Mimer Valley Series; Givetian.

Geminospora svalbardiae (Vigran) comb. nov.

Plate 94, figs. 12–16

1964 Lyceospora svalbardiae Vigran, p. 23, pl. 3, figs. 4, 5; pl. 4, figs. 1, 2.

Description of specimens. Miospores trilite; amb roundly triangular to subcircular. Laesurae usually straight, occasionally slightly sinuous, length three-quarters to full spore radius, frequently accompanied by low lips, individually 1–3 μ wide. Exine, at least in some specimens visibly two-layered; intine thin, less than 1 μ thick, homogeneous, rarely folded, closely appressed to or slightly separate from the exoexine; exoexine 3–7 μ thick, finely infragranulate. Contact areas laevigate, occupying most of the proximal surface, proximo-equatorial (where the contact areas are short of the equatorial margin) and distal surfaces densely granulate. Exoexine frequently with tangential and acuate folds.

Dimensions. (Thirty-four specimens) Equatorial diameter 50–88 μ (mean 72 μ).

Remarks. The arcuate folding (Pl. 94, fig. 13), often gives the impression of a cingulum under lower power, however, the section (Pl. 94, fig. 16) although very compressed, clearly demonstrates the constant exine thickness; also the exclusively distal ornament, and lips formed by an upturning of the exoexine; no intine is visible in the sections. This constant exine thickness and exclusively distal sculpture indicate more appropriate inclusion in Geminospora.

Comparison. Apiculatisporis sp. Hoffmeister, Staplin, and Malloy 1955a (pl. 1, fig. 13) appears to be very similar. However, it is not possible to see from the photograph whether it is sculptured proximally. Retrozoentriletes parvimanus Naumova 1953 var. famenensis Naumova 1953 (p. 124, pl. 18, fig. 22) is clearly similar to some specimens, but there is no mention of a laevigate proximal surface, lips, or the presence of major
folds. Geminospora lemuerata Balme 1962 (p. 5, pl. 1, figs. 5–10) is smaller, lacks lips, and has a slightly thicker distal surface. Archaeozonotriletes atratus Naumova 1953 (p. 99, pl. 15, fig. 23) has much wider and higher lips, and has an ornament of verrucae. Archaeozonotriletes notatus Naumova 1953 (p. 84, pl. 13, fig. 12) lacks lips, and there is no mention of a laevigate proximal surface.

Occurrence. Very common throughout the Upper Minner Valley Series, but also occurs in the Wijde Bay Series, Lower Minner Valley Series and Reutenskloofjellet Sandstone; Emsian to Givetian.

Geminospora spinosa sp. nov.

Plate 94, figs. 17–18

Diagnosis. Miospores trilete; amb roundly triangular to subcircular. Laesurae straight, length three-quarters to full spore radius, simple or more usually accompanied by narrow sharp lips, individually 0.5–2 μ wide, up to 5 μ high. Exine two-layered; intine thin, 0.5–2 μ wide, homogeneous, usually slightly separate at least in part from the exoexine; exoexine 2–5 μ thick, coarsely infragranulate. Contact areas laevigate, frequently depressed, occupying from two-thirds to the whole of the proximal surface, proximo-equatorial (where the contact areas are short of the equatorial margin) and distal surfaces sparsely sculptured with spines, 0.5–1.5 μ wide, 3–6 μ long.

Dimensions. (Fifteen specimens) Equatorial diameter 59–91 μ (mean 70 μ).

Holotype. Preparation KA 243/1, 304 1073, K767, N244.

Locality typical. North ridge of Kinanderjellet, Central Dicksonland, Spitsbergen; Upper Minner Valley Series, probable Upper Givetian.

Description. Holotype subcircular, diameter 80 μ. Laesurae indistinct, masked by elevated lips totalling 4 μ wide. Intine very thin, partly separate from exoexine; exoexine 5 μ thick, radial diameter of depressed contact area 30 μ. Proximo-equatorial and distal spines 1–2 μ wide, 3–5 μ long.

Remarks. The spines are usually appressed against the exoexine. Darkening at the equatorial end of the laesurae in some specimens is usually due to slight folding, and gives the spores an appearance similar to Pulvinispora Balme and Hassell. However, in this genus the darkened appearance is due to a thickening rather than a folding (Balme and Hassell 1962, p. 10).

Comparison. Archaeozonotriletes comans Chibrikova 1959 (p. 70, pl. 19, fig. 3) has shorter simple laesurae, and a denser ornament.

Occurrence. Minner Valley Series; Eifelian and Givetian.

Genus ACANTHOTRILETES (Naumova) Potonié and Kremp 1954

Type species. Acanthotriletes ciliatus (Knox) Potonié and Kremp 1954.

Acanthotriletes raptus sp. nov.

Plate 94, figs. 19–20

Diagnosis. Miospores trilete; amb circular, subcircular to roundly triangular. Laesurae distinct to discernible, simple, straight, length 1/2–1/4 spore radius. Exine 1–2 μ thick, homo-
genous to finely infragranulate; proximal surface laevigate, distal surface evenly crowded with spines and subordinate cones, 0.5–2.5 μ wide, 1.5–4 μ high, with polygonal bases, and often only tapering at their apices.

**Dimensions.** (Fifteen specimens) Equatorial diameter 34–42 μ (mean 38 μ).

**Holotype.** Preparation KA 254/3, 47° 108 7, K92, N245.

**Locus typicus.** South Mineralsen, Central Dicksonand, Westspitzenberg; Reuterskildfjellet Sandstone, Eifelian.

**Description.** Holotype subtriangular with convex sides and broadly rounded apices, diameter 38 μ. Laseurae approximately half spore radius. Exine 1 μ thick, spines 0.5–1.5 μ wide, up to 4 μ high.

**Remarks.** This species is included within *Acanthotriletes* rather than *Apiculatisporis* on the basis of its dominant, albeit short, spinose ornament.

**Comparison.** All species which may be closely compared with *Acanthotriletes raptus* sp. nov. have no record of a laevigate proximal surface. This feature alone I regard as sufficient for specific separation. However, I am aware that unless studied under oil immersion, it is not always easy to identify this feature in small, proximo-distally compressed specimens, and an absence of proximal sculpture may have been overlooked by some authors. I have assumed that this might be the case, and therefore list below other differing features. *A. sullatus* Naumova 1953 (p. 24, pl. 1, fig. 15) is triangular and has longer laseurae. *Apiculatisporis pinnatus* Hoffmeister, Staplin, and Malloy 1955b (p. 38, pl. 3, fig. 3) has a larger, more varied ornament. *Acanthotriletes parvispinosus* Naumova 1953 (p. 24, pl. 1, fig. 16) is smaller and has longer laesurae. *A. tenispinosus* Naumova var. *tenispinosus* has longer laesurae and narrower spines.

**Occurrence.** Reuterskildfjellet Sandstone; Eifelian.

**Genus HYSTRICOSPORITES** McGregor 1960

**Type species.** *Hystricosporites deleciabilis* McGregor 1960.

*Hystricosporites porrectus* (Balme and Hassell) comb. nov.

Plate 95, figs. 1–3


**Description of specimens.** Miospores trilete; amb circular to subcircular. Laesurae obscured by membranous, often sinuous, elevated lips, 32–60 μ high, length equal to full spore radius. Exine three-layered; intine approximately 1 μ thick, homogeneous, closely appressed to the exoexine and often indistinct; exoexine 4–9 μ thick, inner exoexine infragranulate, outer exoexine and sculptural elements homogeneous. Contact areas laevigate, proximo-equatorial and distal surfaces support a dense ornament of grapnel-tipped spines, typically 25–35 μ long (range 15–40 μ) rarely with a bulbous base, the shaft tapering gradually towards the apex. The majority are preserved in lateral compression.

**Dimensions.** (Twenty specimens) Equatorial diameter 90–184 μ (mean 118 μ), polar diameter (including apical processes) 102–170 μ (mean 141 μ).
Remarks. Since the submission for publication of the paper by Balme and Hassell (1962) there has been further generic subdivision of spores with graptol-tipped appendages, and the Australian species may now more suitably be included within *Hystricosporites* McGregor. Sections (Pl. 95, figs. 2, 3) demonstrate clearly the homogeneous intine, the infragranulate inner exoxine and the homogeneous outer exoxine and sculptural elements. The elevated lips are formed only from the outer layer of the exoxine.

Comparison. *Hystricosporites detectabilis* McGregor 1960 (p. 32, pl. 11, figs. 13, 14, text-fig. 2) is larger, and lacks the greatly elevated lips. *Hystricosporites corystus* Richardson 1962 (p. 173, pl. 25, figs. 1, 2) has a sparse ornament of spines, and a thinner exine.

Occurrence. Upper Mimer Valley Series; Givetian.

*Hystricosporites porcatus* (Winslow) comb. nov.

Plate 95, figs. 4-6

1962 *Dicerospora porcata* Winslow, p. 52; pl. 11, figs. 4, 5, 5a; pl. 12, fig. 5; pl. 22, fig. 15.

1964 *Hystricosporites costatus* Vigran, p. 14, pl. 5, figs. 3-5.

Description of specimens. Miospores trilete; amb circular to subcircular. Laesurae indistinct, obscured by sinusus, elevated lips, 10–34 µ high, 2–5 µ wide, length 3/2–1/2 spore radius. Exine three-layered; intine 2 µ or less thick, homogeneous, usually closely appressed to the exoxine and often indistinct; exoxine 6–12 µ thick, inner exoxine infragranulate, outer exoxine and sculptural elements homogeneous. Contact areas, radial diameter 3/4–3/2 spore radius, each supporting 8–15 low, slightly sinusus muri, 2–8 µ wide, 3–6 µ high, 1–8 µ apart, bordered by low curvature 6–10 µ wide. Proximo-equatorial and distal surfaces support bulbous based graptol-tipped spines, typically 15–30 µ long (range 10–45 µ), 17–23 round the equatorial margin.

Dimensions. (Twenty-six specimens) Equatorial diameter 84–164 µ (mean 111 µ); radial diameter of contact area 26–44 µ.

Remarks. In ill-preserved specimens, the intine separates from the exoxine, and is often folded. Section (Pl. 95, fig. 6) demonstrates clearly the low, wide, proximal radial muri; but in this strongly compressed specimen the stratification of the exine is not seen. Dimensions recorded for the Spitsbergen specimens are somewhat smaller than those recorded by Winslow (1962, p. 52).

Comparisons. This is the only species recorded to date, which reports the presence of proximal, radial muri, though it would appear from the illustrated holotype that *Hystricosporites detectabilis* McGregor 1960 (pl. 11, fig. 13) may possess this feature.

Occurrence. Upper Mimer Valley Series; Givetian.

*Hystricosporites nitratus* sp. nov.

Plate 95, figs. 7, 8

Diagnosis. Miospores trilete; amb circular to subcircular. Laesurae indistinct, length approximately half of the spore radius, accompanied by smooth, narrow often sinusus, elevated lips, 2–4 µ wide, 16–27 µ high. Exine 5–12 µ thick, finely infragranulate; contact areas laevigate, small, radial diameter approximately half of the spore radius,
bounded by smooth, narrow elevated curvatucae, basally 3–7 μ wide, 12–20 μ high; proximo-equatorial and distal surfaces support an ornament of grappnel-tipped spines, typically 20–35 μ long (range 12–40 μ), with enlarged, often bulbous bases, 12–25 round the equatorial margin.

*Dimensions.* (Twenty-three specimens) Equatorial diameter 88–136 μ (mean 113 μ); radial diameter of contact area 23–40 μ (mean 32 μ).

*Holotype.* Preparation KA 148/5, 28.8.92–7, F1598, N252.

*Locus typicus.* Huginaspinkardet, Central Dicksonland, Vestspitsbergen; Lower Mimer Valley Series, Eifelian.

*Description.* Holotype subcircular, diameter 120 μ. Lips 18 μ high, each 2–3 μ thick. Curvatucae 18 μ high, radial diameter of contact area 30 μ. Grappnel-tipped spines 24–44 μ long.

*Remarks.* This species was not sectioned, and although no intexine was visible it seems very probable that the exinal stratification is similar to sectioned species of the genus *Hystricosporites* McGregor. The curvatucae are of the same dimensions as the lips, and probably formed during the same developmental stages within the tetrad, and formed only from the outer homogeneous layer of the exoexine.

*Comparison.* *Archaeoitriletes honestus* Naumova 1953 (p. 124, pl. 18, figs. 24, 25) has a thicker exine, thicker, lower curvatucae, and lacks lips, a feature associated with the curvatucae in *H. miratus* sp. nov.

*Occurrence.* Upper *Reuterskioldjellet* Sandstone; and Lower Mimer Valley Series; Emsian and Lower Eifelian.

*Hystricosporites monosaccus* (Archangelskaya) comb. nov.

Plate 96, figs. 1, 2
1963 *Archaeoitriletes monosaccus* Archangelskaya, p. 19, pl. 2, figs. 1–5.
1964 *Hystricosporites coronatus* Virgan, p. 15, pl. 3, figs. 1–3.

*Description of specimens.* Miospores trilote; amb circular to subcircular. Laesurae obscured by high, membranous, sinuous lips, 20–72 μ high, individually 2–4 μ wide at their base, narrowing upwards, length three-quarters to full spore radius. Exine three-layered; intine 1–3 μ thick, homogeneous, frequently partly separated from the exoexine; exoexine 8–18 μ thick, inner exoexine coarsely infragranululate, outer exoexine

**EXPLANATION OF PLATE 95**

All figures ×500 unless otherwise stated; from unretouched negatives.

Figs. 1–8, *Hystricosporites app. 1–3.* *H. porrectus* (Balm and Hassell) comb. nov. 1, Lateral view: KA 123/4, 35–6 94–0, G1358, N246. 2, Section showing the three-layered exine; KA 123/5, 47–5 102–7, G1358, N247. 3, Section (×1000) showing the homogeneous outer exoexine forming the spines, and the infra-granulate inner exoexine; KA 123/40, 52–2 105–5, G1358, N248. 4–6. *H. porrectus* (Wingsso) comb. nov. 4, Proximal surface; KA 1261/4, 49–4 89–3, K491, N249. 5, Proximal oblique aspect (most of the grappnel-tipped spines have been eroded); KA 133/1, 42–3 93–1, G1385, N250. 6, Section showing proximal radial muri; KA 123/54, 42–3 93–8, G1358, N251. 7–8. *H. miratus* sp. nov. 7, Holotype, central oblique focus; KA 148/5, 28–0 92–7, F1598, N252. 8, Proximal oblique aspect; KA 148/5, 28–0 98–4, F1598, N253.
homogeneous to infragranulate. Distally, the outer exoeine separates from the inner exoeine, and distends distally as a crumina, typically 70–90 μ long (range 23–109 μ). Proximal surface supports an ornament of radial muri, 6–10 μ wide, up to 8 μ high; distal surface with graptol-tipped spines, 10–32 μ high, with enlarged and frequently bulbous bases, more sparsely disposed on the crumina.

**Dimensions.** (Twenty-two specimens) Overall equatorial diameter 63–143 μ (mean 99 μ), polar diameter (including apical processes and crumina), 77–248 μ (mean 172 μ).

**Remarks.** This species is included within *Hysticosporites* McGregor 1960, rather than *Archaeotritites* Naumova 1953, because of the absence of an equatorial extension. The great difference between the equatorial and polar axial measurements, results in the spores lying parallel to the longer polar axis, and because the proximal surface is flat, details of the contact areas are rarely seen. Sections (Pl. 96, fig. 2) clearly demonstrate the construction of the distal crumina; this feature is not seen in other Spitsbergen Devonian species. Sections of *Labiidensites fimbriatus* (Waliz) Haquebeard and Beres 1957, in Dettmann and Playford 1962 (p. 675), pl. 96, figs. 1, 2) demonstrates the slight development of a cruminate cingulum.

**Comparison.** *H. monosaccus* (Archangelskaya) comb. nov. differs from all other graptol-tipped species, in possessing a crumina.

**Occurrence.** Upper Miner Valley Series; Givetian.

---

**Hysticosporites corystus** Richardson 1962

**Description of specimens.** Miospores trilite, amb subcircular to subtriangular. Laesurae straight, length approximately three-quarters to full spore radius, frequently obscured by membranous, often sinus, elevated lips, 34–68 μ high, extending to the equatorial margin. Exine three-layered; intexine rarely seen, approximately 1 μ thick, homogeneous; exoeine 14–30 μ thick, inner exoeine infragranulate, outer exoeine and sculptural elements homogeneous. Contact areas inequibent, proximo-equatorial and distal surfaces support a sparse ornament of graptol-tipped spines 30–60 μ long, 8–13 μ wide, 10–13 spines round the equatorial margin.

**Dimensions.** (Fifteen specimens) Equatorial diameter 64–210 μ (mean 141 μ), polar diameter (including apical processes) 96–214 μ (mean 151 μ).

**Occurrence.** Upper Miner Valley Series; Givetian.

---

**Genus** *Raistrickia* (Schöpf, Wilson, and Bentall 1944) Potonié and Krömp 1954

**Type species.** *Raistrickia groenlandica* Schöpf in Schöpf, Wilson, and Bentall 1944.

**Raistrickia aratra** sp. nov.

**Plate** 96, figs. 3, 4

**Diagnosis.** Miospores trilite; amb circular to subcircular, Laesurae indistinct, straight, length 1/3–2/3 spore radius, simple or rarely accompanied by low narrow lips. Exine 2–6 μ thick, homogeneous; supporting a very variable sculpture of predominantly high baculo-verrucae, 3–12 μ wide, 6–14 μ high, with occasional rugulae, 5–7 μ wide, 7–10 μ.
high, up to 25 μ long, cones and spines 2–10 μ wide, 4–12 μ high, the cones often with papillate tips. Concentration of sculptural elements variable, but they are always sparser and more reduced proximally, where spines and cones are more frequent.

Dimensions. (Twenty specimens) Equatorial diameter 38–92 μ (mean 61 μ).

Holotype. Preparation KA 243/1, 27.9 92.3, K767, N256.

Locus typicus. East Manindalen, Central Dicksonland, Vestspitsbergen; Planteklaia Conglomerate; probably Upper Givetian.

Description. Holotype circular, diameter 78 μ. Laesurae simple, straight, length two-thirds of spore radius. Exine 4 μ thick, variable ornament of baculo-verrucae 9–13 μ high, rugulae, up to 8 μ wide and 25 μ long, cones up to 9 μ high, often with papillate tips, and a few small spines. Sculpture reduced proximally.

Remarks. Although the specimens appear well preserved, evidence from occasional specimens suggests that many of the verrucae, cones and spines, are the result of corrosion of bacula and rugulae by a splitting and ‘rounding off’ of originally high, flat-topped sculptural elements. This species is included with the genus Raistrickia on the basis of predominant baculo-verrucae and variable sculptural elements.

Comparison. Lophozonostriites macrogramonos Kedo 1957 (pl. 4, figs. 21, 22) has a thicker wall, and lower more rounded processes. Raistrickia irregularis Kosanke 1950 (p. 47, pl. 11, fig. 5) has longer laesurae accompanied by lips, and smaller sculptural elements. Raistrickia? gibberosa Hacquebard 1957 (p. 310, pl. 2, fig. 1) has longer laeisurae and a more regular ornament. R. cf. clavata Vigran 1964, p. 16, pl. 2, fig. 10, is smaller, and never has sculptural elements over 9 μ high, but is otherwise similar.

Occurrence. Upper Minee Valley Series; Givetian.

Genus Bullatisporites gen. nov.

Type species. Bullatisporites bulatus sp. nov.

Diagnosis. Miospores trilete; amb circular to subcircular. Exine sculptured with pila, the caput frequently supporting a small spine; sculpture somewhat reduced proximally. Contact areas occasionally depressed, and sometimes bounded by curvatural folds.

EXPLANATION OF PLATE 96

All figures ×500 unless otherwise stated; from unretouched negatives.

Figs. 1–2. Hystrocladisporites monosaccus (Archangeliskaya) comb. nov. 1, Lateral view; KA 255/M2, 28.6 108.0, K767, N254. 2, Section showing three-layered exine and crumina; KA 255/S3, 54.4 101.0, K767, N255.

Figs. 3–4. Raistrickia atrata sp. nov. 3, Holotype, proximal oblique aspect; KA 243/1, 27.9 92.3, K767, N256. 4, Lateral view; KA 243/1, 52.3 96.8, K767, N257.

Figs. 5–7. Bullatisporites bulatus gen. et sp. nov. 5, Holotype, proximal surface; KA 258/1, 55.7 101.8, K222, N258. 6, Proximal surface; KA 258/1, 27.8 88.5, K222, N259. 7, Details of the pila on the holotype.

Figs. 8–13. Convolvulatispora spp. 8, C. verniformis Hughes and Playford, Distal surface; KA 261/4, 49.0 98.2, K891, N256. 9–13. C. disparalis sp. nov. 9, Holotype, optical section; KA 243/2, 54.9 103.8, K767, N261. 10, Distal surface; KA 293/1, 48.9 93.4, K556, N262. 11, Proximal surface; KA 243/1, 41.8 105.9, K767, N263. 12, Details of sculpturae; KA 243/3, 54.4 88.9, K767, N264. 13, Holotype (×1000).
Comparison. Differs from other genera within the Infrafratrum Apiculati, in being both circular and pilate. Dictiosporites Richardson (1965) includes species with variable ornament which may possess pila, but the sculptural elements are predominantly biform.

Derivation of name. L. bulla—knob, boss.

**Bullatissporites bullatus** sp. nov.

Plate 96, figs. 5-7

**Diagnosis.** Miospores trilete; originally spherical, amb circular. Laesurae straight, length 1-3 spore radius, accompanied and frequently obscured by lips, 1-3 \( \mu \) wide, up to 5 \( \mu \) high. Exine 1.2 \( \mu \) thick, infragranulate; proxmo-equatorial and distal surfaces densely covered with pila, caput 1-2 \( \mu \) wide, collum 0.5-1.5 \( \mu \) wide, 1-3 \( \mu \) high, the caput frequently supports at its apex a minute spine. The contact areas support a somewhat reduced sculpture of variable concentration and extent; curvatures sometimes present in the radial regions. Major and minor folding common.

**Dimensions.** (Twenty-two specimens) Equatorial diameter 84-112 \( \mu \) (mean 100 \( \mu \)).

**Holotype.** Preparation KA 258/1, 55-7 101-8, K922, N258.

**Locus typicus.** South Mimerdalen, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Emsian.

**Description.** Holotype 98 \( \mu \). Laesurae just perceptible (under oil), length approximately half of the spore radius. Lips each 1.5 \( \mu \) wide, slightly raised. Exine 1 \( \mu \) thick, two major distal folds; proxmo-equatorial and distal pila 1-2.5 \( \mu \) high, caput 1-2 \( \mu \) wide, collum 0.5-1.5 \( \mu \) wide. In the contact areas, pila reduced only in the region adjacent to the lips.

**Remarks.** Lack of preferred orientation suggests a spherical shape. Curvatures imperfectae are present in approximately one-quarter of the specimens. Only under oil immersion can the finer details of the pila be seen.

Comparison. Retusotriletes gibbosus Naumova nom. nud. 1953 (pl. 22, fig. 110) see Kedo 1955 (p. 21, pl. 1, fig. 16) lacks tyification and description; however, the specimen illustrated by Kedo is clearly similar to *B. bullatus* sp. nov. and may be conspecific. Kedo states that the 'protuberances are round' but his illustration indicates that they may be pila.

**Occurrence.** Dicksonfjorden Sandstone, Reuterskioldfjellet Sandstone, and Lower Mimer Valley Series; Siegenian to Eifelian.

Infrafratrum Muronarti Potonié and Kremp 1954

Genus **Convolutispora** Hoffmeister, Staplin, and Malloy 1955

**Type species.** Convolutispora flavidus Hoffmeister, Staplin, and Malloy 1955.

**Convolutispora verniformis** Hughes and Playford 1961

Plate 96, fig. 8

1957 *Convolutispora flexuosa forma minor* Hacquebard, p. 312, pl. 2, fig. 10.

**Dimensions.** (Seventeen specimens) Equatorial diameter 37-52 \( \mu \) (mean 46 \( \mu \)).
Remarks. The Spitsbergen Devonian specimens are somewhat smaller than those described from other areas.

Occurrence. Upper Unifer Valley Series; Givetian.

**Convolutispora disparalis** sp. nov.

Plate 96, figs. 9–13

**Diagnosis.** Miospores trilette; amb circular to subcircular, equatorial margin undulating. Laesurae indistinct, simple, straight, length 1/3–2/3 spore radius. Exine excluding ornament 1–2 μ thick, homogeneous; distal and proximo-equatorial surfaces sculptured with a variable ornament of sinuous, narrow, frequently anastomosing rugulo-crístae, 1–3 μ wide, decreasing in width from their base, 2–5 μ high, usually with an undulating crest, often forming an imperfect reticulum, the intersections of which occasionally support a small papillum or spine. Lumina irregular, up to 6 μ in longest diameter. Contact areas support a reduced, sparse ornament, of low, smooth rugulae, small cones and granules.

**Dimensions.** (Sixty-one specimen) Equatorial diameter (excluding muri) 31–52 μ (mean 40 μ).

**Holotype.** Preparation KA 243/2, 54-9 103-8, K767, N261.

**Locus typicus.** East Mumindalen, Central Dicksonland, Spitsbergen; Plantejofva Conglomerate, probable Upper Givetian.

**Description.** Holotype subcircular, diameter 44 μ. Laesurae length 2/3 spore radius. Exine approximately 1 μ thick; rugulo-crístae 1–2 μ wide, 1–3 μ high, the intersections often with papillate tips.

**Comparison.** The presence of a reduced proximal sculpture, and of papillae on many of the intersections, separates this species from *Convolutispora fromensis* Balme and Hassell 1962 (p. 8, pl. 1, figs. 14–16) which in addition has lower muri; and *Convolutispora venusta* Hoffmeister, staplin, and Malloy 1955b (p. 385, pl. 38, fig. 11) which also has wider, lower ridges.

**Occurrence.** Common throughout the Upper Unifer Valley Series; Givetian.

**Convolutispora minerenesis** (Vigran) comb. nov.

Plate 97, figs. 1–3

1964 Reticulatisporites minerenesis Vigran, p. 17, pl. 2, figs. 16, 17.

**Description of specimens.** Miospores trilette; amb convexly subtriangular to circular. Laesurae simple, straight, length 1/3–2/3 spore radius, frequently obscured by sculptural elements. Exine 5–8 μ thick (including muri), supporting low, smooth, slightly sinuous muri, 2–5 μ broad, 1–3 μ high, most of which anastomose, forming an imperfect reticulum. Lumina irregular, 7 μ wide in longest diameter.

**Dimensions.** (Twenty specimens) Equatorial diameter 36–68 μ (mean 53 μ).

**Remarks.** Variation occurs in the orientation and spacing of the muri which are often radially directed and more widely spaced equatorially (Pl. 97, fig. 2). I have included this species in *Convolutispora* on the basis of its imperfect rather than perfect reticulum.
Comparison. *Convolulatispora crassa* Playford 1962 (p. 594, pl. 81, figs. 10–12) is larger, has a thicker exine and flat-topped muri. *Camptotrilites simplex* Naumova nom. nud. in Kedo 1955 (p. 26, pl. 2, fig. 14) may be conspecific, but the illustration is too poor to see details of the sculpture, and the species lacks holotypic designation.

Occurrence. Upper Minner Valley Series; Givetian.

*Convolulatispora tegula* sp. nov.

Plate 97, figs. 4–8

**Diagnosis.** Miospores trilete; amb circular to subcircular, occasionally oval. Laesurae frequently indistinct, simple, straight, length 1/3–1 spore radius. Exine including ornament 5–9 μ thick, homogeneous, often punctate, with a crowded sculpture of short, broadly rounded, partly anastomosing muri, 2–7 μ wide, 2–4 μ high, the shorter muri often polygonal in outline, lumina subordinate, less than 1 μ wide.

**Dimensions.** (Thirty-five specimens) Equatorial diameter 41–70 μ (mean 53 μ).

**Holotype.** Preparation KA 286/2, 27-4 107-8, K 773, N 267.

**Locus typicus.** East Muniindalen, Central Dicksonland, Spitsbergen; Planteklafen Conglomerate, probable Upper Givetian.

**Description.** Holotype circular, diameter 68 μ. Laesurae indistinct, length approximately two-thirds spore radius. Exine punctate, 8 μ thick, muri 3–7 μ wide, 2–4 μ high.

**Remarks.** Plate 97, fig. 7, shows corrosion of the muri.

Comparison. *Convolulatispora fronensis* Balme and Hassell 1962 (p. 8, pl. 1, figs. 14–16) closely resembles *C. tegula* sp. nov. in sculptural pattern, but has a much thinner exine and narrower muri. *Convolulatispora florita* Hoffmeister, Staplin, and Malloy 1955 (p. 384, pl. 38, figs. 5, 6) has a more extensively anastomosing muroid pattern, and wider lumina. *Convolulatispora usitata* Playford 1962 (p. 595, pl. 82, figs. 4, 7, and 8) has similar sculpture, but is much larger.

Occurrence. Upper Minner Valley Series; Givetian.

**Genus Reticulatisporites** (Ibrahim) Potonié and Kremp 1954

*Type species.* *Reticulatisporites reticulatus* Ibrahim 1933.

*Reticulatisporites ensiensis* sp. nov.

Plate 97, figs. 9–11

**Diagnosis.** Miospores trilete; amb circular to sub-circular. Laesurae distinct to discernible, length 1/3–1 spore radius, simple or more usually accompanied by low narrow folds. Exine 2–4 μ thick (excluding muri), infra-granulate; proximal surface laevigate or more frequently sparsely sculptured with small verrucae or granules, 2 μ or less in height and width, distally sculptured with strongly developed muri 1–4 μ wide, 3–8 μ high, enclosing more or less uniform lumina 8–20 μ in longest diameter, polygonal in outline centrally, more rounded equatorially.
Dimensions. (Twenty-three specimens) Equatorial diameter 49–82 µ (mean 65 µ). Number of equatorial muri 11–20, number of distal lumina 14–36.

Holotype. Preparation KA 240/2, 37-10 101-5, K582, N269.

Locus typicus. Manchesterbreen spur, Central Dicksonland, Spitsbergen; Lower Mimer Valley Series, Emsian.

Description. Holotype circular, diameter 72 µ. Laesurae simple, length two-thirds spore radius. Exine 4 µ thick, very sparse proximal ornament of granules, distal muri 2–3 µ wide basally, narrowing upwards, 5–8 µ high, lumina 12–20 µ wide.

Remarks. Both Naumova (1953) and Chibrikova (1959) include species assignable to Reticulatisporites, within Archaeozonolitae.

Comparison. Small size and exclusively distal reticulate sculpture, separates Reticulatisporites emiensis sp. nov. from the majority of other well-described species of Devonian and Carboniferous age. Reticulatisporites spicatus Haquebard and Barsis 1957 (p. 18, pl. 2, fig. 7) has an exclusively distal reticulum, but is larger, has longer laesurae, wider lips and a thicker exine. Archaeozonolitae retiformis Naumova 1953 (p. 87, pl. 14, fig. 4) is very similar and may be conspecific, but no mention is made of a granulate proximal surface or a reticulum confined to the distal surface.

Occurrence. Reuterskielfjellet Sundstone, and Lower Mimer Valley Series; Emsian.

Reticulatisporites sp. cf. Dictyotritelites minor Naumova 1953

Plate 97, figs. 12, 13

Description of specimen. Miospores trilette; amb circular to subcircular. Laesurae simple, straight, length approximately two-thirds spore radius. Exine 1–2 µ thick, finely infra-
granulate, contact areas laevigate, proximo-equatorial and distal surfaces sculptured with narrow, low muri, basally 1 μ or less wide, narrowing upwards, approximately 1 μ high; lumina 3–7 μ in longest diameter.

Dimensions. (Five specimens) Equatorial diameter 18–32 μ (mean 27 μ).

Comparison. Too few specimens are present for exact comparison: Dictyostriletes minor Naumova 1953 (p. 28, pl. 2, fig. 7) is clearly similar, but is triangular, and the muri are somewhat higher. However, the illustration of D. minor in Kedo 1955 (p. 2, pl. 2, fig. 13) has lower muri, is subcircular, and compares very closely with the Spitsbergen specimens.

Occurrence. Reuterskioldfjellet Sandstone and Miner Valley Series; Emsian to Givetian.

**Genus perforosporites** Scott and Rouse 1961

*Type species.* *Perforosporites robustus* Scott and Rouse 1961.

*Discussion.* Separable from *Foveosporites* Balme 1957 on its regular distribution of fovea.

*Perforosporites* sp.

Plate 97, fig. 14

*Descriptions of specimens.* Miospores trilette; amb circular. Laesurae simple, straight, length 1/4–1/3 spore radius. Exine 6–10 μ thick, infragranulate; contact areas laevigate, proximo-equatorial and distal surfaces with a sparse, regular ornament, of circular to oval fovea, 1–4 μ wide, 3–6 μ long, 3–24 μ apart. Distally the exine slightly ‘overhangs’ the fovea.

Dimensions. (Two specimens) Equatorial diameter 116–17 μ.

Comparison. *Perforosporites robustus* Scott and Rouse 1961 (p. 978, pl. 113, figs. 1–6, pl. 114, figs. 1–5) the only species previously attributed to this genus, is roundly triangular, smaller, has less distinct and longer laesurae, and frequently has blunt, short papillae. *Reticulatisporites textilis* Balme and Hassell 1962 (p. 9, pl. 2, figs. 11, 12) has sculptured contact areas, indistinct laesurae, and more numerous fovea.

Occurrence. Top of the Reuterskioldfjellet Sandstone, and bottom of the Lower Miner Valley Series; Upper Emsian.

**Genus emphatisporites** McGregor 1961


*Emphatisporites rotatus* McGregor 1961

1962. *Radforthia radiata* Winslow, p. 72, pl. 16, figs. 15, 15a, pl. 22, fig. 17.

*Dimensions.* (Ten specimens) Equatorial diameter 34–47 μ (mean 39 μ).

Comparison. *Stenozoosporites ornatus* Naumova nom. nud. (pl. 22, fig. 11) lacks holotypic designation and description, but may have proximal muri, in which case it would be synonymous. *Radiaspora* sp. A Balme 1962 (p. 6, pl. 1, figs. 11, 12), may prove to have proximal rather than distal muri, and would then be conspecific with *E. rotatus*.
McGregor. *Radforthia radiata* Winslow 1962 (p. 72, pl. 16, figs. 15, 15a, pl. 22, figs. 17) appears to differ only in its greater size range, and although neither McGregor (1961) nor Winslow (1962) give the mode of their measurements, *R. radiata* must be synonymous at least in part, with *E. rotatus*.

**Occurrence.** Reuterskildsflæett Sandstone and Lower Mimer Valley Series; Siegenian to Lower Eifelian.

*Emphanisporites neglectus* Vigran 1964

Plate 97, fig. 19

**Description of specimens.** Miospores trilete; amb circular to roundly triangular. Laesurae distinct, straight, length $\frac{1}{2}$ to $\frac{2}{3}$ spore radius, narrow, occasionally accompanied by slightly sinuous lips, each up to 1 $\mu$ wide. Exine 0.5-2.5 $\mu$ thick, infragranulate; depressed contact areas support a distinct to discernible ornament of low, narrow muroid folds, surrounded by low, sharp, curvaturae; proximo-equatorial and distal surfaces laevigate or very finely granulose.

**Dimensions.** (Twenty-six specimens) Equatorial diameter 30-47 $\mu$ (mean 40 $\mu$). Radial diameter of contact area approximately four-fifths of total spore radius.

**Comparison.** Emphanisporites obscuredus McGregor 1961 (p. 5, pl. 1, fig. 14), is larger and lacks curvaturae.

**Occurrence.** Dicksonfjorden Sandstone, Reuterskildsflæett Sandstone, and Lower Mimer Valley Series; Siegenian, Ermsian.

*Emphanisporites decoratus* sp. nov.

Plate 97, figs. 15-18

**Diagnosis.** Miospores trilete; amb roundly triangular to subcircular and occasionally oval. Laesurae distinct, straight, length two-thirds to full spore radius, occasionally accompanied by low, smooth lips, individually less than 1 $\mu$ wide. Exine 1-4 $\mu$ thick, homogeneous to infragranulate; proximal surface with distinct to discernible radially disposed muroid folds of variable number, 2 $\mu$ or less wide, distal surface supporting an ornament of cones and spines, 1.5-5 $\mu$ high, 0.5-2 $\mu$ wide.

**Dimensions.** (Twenty-nine specimens) Equatorial diameter 34-61 $\mu$ (mean 49 $\mu$).

**Holotype.** Preparation KA 251/3, 33-5 889, K905, N274.

**Locus typicus.** South Mimerdalen, Central Dicksonland, Spitsbergen; Reuterskildsfjellet Sandstone, Siegenian.

**Description.** Holotype roundly triangular, diameter 51 $\mu$. Laesurae simple, almost reaching equatorial margin. Exine 3 $\mu$ thick; proximal muri indistinct, distal surface supporting a predominance of cones, 1 $\mu$ wide, up to 1.5 $\mu$ high.

**Remarks.** Although cones usually predominate, specimens with a dominance of spines exist.

**Comparison.** Differs from other species of *Emphanisporites* yet described in having a strongly sculptured distal surface. *Emphanisporites neglectus* Vigran (Pl. 97, fig. 19) is occasionally sculptured, but then, only with very fine granules.

**Occurrence.** Lower Reuterskildsfjellet Sandstone, Siegenian.
K. C. ALLEN: LOWER AND MIDDLE DEVONIAN SPORES

**Enphanisporites minitus** sp. nov.

Plate 97, fig. 20

*Diagnosis.* Miospores trilete; amb roundly triangular to subcircular. Laesurae straight, length three-quarters to full spore radius, accompanied by smooth, narrow lips, individually less than 1 μ wide. Exine 2–3 μ thick, homogeneous to infragranulate; proximal surface with 15–30 radially disposed muri, approximately 1 μ wide, distal surface laevigate.

*Dimensions.* (Twenty specimens) Equatorial diameter 167–27 μ (mean 24 μ).

*Holotype.* Preparation KA 262/4 56:8 91:5, K908, N276.

*Locus typicus.* South Mjoindalen, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Siegenian.

*Description.* Holotype subtriangular, diameter 26 μ. Lips extend almost to the equatorial margin. Exine 2 μ thick; proximal surface with twenty-five radially disposed ribs, 0.5–1 μ wide.

*Comparison.* Enphanisporites rotatus McGregor 1961 (p. 3, pl. 1, figs. 1–4) is considerably larger and the laesurae are frequently unaccompanied by lips.

*Occurrence.* Frenkelbryggen Division and Reuterskioldfjellet Sandstone, Gedinbian to Lower Emsian.

**Enphanisporites patagiatus** sp. nov.

Plate 97, fig. 21

*Diagnosis.* Miospores trilete; amb subcircular to subtriangular, periphery often undulating. Laesurae simple, straight, length ½ spore radius. Exine 2–6 μ thick, homogeneous to infragranulate; proximal surface with 8–15 radially disposed muri, 3–14 μ wide, up to 4 μ high, extending ½ spore radius from the equatorial margin, proximal polar region and distal surface laevigate.

*Dimensions.* (Fifteen specimens) Equatorial diameter 33–50 μ (mean 45 μ).

*Holotype.* Preparation KA 271/3, 38:1 99-2, K897, N277.

*Locus typicus.* South Mjoindalen, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Emsian.

*Description.* Holotype roundly triangular, diameter 49 μ. Laesurae length two-thirds of spore radius. Exine 6 μ thick, finely infragranulate, nine proximal radial ribs, 4–13 μ wide, extend ½ spore radius from the equatorial margin.

*Comparison.* Enphanisporites robustus McGregor 1961 (p. 4, pl. 1, fig. 13) is larger and lacks the laevigate proximal polar region.

*Occurrence.* Reuterskioldfjellet Sandstone; Siegenian and Emsian.

**Suturesa ZONOTRILETES** Waltz 1935

**Infrastrutrum TRICRASSATI** Dettmann 1963

**Genus CRASPEDISPORA** gen. nov.

*Type species.* Craspedispora craspeda sp. nov.

*Diagnosis.* Miospores trilete; amb subcircular to roundly triangular. Laesurae usually

---

3 A
well defined, simple or accompanied by lips. Central area encompassed inter-radially by a narrow zona. Central area sculptured proximo-equatorially and distally.

**Discussion.** Differs from both *Reinschispora* Schopf, Wilson, and Bentall 1944 and *Diatomozoneotriteles* (Naumova) Playford 1962 in having a more roundly triangular shape, and a non-fimbriate zona rather than a corona. *Camarozooneotriteles* (Naumova) Potonié 1958 has a thick interradial crassitude.

**Derivation of name.** Gr. krespedon—edge, border.

**Craspedispora craspeda** sp. nov.

**Plate 97, figs. 22, 23**

**Diagnosis.** Miospores trilete; amb subcircular to roundly triangular. Laesurae straight, distinct, length \( \frac{1}{3} - \frac{1}{4} \) spore radius, simple or accompanied by narrow, smooth lips individually 0.5–1 \( \mu \) wide. Exine of central area 1.2–5 \( \mu \) thick, sometimes slightly thicker inter-radially, homogeneous to finely infragranulate, extending interradially as a thin, membranous zona 2–5 \( \mu \) wide, the zona never develops in the radial regions. Contact areas often slightly darkened, laevigate, proximo-equatorial and distal surfaces of the central area with a distinct ornament of cones, 1–5 \( \mu \) or less in height and basal diameter. Zona laevigate, or occasionally with a few small cones. Curvartual folds sometimes present.

**Dimensions.** (Thirty-four specimens) Equatorial diameter (including zona) 35–42 \( \mu \) (mean 39 \( \mu \)).

**Holotype.** Preparation KA 258/3, 42 A 49/4, K922, N278.

**Locus typicus.** South Mimerdale, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Emilian.

**Description.** Holotype roundly triangular, diameter 41 \( \mu \). Laesurae length two-thirds of spore radius. Exine 2 \( \mu \) thick, slightly less at the apices, zona 2–5 \( \mu \) wide.

**Remarks.** Corrosion of the thin zona frequently occurs, giving the outer margin an irregular appearance. In oblique aspect, the zona is very difficult to see.

**Occurrence.** Reuterskioldfjellet Sandstone, and Lower Mimer Valley Series; Emilian and Eifelian.

**Genus diatomozoneotriteles** (Naumova) Playford 1962

**Type species.** *Diatomozoneotriteles scutarius* (Hacquebard and Barss 1957) Hughes and Playford 1961.

**Diatomozoneotriteles** sp.

**Plate 97, figs. 24, 25**

**Description of specimens.** Miospores trilete; amb triangular, with straight to slightly concave sides, and rounded apices. Laesurae indistinct, simple, straight, length approximately three-quarters spore radius. Corona composed of discrete, closely spaced, pointed saetae, 2–5 to 3 \( \mu \) long interradially, diminishing in size towards the triangular apices, from which they are absent. Exine of central area approximately 1 \( \mu \) thick, finely infragranulate, proximally laevigate, distally supporting an ornament of small discrete cones, 1–5 \( \mu \) or less in height and basal diameter. Exine folded.
K. C. ALLEN: LOWER AND MIDDLE DEVONIAN SPORES

Dimensions. (Three specimens) Overall equatorial diameter 25-27 μ.

Remarks. Although too few specimens are present to warrant specific assignment, these specimens are interesting in that they provide the lowest stratigraphical record for this genus.

Occurrence. Planteklofta Conglomerate and Fiskeklofta Formation; probable Upper Givetian.

Infraurina cingulati (Potonî and Klaus) Dettmann 1963
Genus stenozonotriletes (Naumova) Potonî 1958

Type species. Stenozonotriletes conformis Naumova 1953.

Stenozonotriletes furitus s. nov.
Plate 98, figs. 2, 3

Diagnosis. Miospores triletic; amb rounded triangular to subcircular. Laesurae distinct, straight, length 0.5-0.7 spore radius, simple or more frequently accompanied by low, flat-topped lips, individually 2-3 μ wide at the polar end, decreasing gradually equatorially. Exine laevisate to finely punctate; cingulum smooth, uniform or slightly narrower interradially.

Dimensions. (Seventeen specimens) Overall equatorial diameter 65-108 μ (mean 81 μ); width of cingulum 10-19 μ (mean 12 μ).

Holotype. Preparation KA 274/4, 44 8 94-4, K 872, N 281.

Description. Holotype rounded triangular, overall diameter 70 μ. Laesurae half spore radius, accompanied by low thickened lips, individually 3 μ wide. Cingulum uniform, 10 μ wide.

Remarks. Frequently the cingulum is eroded, giving it an irregular appearance.

Comparison. Archaeozonotriletes subcompactus Naumova 1955 (p. 84, pl. 13, fig. 14 and p. 35, pl. 13, fig. 9) is circular and has a sculpture of small protuberances. Triletes dubius Eisenack 1944 (p. 115, pl. 2, fig. 7, text-fig. 14) has a narrower cingulum and the exine thickens towards the polar axis, forming a darkened triangular area, unlike the lip formation in S. furitus s. nov.

Occurrence. Dicksonfjorden Sandstone, Reuterskigelfjellet Sandstone, and Lower Miner Valley Series; Upper Siegenian to Eifelian.

Stenozonotriletes inessus s. nov.
Plate 98, fig. 1

Diagnosis. Miospores triletic; amb convexly subtrangular. Laesurae straight, extending almost to the equatorial margin, accompanied by narrow lips, each approximately 0.5 μ wide, up to 2.5 μ high. Exine homogeneous to finely infragranulate, laevisate. Cingulum uniform.

Dimensions. (Twenty specimens) Overall equatorial diameter 24-36 μ (mean 30 μ); width of cingulum 3-6 μ (mean 4 μ).

Holotype. Preparation KA 223/2, 35 5 89-7, K 829, N 283.
Locus typicus. South Mimerdalen, Central Dickeonland, Spitsbergen; Reuterskioldfjellet Sandstone, Emsian.

Description. Holotype overall diameter 36 µ, lips individually 0-5 µ wide, 2 µ high. Cingulum 4 µ wide.

Comparison. *Archaeozonotriletes pusillus* Naumova 1953 (p. 86, pl. 13, fig. 19) has simple laesurae which often have 'elavate endings'; but is otherwise similar. *Stenozonotriletes extensus* Naumova var. *minor* Naumova 1953 (p. 37, pl. 3, fig. 18; p. 72, pl. 10, fig. 21; p. 130, pl. 19, figs. 19, 20) is more coarsely infragranulate and has simple laesurae.

Occurrence. Reuterskioldfjellet Sandstone, and Lower Miner Valley Series; Siegenian to Eifelian.

*Stenozonotriletes* sp.

Plate 98, fig. 4

Description of specimens. Miospores trilete; amb convexly subtriangular. Laesurae straight or slightly sinuos, length three-quarters to full central area radius. Exine finely punctate; cingulum smooth, usually slightly thicker interradially.

Dimensions. (Six specimens) Overall equatorial diameter 54-66 µ (mean 58 µ), width of cingulum 6-8 µ interradially, 4-6 µ radially.

Comparison. Too few specimens are present to warrant the erection of a new species. *Stenozonotriletes perforatus* Playford 1962 (p. 607, pl. 86, figs. 8-9, text-fig. 5c), has a narrower, laevigate cingulum, but is otherwise similar. *Stenozonotriletes* sp. cf. *S. recognitius* var. *recognitius* Naumova in Balme and Hassell 1962 (p. 14, pl. 3, figs. 3, 4) differs only in having a darker contact area.

Occurrence. Upper Reuterskioldfjellet Sandstone, and Lower Miner Valley Series; Upper Emsian, Lower Eifelian.

Genus *Lycospora* (Schopf, Wilson, and Bantall) Potonié and Kremp 1954

Type species. *Lycospora micropapillata* (Wilson and Coe) Schopf, Wilson, and Bantall 1944.

**Explanation of Plate 98**

All figures ×500; from unretouched negatives.


Figs. 5–6. *Doxasporites devonius* Richardson. 5, Proximal surface; KA 209/11, 38-8 90-8, K519, N285. 6, Section; KA 206/S12, 32-6 96-8, K773, N286.

Figs. 7–8. *Lycospora calva* sp. nov. Holotype, proximal and distal surfaces respectively; KA 262/4, 57-7 106-4, K908, N287.

Figs. 9–10. *Samarsporites* spp. 9–10. *S. protoceris* (Naumova) comb. nov., Proximal and distal surfaces respectively; KA 243/1, 32-8 105-3, K767, N289. 11, *S. sonorus* sp. nov. Holotype, sectional focus; KA 243/2, 32-8 105-3, K767, N289. 12–16. *S. sperpera* sp. nov. 12, 13, Holotype, proximal and distal surfaces respectively; KA 243/3, 32-7 102-7, K767, N290. 14, Distal surface; KA 243/3, 24-7 93-4, K767, N291. 15, Distal surface showing cristo-reticulate sculpture; KA 243/3, 37-6 103-4, K767, N262. 16, Section, showing the cingulate exine and distal sculpture; KA 243/S11, 43-4 99-8, K767, N293.
K. C. ALLEN: LOWER AND MIDDLE DEVONIAN SPORES

Lyiospora culpa sp. nov.

Plate 98, figs. 7, 8

Diagnosis. Miospores trilet; amb roundly triangular with acute to broadly rounded apices, occasionally subcircular, conformable with the central area outline. Laesurae indistinct, straight, length two-thirds to full central area radius, accompanied by narrow, smooth, low lips, individually 0.5-1.5 μ wide, length three-quarters to full spore radius. Exine two-layered; intine approximately 1 μ thick, closely appressed to the eoxine and usually indistinct, eoxine of both central area and equatorial flange finely infragranulate. Proximal surface laevigate, distal surface of central area sparsely covered with small cones and granules 1-5 μ or less in height and basal diameter, equatorial flange laevigate. Proximal surface usually with numerous folds.

Dimensions. (Twenty specimens) Overall equatorial diameter 33-60 μ (mean 47 μ), width of cingulum 2-14 μ (mean 6 μ).

Holotype. Preparation KA 262/4, 57-7 106-4, K908, N287.

Locus typicus. South Mirandalen, Central Dickson Land, Spitsbergen; Lower Reuterskioldfjellet Sandstone, Siegenian.

Description. Holotype roundly triangular with convex sides and acute apices, diameter 51 μ, width of cingulum 6 μ. Laesurae indistinct, lips 1 μ wide, extending full radius of the central area. Intine 1 μ thick, eoxine proximally folded, distally with grana and small cones on the central area.

Remarks. Some specimens are slightly thicker at the very inner margin of the cingulum, but in no specimen is it truly bizonate. This species provides a very low stratigraphical record for the genus Lyiospora.

Comparison. Lyiospora abe (Hoffmeister, Staplin, and Malloy) Staplin 1960 (p. 20, pl. 4, figs. 13, 17, 18, 20) is smaller, and only faintly granulose. Hymenozonotrilites millegratus Naumova 1953 (p. 126, pl. 18, figs. 31, 32) is bizonate, and more densely sculptured. Hymenozonotrilites macrus Naumova 1953 (p. 63, pl. 8, fig. 17) has a laevigate distal central area. Hymenozonotrilites limpidus Naumova 1953 (p. 98, pl. 15, fig. 21) is circular, lacks lips, and is more densely sculptured.

Occurrence. Lower Reuterskioldfjellet Sandstone, Siegenian.

Genus Densosporites (Berry) Potonié and Kremp 1954

Type species. Densosporites covenstis Berry 1937.

Densosporites deovinicus Richardson 1960

Plate 98, figs. 5, 6

Dimensions. (Forty specimens) Overall equatorial diameter 66-156 μ (mean 99 μ); total width of cingulum 18-40 μ (mean 26 μ), inner zone 12-27 μ (mean 18 μ).

Remarks. The section of D. deovinicus Richardson (Pl. 98, fig. 6) demonstrates the raised lips, distal sculpture, and thick eoxine. The intine cannot be seen in this section.

Occurrence. Upper Minir Valley Series; Givetian.
Type species. *Samarisporites (Cristatisporites) orcadensis* (Richardson) Richardson 1965.

Discussion. *Samarisporites triangulatus* sp. nov. and *Samarisporites insitatus* sp. nov. (see below) both have equatorial structures which vary from a zone to a cingulum (here referred to as an equatorial flange), giving evidence in support of Dettmann’s (1963) emendation of the infratruma Cingulati (Potonié and Klaus 1954), to include zonate forms.

*Samarisporites praetervisus* (Naumova) comb. nov.

Plate 98, figs. 9, 10

1953 *Hymenozonotriletes praetervisus* Naumova, p. 40, pl. 4, fig. 8.

Description of specimens. Miospores trilete; amb rounded triangular to subtriangular. Laesurae indistinct, obscured by smooth elevated lips, individually 1–2 μ wide, 5–10 μ high, almost extending to the equatorial margin. Exine two-layered; intexine homogeneous 2 μ or less wide, closely appressed to the exoxine and often indistinct; exoxine of both central area and cingulum finely to coarsely infragranulate, proximally laevigate, distal surface densely ornamented with cones, 2–7 μ wide, 3–8 μ high. Cones on the central area variable both in shape and distribution, commonly with rounded apices, often supporting an apical capitula spine, the cones are usually closely spaced, with rounded polygonal or occasionally fused bases. Cones on the cingulum less dense, with pointed to slightly rounded apices, 33–52 cones round the equatorial margin. Cingulum uniform, tapering, differentiation from the central area distinct to obscure.

Dimensions. (Sixteen specimens) Overall equatorial diameter 70–124 μ (mean 86 μ); width of cingulum 16–30 μ (mean 21 μ).

Comparison. *Samarisporites orcadensis* (Richardson 1960, p. 58, pl. 14, fig. 12, text-fig. 8) Richardson 1965, is considerably larger.

Occurrence. Upper Mimer Valley Series; Givetian.

*Samarisporites senatus* sp. nov.

Plate 98, fig. 11

Diagnosis. Miospores trilete; amb convexly triangular, irregular, central area outline circular. Laesurae straight, length two-thirds to full radius of the central area, accompanied by smooth, narrow, often sinuous lips, individually 1–1.5 μ wide, extending on to the cingulum, usually to the equatorial margin. Exine two-layered; intexine thin, approximately 1 μ wide, closely appressed to the exoxine, and often indistinct; exoxine of both central area and cingulum finely infra-granulate. Proximal surface laevigate, distal surface very sparsely covered with small spines and cones, 1–4 μ wide, 2–4 μ high, the cones frequently support a small apical spine. Cingulum of uniform width, proximally occasionally raised above the central area, the inner distal margin may be slightly thickened, but the cingulum is never distinctly bizonate.

Dimensions. (Sixteen specimens) Overall equatorial diameter 50–64 μ (mean 57 μ); width of cingulum 12–16 μ (mean 15 μ).

Holotype. Preparation KA 243/2, 328 105-3, K767, N289.
K. C. Allen: Lower and Middle Devonian Spores

Locus typicus. East Munindalen, Central Dicksonland, Spitsbergen; Planterklofta Conglomerate, probable Upper Givetian.

Description. Holotype diameter 57 μ, cingulum 12 μ wide. Laesurae straight, length two-thirds central area radius, lips each 1 μ wide, extending almost to the equatorial margin. Distal spines and cones 1–3 μ wide, 2–3 μ high, somewhat corroded.

Remarks. In corroded specimens, the sculptural elements may be partially or completely eroded.

Comparison. *Hymenozyonotriletes spinosus* Naumova 1953 (p. 41, pl. 14, fig. 9) is much larger, and has a more regular ornament. *Zonotriletes deliquescent* Luber, in Luber and Waltz 1941 (p. 50, pl. 1, fig. 6), is larger, and the inner part of the cingulum is not thickened. *Hymenozyonotriletes pusillus* (Ibrahim) Ishchenko 1952 (p. 50, pl. 13, fig. 122) is smaller, the lips are shorter, and there is a sparser ornament on the cingulum. *Densosporites lanedii* Staplin 1960 (p. 25, pl. 5, fig. 11) has an ornament only of cones, shorter lips, and a distinctly bizonate cingulum.

Occurrence. Upper Mimer Valley Series; Givetian.

*Samarisporites hesperus* sp. nov.

Plate 98, figs. 12–16

Diagnosis. Miospores trilete; amb circular to subcircular conformable with the central area outline. Laesurae indistinct, length three-quarters to full central area radius, accompanied and usually obscured by narrow, often slightly sinuous, elevated lips, individually 1–2.5 μ wide, extending to the inner margin of the cingulum. Exine one-layered, finely infra-granulate, proximally laevigate, distally with an even distribution of cones on both central area and cingulum. The cones 2–6 μ wide, 2–6 μ high, have rounded apices, and a capitate apical spine in well-preserved specimens; the bases of the cones on the central area are usually fused, often to such an extent as to form an imperfect reticulum. Cingulum uniform, tapering abruptly at the outer margin, differentiation from the central area is sometimes indistinct.

Dimensions. (Fifty-three specimens) Overall equatorial diameter 52–89 μ (mean 73 μ); width of cingulum 7–12 μ (mean 10 μ).

Holotype. Preparation KA 243/3, 517 1027, K767, N290.

Locus typicus. East Munindalen, Central Dicksonland, Spitsbergen; Planterklofta Conglomerate, probably Upper Givetian.

Description. Holotype subcircular, diameter 68 μ, cingulum 9 μ wide. Laesurae indistinct, lips approximately 1 μ wide, cones 4–6 μ wide, 3–6 μ high, occasionally fused near the distal pole. Capitate spines eroded from many cones.

Remarks. The section (Pl. 98, fig. 16) clearly demonstrates the laevigate proximal surface, raised lips, one-layered exine, and abruptly tapering cingulum. In specimens where the cones are eroded, the fused bases are clearly seen (Pl. 98, fig. 15).

Comparison. *Archaeozonotriletes crassispinosus* Chibrikova 1959 (p. 62, pl. 8, fig. 5) is roundly triangular, lacks lips, and there is no evidence of small spines on the cones.
Lycospora magnifica McGregor 1960 (p. 35, pl. 12, fig. 5, pl. 13, figs. 2–4) is much larger, and has a smaller sculptural pattern. Lycospora rugulata Vigran 1964 (p. 23, pl. 1, figs. 17, 18; pl. 2, fig. 15) is clearly similar, but lacking cones, has a rugulate rather than a cristate sculpture. The lack of cones in Vigran’s specimens may be due to poor preservation; if this is proved to be so, then Samarispores hesperus sp. nov. would be synonymous with L. rugulata.

Occurrence. Upper Minter Valley Series, particularly common in the Planteikofa Conglomerate; probable Givetian.

Samarispores triangulatus sp. nov.

Plate 99, figs. 1–6

Diagnosis. Miospores trilete, amb triangular, with straight to moderately convex sides, central area outline circular to roundly triangular. Laesurae indistinct, length where seen two-thirds to full central area radius, accompanied by smooth, elevated lips, individually 0.5–3 μ wide, extending on to the equatorial flange, and frequently to the equatorial margin. Exine two-layered; intine 1–2 μ wide, closely appressed to the exoxine, and often indistinct; exoxine of both central area and equatorial flange finely infragranulate. Proximal surface laevidate, distally the central area supports a closely spaced ornament of cones, 2–5 μ in height and basal diameter, the cones occasionally support a small apical spine. Variation occurs in the basal sculpture of the elements, which may be separate, occasionally fused, or more comprehensively associated, forming an imperfect reticulum; distally the equatorial flange is laevidate, or rarely with a sparse ornament of small cones. Equatorial flange acutely tapering, irregular, reaching its maximum width radially, frequently being only just perceptible in the inter-radial regions.

Dimensions. (Forty-five specimens) Overall equatorial diameter 46–78 μ (mean 62 μ); diameter of central area 32–54 μ (mean 43 μ); width of cingulum radially 10–20 μ (mean 13 μ), interradially 1–9 μ (mean 5 μ).


Locus typicus. East Mündalen, Central Dicksonland, Spitsbergen; Planteikofa Conglomerate, probable Upper Givetian.

EXPLANATION OF PLATE 99

All figures × 500; from untouched negatives.

Figs. 1–9. Samarispores spp. 1–6. S. triangulatus sp. nov. 1, 2, Holotype, proximal and distal surfaces respectively; KA 243/1, 39:6 97:6, K767, N294. 3, Proximal surface; KA 243/3, 57:8 108:3, K767, N295. 4, Lateral view; KA 243/2, 35:1 87:6, K767, N296. 5, 6, Sections showing the equatorial flange; KA 242/3, 36:5 100:0, K772, N297 and KA 242/3, 5:1 97:7, K772, N298 respectively. 7–9. S. insulatus sp. nov. 7, 8, Holotype; proximal and distal surfaces respectively; KA 243/3, 52:2 101:3, K767, N299. 9, Lateral view; KA 243/1, 30:6 96:0, K767, N300.

Figs. 10–13. Cirripedoides avis sp. nov. 10, Holotype, proximal surface; KA 242/1, 21:2 89:7, K772, N301. 11, 12, Sections showing the three-layered exine; KA 290/4, 53:0 91:2, K681, N302. 13, Proximal oblique aspect; KA 290/2, 45:9 108:4, K681, N304.

Figs. 14–15. Compositoconodites ascomorphus sp. nov. 14, Holotype, proximal oblique aspect; KA 290/4, 53:0 91:2, K681, N307. 15, Proximal surface; KA 290/1, 38:8 103:2, K681, N308.

Figs. 16–17. Cirripedoides disjunctus sp. nov. 16, Holotype, the equatorial flange is somewhat eroded, as in all specimens; KA 251/3, 33:0 89:2, K905, N305. 17. Specimen showing the flange characteristically eroded in the inter-radial areas; KA 262/M5, 36:6 99:6, K908, N306.
Description. Holotype amb triangular, central area circular, overall diameter 54 μ, central area 40 μ, width of equatorial flange radially 12 μ, inter-radially 1–4 μ. Lips individually 2.5 μ wide, extend almost to equatorial margin. Distal central area cones 3–4 μ wide, 2–5 μ high, with separate bases, distal equatorial flange laevigate. Sculptural elements obscure the equatorial flange completely in one inter-radial region.

Remarks. There is some variation in the proximo-distal thickness of the cingulum, which may be very thin (Pl. 99, fig. 4) and represent a zona, or more definitely a cingulum, as demonstrated in the sections (Pl. 99, figs. 5, 6). Sections also show the interzone and exclusively distal ornament.

Comparison. The distinctive equatorial flange separates this species from others assignable to Samarisporites.

Occurrence. Upper Mimer Valley Series; Givetian.

Samarisporites insitatus sp. nov.

Plate 99, figs. 7–9

Diagnosis. Miospores triete; amb circular to roundly triangular, conformable with the central area outline. Laeves obscured by smooth, elevated lips, individually 1–2 μ wide, 3–8 μ high, extending to the equatorial margin. Exine homogeneous to finely infragranulatte, proximally laevigate, distally the central area supports an ornament of cones, 1–4 μ wide, 1–6 μ high, the cones often supporting a small apical spine. Considerable variation occurs in the basal sculpture of the cones which may be separate, fused, or more comprehensively associated as an imperfect reticulum; distally the equatorial flange is laevigate or rarely with a sparse ornament of small cones. Equatorial flange acutely tapering, uniform.

Dimensions. (Eighteen specimens) Overall equatorial diameter 60–66 μ (mean 62 μ); width of equatorial flange 5–9 μ (mean 6.5 μ).


Locus typicus. East Meinadalen, Central Dicksonland, Spitsbergen; Planteklofta Conglomerate, probable Upper Givetian.

Description. Holotype circular, overall diameter 62 μ, equatorial flange 7 μ. Lips each approximately 1 μ wide, 3 μ high. Distal cones 1–3 μ in height and diameter, occasionally fused basally.

Remarks. Specimens in oblique aspect (Pl. 99, fig. 9) demonstrate the thin equatorial flange.

Comparison. Samarisporites hesperus sp. nov. (Pl. 98, figs. 12–16) has a larger, denser sculpture, and a strong cingulum. Hymenozonotriletes celerb Chibrikova 1959 (p. 77, pl. 13, fig. 3) is considerably larger, and has a much wider equatorial flange.

Occurrence. Fiskeklofta Formation, Planterygen Sandstone, and Planteklofta Conglomerate; probable Upper Givetian.
Genus Cirratiradites Wilson and Coe 1940

Type species. Cirratiradites saturni (ibrahim) Schoepf, Wilson, and Bentall 1944.

Discussion. Cirratiradites avitus sp. nov. (Pl. 99, figs. 10–13) and Cirratiradites dissutus sp. nov. (Pl. 99, figs. 16–17) are included within this genus on the basis of their apparently thin equatorial flange, and reduced sculpture.

Cirratiradites avitus sp. nov.

Plate 99, figs. 10–13

Diagnosis. Miopores trilete; amb roundly triangular, with convex sides and sharply to broadly rounded apices. Laesurae indistinct, accompanied by smooth elevated lips, individually 1–3 μ wide, length three-quarters to full spore radius. Exine three-layered; intexine finely infra-granulate, approximately 2 μ thick, closely appressed to the exoexine, and seen only in over-macerated specimens or sections; exoexine two-layered, inner exoexine coarsely infra-granulate, outer exoexine homogeneous. Proximal surface laevigate, distal surface laevigate, or very sparsely ornamented with cones 1–2 μ wide, 1–4 μ high; equatorial flange moderately to acutely tapering, uniform, differentiation from the central area often indistinct.

Dimensions. (Twenty specimens) Overall equatorial diameter 84–172 μ (mean 123 μ), width of equatorial flange 16–36 μ (mean 27 μ).

Holotype. Preparation KA 242/1, 21/2 89/7, K772, N301.

Locus typicus. East Muniniden, Central Dicksand, Spitsbergen; Plantekliaflata Conglomerate, probable Upper Givetian.

Description. Holotype diameter 121 μ, equatorial flange approximately 22 μ wide. Lips narrow, total width 5 μ, inaperturate, extend on to the inner margin of the cingulum. Exine laevigate, equatorial flange corroded.

Remarks. Sections (Pl. 99, figs. 11, 12) show the three-layered exine, and the elevated lips formed as an extension of the homogeneous outer exoexine only, which in this specimen are inaperturate. The inner exoexine is very thick distally, which probably accounts for the indistinct intexine and central area outline. As demonstrated in Cirratiradites elegans by Hughes, Dettmann, and Playford (1962), sections of what appears in proximo-distal aspect to be a thin equatorial flange, is in fact surprisingly thick.

Comparison. Cirratiradites elegans (Waltz) Potonié and Kremp 1956 (p. 126) is clearly similar, but has a more distinct and scabrate central area, and as seen in section (Hughes, Dettmann, and Playford 1962, p. 251, pl. 38, figs. 6, 7), has a thinner intexine, and an undivided exoexine.

Occurrence. Upper Minner Valley Series; Givetian.

Cirratiradites dissutus sp. nov.

Plate 99, figs. 16, 17

Diagnosis. Miopores trilete; amb circular, subcircular to oval, conformable with the central area outline. Laesurae straight often open, length equal to full central area.
radius, accompanied by membranous, elevated lips, individually 1.5–6 μ wide, up to 8 μ high, extending on to the equatorial flange, and frequently to the equatorial margin. Exine apparently one-layered, coarsely infra-granulate, central area 4–10 μ thick, slightly thicker distally, punctate, occasionally microreticulate proximally, laevigate distally; equatorial flange much lighter in colour, thin, uniform, laevigate, often broken radially. Proximal and distal minor folds occasionally present.

**Dimensions.** (Twenty-one specimens) Overall equatorial diameter 71–123 μ (mean 90 μ), diameter of equatorial flange 4–20 μ (mean 11 μ).

**Holotype.** Preparation KA 251/3, 330 89-2, K905, N305.

**Locus typicus.** South Mimndalen, Central Dicksonland, Spitsbergen; Lower Reuterskioldfjellet Sandstone, Siegenian.

**Description.** Holotype subcircular, diameter 96 μ, flange 10 μ wide. Lasurae open, lips up to 6 μ wide extend to the equatorial margin. Exine of central area 8 μ thick, proximally microreticulate.

**Remarks.** The majority of specimens are dark and ill preserved, and are very difficult to macerate satisfactorily. The breakdown of the equatorial flange radially (Pl. 99, fig. 17) in the majority of specimens, gives the spore a very distinctive appearance. Corrosion of the coarsely infra-granulate exine gives the spore a pseudosculpture of granules.

**Comparison.** *Hymenozonotriletes varius* Naumova 1953 var. *variatus* (p. 38, pl. 4, fig. 10) is smaller, and has a very different lip construction.

**Occurrence.** Common in the Lower Reuterskioldfjellet Sandstone, but extends up into the Lower Minor Valley Series; Siegenian and Emsian.

**Genus Hymenozonotriletes** Staplin 1960

**Type species.** *Camptozonotriletes verruculatus* Staplin 1960.

**Camptozonotriletes asamithus** sp. nov.

Plate 99, figs. 14, 15

**Diagnosis.** Miospores trilete; proximally flattened, distally convex, amb circular, conformable in outline with the central area. Lasurae indistinct, straight, length two-thirds to full central area radius, accompanied and frequently masked by smooth, often sinuous, elevated lips, individually 3–5 μ wide, 7–12 μ high, extending on to the equatorial flange, and occasionally reaching the equatorial margin. Exine one-layered, coarsely infra-granulate, central area exine 2–10 μ thick, slightly thicker distally, equatorial flange lighter in colour, tapering equatorially; proximal surface laevigate, distal surface densely sculptured with low verrucae and occasional cones, 2–5 μ wide, 2–4 μ high, somewhat reduced and occasionally absent from the equatorial flange. Proximal surface frequently with conspicuous radially directed folds.

**Dimensions.** (Twenty-eight specimens) Overall equatorial diameter 80–108 μ (mean 89 μ) equatorial flange 6–24 μ wide (mean 13 μ).

**Holotype.** Preparation KA 290/4, 530 91-2, K681, N307.
Loca** tus typo**icus. West Lagercrantzberget, Central Dicksonland, Spitsbergen; Upper Mimer Valley Series, Upper Givetian.

**Description.** Holotype diameter 96 μ, equatorial flange 11 μ wide. Laesurae indistinct, lips each 3 μ wide, 7 μ high, extending to equatorial margin. Distal verrucae 3–4 μ in height and basal diameter, only slightly reduced on the equatorial flange.

Remarks. The majority of specimens are only slightly compressed, and as the proximal surface is flat, and the distal surface deeply convex, they are preserved in oblique aspect. The coarsely infra-granulate structure of the distal verrucae often results in their gradual corrosion and specimens with only a slightly undulose distal surface are frequent.

Comparison. Hymenozonotriletes trichomirovi Naumova 1953 (p. 62, pl. 8, fig. 12) is smaller, and has an ornament of spines on the equatorial flange. Cirratrildies ornatus Neves 1960 (p. 269, pl. 33, fig. 3) has a punctate central exine, and an ornament of cones.

**Occurrence.** Upper Mimer Valley Series; Givetian.

**Campto**zonotrietes aliquantus sp. nov.

Plate 100, figs. 1, 2

Diagnosis. Miospores trilete; amb roundly triangular, with moderately to strongly convex sides and well rounded or occasionally acute apices, conformable in outline with the central area. Laesurae distinct to discernible, simple, straight, length two-thirds to full central area radius. Exine two-layered; intine 1–3 μ thick, infra-punctate, often slightly separate from the exoexine and usually distinct; exoexine homogeneous to infra-punctate extending beyond the intine as a membranous flange. Proximal surface laevigate, distal central area comprehensively sculptured with high, narrow muri 1–3 μ wide, which frequently anastomose to form an imperfect reticulum; on the equatorial flange, the muri are somewhat lower, and are radially directed, occasionally extending to the equatorial margin. Major compressional folding frequent, the intine is sometimes folded independently of the exoexine. All specimens are slightly corroded.

Dimensions. (Fifteen specimens) Diameter of exoexine 57–97 μ (mean 76 μ); diameter of intine 40–74 μ (mean 55 μ); equatorial flange 9–16 μ (mean 12 μ).

Holotype. Preparation KA 281/2, 374 96-4, K850, N589.

Loca** tus typo**icus. Estheriahaugen, Central Dicksonland, Spitsbergen; Emsian.

**Description.** Holotype roundly triangular, diameter of exoexine 80 μ, of intine 50 μ, equatorial flange 10–12 μ wide. Laesurae indistinct, only one laesa clearly seen. Intine 3 μ thick, unfolded; distal exoexine with an imperfect reticulum centrally, muri slightly corroded; radially directed muri do not reach the equatorial margin of the flange. One major distal fold.

Remarks. The radially directed muri on the equatorial flange are an easily recognizable feature of this species. Campto**zonotriletes aliquantus sp. nov. is included in this genus and not in Cirratrildies Wilson and Coe 1940, on the basis of the very prominent distal sculpture.

**Occurrence.** Reuterskioldfjellet Sandstone, and Lower Mimer Valley Series; Siegenian to Lower Eifelian.
Emended diagnosis. Miospores trilete; amb circular, subcircular to subtriangular. Lascureae usually long, simple, or accompanied by lips. Exine one- or two-layered, acutate, laevigate, or punctate; distally patinate. The patina may be of uniform thick-ness, or thickest in the distal polar region.

Type species. Archaeozonotriletes variabilis Naumova 1953, p. 30, pl. 2, fig. 12 (designated by Potonié 1958, p. 28).

Other species. The following species can probably be included within Archaeozonotriletes (Naumova) emend.


Discussion. The type species selected by Potonié 1958, is somewhat atypical amongst the large number of species recorded within Archaeozonotriletes by Naumova (1953). More typical, are thick-walled apiculate forms, which have an intexine partly separated from the exocine; many of these latter species, however, can be included within Gemmospora Balme 1962. Potonié 1958 (p. 28) interpreted the construction of A. variabilis as an irregular cingulum. Evidence from the Spitsbergen specimens, however, shows that A. variabilis has a very thick distal patina, and therefore is frequently preserved in oblique aspect, thus giving the impression of an irregular cingulum.

Comparison. The validation of Archaeozonotriletes by Potonié 1958, precedes by one month the erection of Tholiosporites Butterworth and Williams 1958. In Tholiosporites, however, the patina is thickest in the equatorial region, and is, according to Butterworth and Williams 1958 (p. 382) closely related to Densosporites and Amalitsporites; whereas the uniform or distal polar thickened patina of Archaeozonotriletes shows little constructive similarity to Densosporites. Also in Tholiosporites, the patina appears to end abruptly on the proximal area, whereas in Archaeozonotriletes, the exine gradually thins over the proximal surface.

Archaeozonotriletes variabilis (Naumova) emend.

Plate 100, figs. 3-6

Emended diagnosis. Miospores trilete, amb circular to subcircular, conformable with the central area outline. Lascureae straight, length three-quarters to full central area radius. Exine homogeneous, laevigate to finely punctate, proximally 1-5-4 µ thick; distally strongly patinate, 5-23 µ thick.
Dimensions. (Nineteen specimens) Equatorial diameter 42–60 μ (mean 53 μ); polar diameter 49–74 μ (mean 61 μ).


Description. (From the illustration in Naumova 1953, pl. 2, fig. 12.) Holotype diameter in oblique aspect 50 μ. Lasiure simple, straight, length equal to full central area radius exine patinate, proximal oblique aspect 6 μ, distal oblique aspect 20 μ.

Remarks. The thickness of the patina is often as much as 30 per cent. of the total polar diameter (Pl. 100, fig. 4). In well-preserved specimens, the punctate nature of the exine is not always obvious, whilst in poorly preserved specimens the punctae are clearly seen (Pl. 100, fig. 5). Spores with a thicker distal hemisphere, are common both in Devonian samples from Melville Island, Arctic Canada, McGregor 1960 (p. 38) and from Spitsbergen. It is quite possible that some of the species included within the genus Stenozoonostriletes by many Russian authors, may in fact possess a patina. Specimens in oblique aspect are the most informative for distinguishing species of Archaeozoonostriletes from thick-walled Punctatisporites, and Stenozoonostriletes. Russian authors who use the term 'otorochka', appear to use it both for equatorial structures and normal exine thickness.

Comparison. Tholisporites tenius McGregor 1960 (p. 38, pl. 13, fig. 9) has a proximal membranous veil and a thinner patina. T. scoticus Butterworth and Williams 1958 (p. 382, pl. 3, figs. 48–50) is smaller, and the patina has its greatest thickness equatorially. Trematozoonostriletes irregularis (Andrejeva, in Lubier and Waltz 1941) Ishcheko 1959 (p. 79, pl. 9, fig. 116) appears very similar, but the punctae are confined to the inner margin of the patina. Stenozoonostriletes fixus Ishcheko 1952 (p. 56, pl. 16, fig. 141) with its punctate exine, appears to be similar to poorly preserved specimens of A. variabilis (Naumova), but is cingulate rather than patinate.

Occurrence. Upper Mimer Valley Series; Givetian.

Archaeozonotriletes sarus sp. nov.

Plate 100, fig. 7

Diagnosis. Miospores trite; amb circular. Laesurae short, distinct, length ½–⅓ spore radius, accompanied at least in part by narrow lips, individually 1 µ or less wide, the laesurae often extend equatorially beyond the lips. Exine infra-punctate, laevigate; proximally 2–3 µ thick, distal surface slightly patinate, 3–5 µ thick.

Dimensions. (Twenty-five specimens) Equatorial diameter 42–57 µ (mean 50 µ).

Holotype. Preparation KA 261/1, 324 103-2, K891, N315.

Locus typicus. North Mimerdale, Central Dicksonland, Spitsbergen; Fiskelfota Formation, Givetian.

Description. Holotype diameter 56 µ. Laesurae approximately half spore radius, lips individually 0.5 µ wide, length one-third spore radius. Proximal oblique aspect 2.5 µ, distal oblique aspect 4.5 µ.

Comparison. Trematozonaltriletes irregularis (Andreyeva, in Luber and Waltz 1941) Ishchenko 1958 (p. 79, pl. 9, fig. 116) is smaller, has longer laesurae and a thicker patina. Thollisporites tenus McGregor 1960 (p. 38, pl. 13, fig. 9) has simple laesurae and a thin membranous proximal surface. T. densus McGregor 1960 (p. 37, pl. 13, figs. 6, 7) has longer, simple laesurae, a thicker patina and a proximal membranous veil. A. variabilis (Naumova) emend. has longer, simple laesurae, and a thicker patina.

Occurrence. Upper Mimer Valley Series; Givetian.

Archaeozonotriletes columbus sp. nov.

Plate 100, figs. 8–10

Diagnosis. Miospores trite; amb circular, subcircular to oval. Laesurae simple, straight, length three-quarters to full central area radius. Exine thick, homogeneous to infra-granulate, finely to coarsely punctate; proximally 4–10 µ thick, distally patinate 8–28 µ thick.

Dimensions. (Forty specimens) Equatorial diameter 76–145 µ (mean 107 µ).

Holotype. Preparation KA 278/1, 276 101-8, K855, N316.

Locus typicus. Estheriahaug, Central Dicksonland, Spitsbergen; Plantsklofta Sandstone, probably Upper Givetian.

Description. Holotype 116 µ, laesurae extend full central area radius. Proximal oblique aspect 9 µ, distal oblique aspect 21 µ.

Remarks. The section (Plate 100, fig. 9) clearly demonstrates the overall thickness of the exine, together with the thickened distal hemisphere. Corrosion of the exine results in an increase in the diameter of the punctae and more drastically in their fusion.

Comparison. Thollisporites punctatus McGregor 1960 (p. 38, pl. 13, fig. 10) is somewhat smaller, and has the suggestion of a thin proximal membrane. Archaeozonotriletes variabilis (Naumova, p. 30, pl. 2, fig. 12) emend. is smaller, and in relation of its proximal hemisphere, is more strongly patinate. A. viiex Chibrikova 1959 (p. 69, pl. 10, fig. 4) has according to Chibrikova, a tuberculate ornament, though it would appear from the
Illustration to be foveo-reticulate, rather than punctate. *Foreoosporites pertusus* Vigran 1964 (p. 18, pl. 4, figs. 3, 4; pl. 5, figs. 1, 2e–d) is clearly similar, but although the thickness of the exine varies from 4–17 μ, Vigran gives no indication that this species is patinate.

**Occurrence.** Upper Miner Valley Series; Givetian.

*Archaeozonotriletes meandricus* sp. nov.

Plate 100, figs. 13, 14

**Diagnosis.** Miospores trilette, amb circular. Laesurae straight, length \( \frac{1}{4} - \frac{3}{4} \) spore radius, accompanied by distinctive, smooth, sinuous, elevated lips, which increase markedly in width equatorially (total width at polar end 4–8 μ, at equatorial end 21–26 μ), length \( \frac{1}{4} - \frac{3}{4} \) spore radius. Exine probably one-layered, 4–9 μ thick equatorially and distally, thinning proximally, coarsely infra-granulate, laevigate (punctate in corroded specimens). Contact areas depressed, radial diameter 26–50 μ, bounded by distinct, low, curvartual ridges.

**Dimensions.** (Eighteen specimens) Equatorial diameter 82–173 μ (mean 117 μ).

**Holotype.** Preparation KA 209/2, 357 88-6, K519, N316.

**Locus typicus.** West Odellfjellet, North Dicksonland, Spitsbergen; Lower Miner Valley Series, Lower Eifelian.

**Description.** Holotype 137 μ. Laesurae straight, lips totalling 5 μ wide proximally, 24 μ wide equatorially, length two-thirds spore radius, extending beyond the contact areas. Radial diameter of contact areas 40–42 μ.

**Comparison.** The very distinctive sinuous lips which increase in thickness equatorially, separate *A. meandricus* sp. nov. from other laevigate, patinate species.

**Occurrence.** Upper Reuterskioldfjellet Sandstone, and Lower Miner Valley Series; Emsian and Eifelian.

*Genus Tholispores* Butterworth and Williams 1958

**Type species.** *Tholispores scoticus* Butterworth and Williams 1958.

*Tholispores ancylus* sp. nov.

Plate 101, figs. 1–7

**Diagnosis.** Miospores trilette; amb subcircular to roundly triangular, with convex sides and broadly rounded apices, occasionally oval. Laesurae straight, length \( \frac{1}{4} - \frac{3}{4} \) spore radius, rarely accompanied by lips. Exine two-layered; the inner layer (? intexine) 2–5 μ thick, homogeneous, proximally minutely granulate, distally laevigate (seen only when the outer layer is absent); outer layer (?) exoexine) laevigate, patinate, equatorially 4–18 μ wide, decreasing in thickness towards the distal pole, extends proximally only a short distance, its maximum extension being in the radial regions. The outer patinate layer is corroded in all specimens, and probably because of its structure, corrodes in a constant pattern, giving the spores a 'sculptured' appearance. Equatorially the corroded patina appears as large broadly rounded segments, and distally as irregular, partly anastomosing ridges, often radially directed.
Dimensions. (Twenty-one specimens) Overall equatorial diameter 80–116 μ (mean 94 μ). Diameter of the inner layer 64–100 μ (mean 78 μ). Maximum proximal enclosure of the inner layer by the outer layer, radially 18 μ, inter-radially 6 μ.

Holotype. Preparation KA 240/2, 50 2 100 6, K582, N321.

Locus typicus. Manchesterbreen Spur, Central Dicksonland, Spitsbergen; Lower Mimer Valley Series; Upper Emsian.

Description. Holotype roundly triangular, with broadly rounded apices and convex sides, overall diameter 96 μ, diameter of inner layer 80 μ. Laeurae indistinct, length approximately one-third of spore radius. Inner layer 2 μ thick, outer layer equatorially approximately 16 μ thick, absent from the distal pole, where the laevigate inner layer can be seen. Proximal overlap of the outer layer 12 μ radially, 3 μ inter-radially.

Remarks. The author regards the 'sculpturing' as the effect of corrosion of a finely punctate exine rather than a true sculptural pattern primarily for two reasons. The considerable variation in the size of the 'sculptural' elements, being much larger and less numerous in the best preserved specimens (Pl. 101, fig. 5) suggesting further breakdown of the exinal layer with increased corrosion. True sculptural elements in miospores are frequently more homogeneous than the exine which supports them, and with corrosion they tend to become shorter and rounder, rather than breaking up into more numerous elements as in Tholiiosporites ancyhus sp. nov. If these were true sculptural elements, it is unlikely that they would extend completely to the base of the outer exinal layer, as demonstrated in the sections (Pl. 101, figs. 3, 4).

The corrosion pattern occurs in all specimens, and is a morphological feature easily recognizable, and is here included in the diagnosis. Sections (Pl. 101, figs. 3, 4) show the distal and proximo-equatorial extension of the outer layer. The outer layer occasionally breaks away from the inner layer.

Occurrence. Dicksonfjorden Sandstone, Reuterskioldjellet Sandstone, and Lower Mimer Valley Series; Emsian and Eifelian.

Genus Cymbosporites gen. nov.

Type species. Cymbosporites cyathus sp. nov.

Diagnosis. Miospores trilete; amb circular, subcircular, to roundly triangular. Laeurae long, usually accompanied by lips. Exine thin proximally, equatorially and distally patinate, the patina of even thickness, or with its greatest thickness in the distal polar region. Patina variably sculptured with cones, spines, and granules.

Comparison. Archaeozonotrilites (Naumova) emend., has a laevigate or punctate patina. Tholiiosporites Butterworth and Williams 1958 has its greatest thickness equatorially, and is laevigate or with very small sculptural elements.

Derivation of name: L. cymba (Gr. kymbe)—cup, bowl.

Cymbosporites cyathus sp. nov.

Plate 101, figs. 8–11

Diagnosis. Miospores trilete; amb subcircular to roundly triangular with convex sides and broadly rounded apices, conformance with the central area outline. Laeurae
straight often indistinct, extending full central area radius, accompanied by smooth, elevated lips, individually 0.5–3 μ wide, 2–5 μ high. Exine proximally 1–3 μ thick, equatorially and distally patinate, 8–12 μ thick, homogeneous to finely infra-granulate. Proximal surface laevigate; patina supporting a variable concentration of cones, 2–5 μ wide, 1–5 μ high, often supporting a small apical spine; where densely packed, the cones have polygonal bases. Arcuate folding of the proximal exine at the central area margin is very common.

Dimensions. (Twenty-four specimens) Equatorial diameter 53–80 μ (mean 63 μ).

Holotype. Preparation KA 287/2, 55:2 94-0, K846, N326.

Locus typicus. Estheriahaugen, Central Dickeonland, Spitsbergen; Estheriahaugen Formation, Givetian.

Description. Holotype subcircular, diameter 61 μ. Laesurae indistinct, accompanied by narrow lips, individually 0.5 μ wide. Exine very thin proximally, patina equatorially 12 μ thick; patina densely covered with cones, 3–5 μ wide, 2–5 μ high, often with polygonal bases.

Remarks. The very thin proximal exine often sags into the ‘cup-shaped’ patina, resulting in arcuate folding along the central area margin.

Comparison. It is difficult to make exact comparisons with Russian species of similar appearance in proximo-distal aspect; unless mentioned in the description, or illustrated in oblique aspect, these species may appear cingulate. Many of the Russian species may in fact be patinate rather than cingulate. Archaeozonotriletes fanenensis Naumova 1953 (p. 117, pl. 17, figs. 31–34) is probably of similar construction, but is smaller, and has lips which extend on to the thicker equatorial exine. A. pastulatus Naumova 1953 (p. 35, pl. 3, fig. 10) is smaller, lacks lips, and has a sparser ornament. A. decorus Naumova 1953 (p. 35, pl. 3, figs. 11, 12) lacks lips, and the equatorial exine is thicker. Lepidozonotriletes subbisiquetras (Luber, in Luber and Waltz 1941) Luber 1955 (pl. 5,

EXPLANATION OF PLATE 101

All figures × 500, unless otherwise stated; from unretouched negatives.

Figs. 1–7. Tholosporites ancylius sp. nov., 1, 2. Holotype, proximal and distal surfaces respectively, the proximal view shows the extent of the outer layer; KA 240/2, 50:2 100-6, K852, N321. 3. Section showing extent of the outer layer; KA 274/8, 24:2 94-8, K872, N322. 4. (×1000) the same. 5. corrosion pattern; KA 202/3, 30:6 92-2, K555, N332. 6. Pseudo-ornament of verrucae formed by corrosion of the patina; KA 271/3, 23:8 87-8, K897, N324. 7. Corrosion pattern, much of the outer layer has corroded away; KA 274/6, 52:7 104-2, K872, N325.

Figs. 8–11. Cymbosporites cyhalus gen. et sp. nov. 8, 9. Holotype, proximal and distal surfaces respectively; KA 287/2, 55:2 94-0, K846, N326. 10. Proximal oblique aspect, showing patina and distal sculpture; KA 293/1, 42:5 94-5, K556, N327. 11. Proximal surface; KA 243/3, 23:8 96-7, K767, N332.

Figs. 12–20. Chelinospora concina gen. et sp. nov. 12, 13. Holotype, proximal and distal surfaces respectively; KA 293/1, 31:7 91-2, K556, N331. 14. Paratype, proximal oblique aspect, showing patina; KA 286/1, 50:3 105-0, K773, N332. 15, 16. Specimens showing proximally reduced sculpture; KA 243/2, 35:6 106-3, K767, N333, and KA 243/2, 55:0 90-0, K767, N334 respectively. 17. Distal surface; KA 243/1, 54:8 96-5, K767, N335. 18. Lateral view showing very thick corroded patina; KA 293/1, 26:9 90-7, K556, N336. 19, 20. Specimens showing corrosion of the patina; KA 243/2, 24:8 103-5, K767, N337, and KA 293/1, 35:4 89-7, K556, N338 respectively.
K. C. Allen: Lower and Middle Devonian Spores

Figs. 94 and 95) is smaller, and is probably cingulate. Lycospora magnifica McGregor 1960 (p. 35, pl. 12, fig. 5, pl. 13, figs. 2-4) is considerably larger, and has some fusion of the basal ornament.

Occurrence. Upper Miner Valley Series; Givetian.

Cymbosporites catillus sp. nov.

Plate 100, figs. 11-12

Diagnosis. Miospores trilete; amb circular, subcircumace to roundly triangular, with moderately convex sides and broadly rounded apices, conformable with the central area outline. Laesurae straight, often indistinct, extend almost to the central area margin, accompanied by smooth, slightly elevated lips, individually 0.5-2 μ wide. Exine proximally 1-2 μ thick, distally and equatorially patinate, 6-9 μ thick, homogeneous. Proximal surface laevigate, patina sculptured with densely packed granules or small verrucae, 1-5 μ or less in height. Frequent arculate folding of the thin proximal exine occurs at the central area margin.

Dimensions. (Thirty-five specimens) Equatorial diameter 34-50 μ (mean 40 μ).

Holotype. Preparation KA 267/2, 34/1 94/2, K846, N329.

Locality type. Estheriahaugen; Central Dicksonland, Spitsbergen; Estheriahaugen Formation, Givetian.

Description. Holotype roundly triangular, with convex sides and broadly rounded apices, diameter 44 μ. Laesurae indistinct, accompanied by lips, individually 0.5 μ wide. Exine very thin proximally, equatorial patina 7 μ thick, patina densely covered with granules.

Remarks. Specimens in oblique aspect clearly demonstrate the nature of the uniform distal patina. As in Cymbosporites cyanus sp. nov. the thin proximal surface sags into the ‘cup-shaped’ patina, resulting in arculate folding of the proximal surface at the central area margin, which tends to support the thin proximal wall at this point.

Comparison. Cymbosporites cyanus sp. nov. (Pl. 101, figs. 8-11) is larger, and has an ornament of cones. Several Russian species included within Archaeozonotriletes and Retuporitriletes have a similar proximo-distal appearance, descriptions make it difficult to interpret their construction, which may be patinate, cingulate, or thick-walled apiculate. Below are listed species with somewhat similar proximo-distal appearance, size range, and sculptural elements, which may prove to have a patinate construction similar to C. catillus sp. nov.: Retuporitriletes verrucosis Kedo 1955, p. 22, pl. 1, fig. 17.

Archaeozonotriletes basilaris Naumova 1953, p. 81, pl. 13, fig. 16; p. 33, pl. 3, fig. 30; p. 128, pl. 19, fig. 8.

Retuporitriletes accuratus Chibrikova 1959, p. 51, pl. 5, fig. 6.

Archaeozonotriletes subpusillus Chibrikova 1959, p. 61, pl. 8, fig. 2.

Archaeozonotriletes truncatus Naumova 1953, p. 34, pl. 3, fig. 7.

Occurrence. Upper Miner Valley Series, particularly common in shale samples; Givetian.
Type species. *Chelinospora concinna* sp. nov.

*Diagnosis.* Miospores trilet; amb circular to roundly triangular. Laesurae distinct, usually long, simple or accompanied by narrow folds. Exine one or two-layered, aciculate, thin proximally, equatorially and distally patinate, the patina may be of even thickness, or with its maximum thickness either equatorially or distally. Patina reticulate or foveoreticulate, contact areas laevigate or with a reduced sculpture of muri, granules, and cones.

*Comparison.* Differs from other patinate genera in having a reticulate or foveoreticulate patina.

*Derivation of name.* Gr. Chelinos—netted.

*Chelinospora concinna* sp. nov.

Plate 101, figs. 12-20

*Diagnosis.* Miospores trilet; amb circular to subcircular, conformable with the central area outline. Laesurae distinct to discernible, straight, length three-quarters to full central area radius, simple or accompanied by low, smooth, narrow lips, less than 1 μ wide. Exine homogeneous to infra-punctate, equatorially 3-12 μ thick (including muri), proximal oblique aspect 2-5 μ thick, distal surface variably patinate 5-32 μ thick, the patina is usually thickest in the distal polar region, and occasionally extends on to the proximal surface. Contact areas support a sparse ornament of small verrucae or granules, 2 μ or less in width and height, and less frequently rugulae or muri, 4-6 μ long, 0.5-2 μ wide. Patina coarsely reticulate, muri 0.5-2 μ wide, 1-4 μ high, enclosing large polygonal to irregularly rounded lumina 5-22 μ in longest diameter.

*Dimensions.* (Thirty specimens) Equatorial diameter 32-54 μ (mean 41 μ), polar diameter 36-74 μ.

*Holotype.* Preparation KA 293/1, 317-91/2, K556, N331.

*Paratype.* Preparation KA 286/1, 503-105/0, K773, N332.

*Locus typicus.* North ridge of Kinanderfjellet, Central Dicksonland, Spitsbergen; Upper Mirrion Valley Series, Givetian.

*Description.* Holotype subcircular, equatorial diameter 48 μ. Laesurae straight, length three-quarters central area radius, accompanied by narrow lips. Exine 6-11 μ thick equatorially (including muri), patina thins abruptly on the proximal surface. Contact areas with a sparse ornament of verrucae and granules 2 μ or less wide, distal muri 1 μ or less wide, 2 μ high, lumina 10 to 22 μ in longest diameter.

Paratype in oblique aspect, proximally 2-3 μ thick, distally 12-13 μ thick. Laesurae straight, length two-thirds spore radius. Muri 1 μ wide, approximately 1 μ high, lumina 10-24 μ wide. Reduced muroid ridges proximally.

*Remarks.* There is considerable variation in width of the patina, thickness of muri and size of lumina. Corrosion of the reticulum and patina is common, giving spores an unusual appearance (PL 101, figs. 19, 20).
Comparison. Koxiosporites reticulatus Vigran 1964 (p. 22, pl. 1, figs. 10-12; pl. 2, figs. 8, 9) is similar but has a laevigate proximal surface. Verucosisporites variabilis McGregor 1960 (p. 30, pl. 11, fig. 15) resembles ill-preserved specimens, in which the patina has broken down, and the variable ornament recorded, including large flat-topped elements, may be the result of a corroded patina. However, there is no mention by McGregor of any reticulate sculpture. Archaeosporotriletes strangulatus Naumova 1953 (p. 73, pl. 11, figs. 22, 23) is subtriangular, has shorter laesurae, is proximally laevigate, and there is no mention of variable exine thickness.

Occurrence. Mimer Valley Series; Givetian and probable Upper Eifelian.

**Chelinospora ligurata** sp. nov.

Plate 102, figs. 1-7

**Diagnosis.** Miospores trilete; amb circular to roundly triangular, with convex sides and broadly rounded apices. Laesurae simple, straight, length three-quarters to full central area radius. Exine at least in some specimens two-layered; intine 1–2 \( \mu \) thick, homogeneous; exoexine homogeneous to infra-punctate, proximally thin, distally patinate 10–21 \( \mu \) thick (including muri), maximum thickness either equatorially or in the distal polar region; the patina occasionally extends on to the proximal surface, where it may thin gradually or abruptly. Proximal surface laevigate or with a sparse ornament of small verrucae or cones, 2 \( \mu \) or less in height and basal diameter; patina with a high indistinct reticulum, muri 1–3 \( \mu \) wide, 2–7 \( \mu \) high, lumina 4–9 \( \mu \) wide.

**Dimensions.** (Thirty specimens) Equatorial diameter 42–70 \( \mu \) (mean 55 \( \mu \)).

**Holotype.** Preparation KA 243/2, 53-5 91-0, K767, N39.

**Locus typicus.** East Munindalen, Central Dicksonland, Spitsbergen; Planteklofta Conglomerate, probably Upper Givetian.

**Description.** Holotype roundly triangular, diameter 58 \( \mu \). Laesurae equal full central area radius. Intine indistinct; exoexine proximal surface sparsely sculptured with small cones and verrucae 1–2 \( \mu \) in height and basal diameter, equatorially patina 10 \( \mu \) wide (excluding muri), muri 2–3 \( \mu \) wide, 5–6 \( \mu \) high; distal reticulate pattern indistinct.

**Remarks.** Corrosion in the majority of specimens results in both the reticulum and the patina breaking down, giving the spore a very distinctive 'sculptured' appearance of high, close bacula (Pl. 102, figs. 6, 7).

Comparison. Chelinospora concinna sp. nov. (Pl. 101, figs. 12–20) has a coarser, lower reticulum.

**Occurrence.** Fiskeklofta Formation, Plantergygen Sandstone, and Planteklofta Conglomerate; probably Upper Givetian.

**Chelinospora perforata** sp. nov.

Plate 102, figs. 8-10

**Diagnosis.** Miospores trilete; amb roundly triangular, to subcircular, conformable with the central area outline. Laesurae straight, length three-quarters to full central area radius, accompanied and frequently obscured by smooth, narrow lips, individually 0–5–
2 μ wide. Exine infra-granulate, thin proximally, distally patinate, equatorially 11–17 μ thick, gradually thinning towards the distal pole. Contact areas laevigate, patina foveo-reticulate, fovea 2–6 μ in longest diameter, circular, oval, or occasionally irregular, 1–5 μ apart.

Dimensions. (Sixteen specimens) Equatorial diameter 58–86 μ (mean 71 μ).

Holotype. Preparation KA 272/2, 30° 97–6, C626, N344.

Locus typicus. Huginaspikardet, Central Dicksonland, Spitsbergen; Lower Minner Valley Series, Lower Eifelian.

Description. Holotype rounded triangular, diameter 58 μ. Laesurus length two-thirds of spore radius, lips each 1–5 μ wide. Equatorial patina 11 μ thick. Fovea 2–5 μ in longest diameter.

Comparison. Perforosporites robustus Scott and Rouse 1961 (p. 978, pl. 113, figs. 1–6, pl. 114, figs. 1–5) is smaller, lacks lips, is frequently sculptured with papillae, and lacks a patina.

Occurrence. Upper Reutenklofdjeflet Sandstone, and Lower Minner Valley Series; Emsian and Eifelian.

Subsupeturina perinotrilites (Erdtman) Dettman 1963

Genus AURORASPORA Hoffmeister, Staplin, and Malloy

Type species. Auroraspora solisoris Hoffmeister, Staplin, and Malloy 1955.

Auroraspora macromanifestus (Hacquebard) Richardson 1960

Dimensions. (Six specimens) Diameter of exoexine 192–216 μ; diameter of intexine 107–26 μ.

Occurrence. Fiskekeldja Formation and Planteryggen Sandstone; Upper Givetian.

Genus PEROTRILITES (Erdtman) ex Couper 1953

Type species. Perotrilites granulatus Couper 1953.

EXPLANATION OF PLATE 102

All figures × 500 unless otherwise stated; from untouched negatives.


Discussion. The species listed below are included within Perotritiles (Ertdman) ex Couper 1953, on the basis that they possess a thin homogeneous or finely infra-granulate outer layer, in comparison with the much thicker infra-granulate inner layer. As the exact nature of this outer layer is not known (it may in fact be an outer exooxine layer), the term perine is not used, and the terms inner and outer sculptine (Ertdman 1952, p. 468) are employed for these two layers. Where an intine is also demonstrated, the term selerine (Ertdman 1952, p. 468) is used for all three layers. The cavity occurs between the outer and inner sculptine, and not between the inner sculptine and intine. Sectioned species included in Grandispora (Pl. 103, fig. 9) and Calypiosporites (Pl. 103, fig. 11), show an exoexine and intine of approximately equal thickness.

**Perotritiles eximius** sp. nov.

Plate 102, figs. 11–13

**Diagnosis.** Miospores trilete; cavate; amb and inner sculptine outline convexly triangular to circular. Laesurae straight, short, length \( \frac{1}{2}-\frac{2}{3} \) central area radius, often accompanied and exceeded equatorially by triradiate folds of the outer sculptine, total width 4–12 \( \mu \). Exine three-layered; intine thin, 0.5–1.5 \( \mu \), homogeneous, closely appressed to the inner sculptine, and seen only in sections; inner sculptine 4–9 \( \mu \) thick, homogeneous to finely infra-granulate, laevigate; outer sculptine 1–2.5 \( \mu \) thick, homogeneous. Proximal surface laevigate, distal surface supporting a variable ornament of cones and occasional spines, 3–7 \( \mu \) wide, 4–8 \( \mu \) high, the majority of cones supporting a smaller apical cone or bifurcate-tipped spine. Proximal surface often with numerous minor folds.

**Dimensions.** (Forty-four specimens) Diameter of outer sculptine 80–160 \( \mu \); diameter of inner sculptine 52–105 \( \mu \) (mean 90 \( \mu \)).

**Holotype.** Preparation KA 295/M4, 49.2 961, K922, N446.

**Locus typicus.** South Minerdalen, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Emsian.

**Description.** Holotype roundly triangular, outer sculptine diameter 136 \( \mu \); inner sculptine diameter 102 \( \mu \). Laesurae approximately half inner sculptine radius, elevated lips 11 \( \mu \) high, length four-fifths spore radius. Inner sculptine 9 \( \mu \) thick, outer sculptine 2 \( \mu \) thick. Distal cones 3–6 \( \mu \) wide, 3–8 \( \mu \) high, somewhat smaller on the outer sculptine extension.

**Remarks.** The section (Pl. 102, fig. 12) clearly shows the three-layered selerine, composed of an intine and an inner and outer sculptine. Although the outer sculptine is not diaphanous, the thick inner sculptine is undoubtedly an exooxinal layer, and the species is included within Perotritiles (Ertdman) ex Couper 1953, on the basis of having a much thinner layer outside this exooxinal layer.

**Occurrence.** Dicksonfjorden Sandstone, Upper Reuterskioldfjellet Sandstone, and Lower Minerdalen Valley Series; Emsian and Eifelian.

**Perotritiles ergatus** sp. nov.

Plate 102, figs. 16–20

**Diagnosis.** Miospores trilete; cavate; amb and inner sculptine outline convexly triangular to circular. Laesurae straight, length \( \frac{1}{3}-\frac{2}{3} \) central area radius, usually obscured by
triradiate folds of the outer sculptine, totalling 1–2 μ wide, 2–7 μ high, extending to the equatorial margin. Inner sculptine inter-radially 6–10 μ thick, radially 4–7 μ thick, coarsely infra-granulate, laevigate; outer sculptine 1–2 μ thick, homogeneous to finely infra-granulate, extends 4–14 μ beyond the inner sculptine, proximally laevigate, distally supporting a sparse ornament of cones, 1–3 μ in height and basal diameter. Distal surface frequently with small muroid folds, 1–3 μ wide, occasionally anastomosing as an imperfect reticulum.

Dimensions. (Thirty-two specimens) Diameter of outer sculptine 71–124 μ (mean 91 μ); diameter of inner sculptine 60–108 μ (mean 79 μ).

Holotype. Preparation KA 261/4, 53:0 98–5, K891, N349.

Locus typicus. Estheroihaugen, Central Dicksonland, Spitsbergen: Fiskeklofiøa Formation, Givetian.

Description. Holotype amb and inner sculptine rounded triangular, outer sculptine diameter 84 μ, inner sculptine diameter 69 μ. Laesurae length three-quarters inner sculptine radius. Inner sculptine 4 μ thick radially, 8 μ thick inter-radially, outer sculptine 1–2 μ thick. Distal surface with occasionally anastomosing muroid folds.

Remarks. Sections (Pl. 102, figs. 19, 20) show clearly the cavate nature of the sculptine, the thick infra-granulate inner sculptine, and the triradiate folds. It is not certain from the strongly compressed sections whether an intexine is present as seen in Perotrillites eximius sp. nov. (Pl. 102, fig. 12).

Comparison. Perotrillites eximius sp. nov. (Pl. 102, figs. 11–13) has much larger sculptural elements, and a uniformly thick inner sculptine. Diaphanospore sp. Balme and Hassell 1962 (p. 22, pl. 4, figs. 8, 9) is smaller, and has a laevigate outer sculptine. Archaeozootrillites arduas Archangelskaya 1963 (p. 23, pl. 8, figs. 1–5) has a thicker distal surface, and the muroid folds are in the contact areas and not proximo-equatorial and distal.

Occurrence. Dicksonfjorden Sandstone, Upper Reuterskioldefjellet Sandstone, and Mine Valley Series; Emsian to Givetian.

Perotrillites pannosus sp. nov.

Plate 102, figs. 14, 15

1964 Perotrillites cf. perimitus Vigran, p. 19, pl. 3, figs. 7, 8.

Diagnosis. Miospores trilete; cavate amb and inner sculptine outline convexly triangular to circular. Laesurae straight, 3–5 central area radius, usually masked by triradiate folds of the outer sculptine, totalling 2–3 μ wide, 2–5 μ high. Inner sculptine 3–5 μ thick, infra-granulate, laevigate; outer sculptine 1–2 μ thick, homogeneous, loose-fitting. Contact areas laevigate, proximo-equatorial and distal surfaces with a distinct pattern of muroid folds, 0.5–2 μ wide, which may be arcuate, or anastomosing to form an imperfect reticulum. Distal surface with a sparse ornament of small cones, 1–2.5 μ in height and basal diameter, the cones frequently support a small apical spine.

Dimensions. (Forty-one specimens) Diameter of outer sculptine 40–74 μ (mean 62 μ); diameter of inner sculptine 37–64 μ (mean 54 μ).

Holotype. Preparation KA 243/1, 29-2 96–6, K767, N353.

Locus typicus. East Mundidalen, Central Dicksonland, Spitsbergen; Planteklofia Conglomerate, probable Upper Givetian.
Description. Holotype amb and inner scultpina outline subcircular, outer sculpture diameter 63 μ, inner sculpture diameter 36 μ. Laureae straight, length half inner sculpture radius, triadiate folds 1:3:2 outer sculpture radius. Muroid folds on proximo-equatorial and distal surfaces, forming an imperfect reticulum. Distal cones 1–2 μ wide, 1–2.5 μ high.

Comparison. Perotritiles bifurcatus Richardson 1962 (p. 174, pl. 25, figs. 4, 5, text-fig. 3) is considerably larger, has a larger ornament of spines and the outer sculpture is not folded in a definite pattern. Perotritiles sp. McGregor 1960 (p. 35, pl. 12, fig. 8) has a granulate outer sculpture. Diasparispora riciniata Balme and Hassell 1962 (p. 22, pl. 4, figs. 1–4; text-fig. 5) has a laevigate outer sculpture, and a cingulate inner sculpture. Perotritiles ergatis sp. nov. (Pl. 102, figs. 16–20) is larger and lacks a uniformly thick inner sculpture.

Occurrence. Dicksonfjorden Sandstone, Upper Reuterskioldfjellet Sandstone, and Miler Valley Series; Emsian to Givetian.

Genus Grandispora Hoffmeister, Staplin, and Malloy 1955

Type species. Grandispora spinosa Hoffmeister, Staplin, and Malloy 1955.

Grandispora dianphida sp. nov.

Plate IG, figs. 1–6

Diagnosis. Miospores trilete; cavate; amb and intexine outline circular to subcircular. Laureae straight, often indistinct, length three-quarters to full radius of the intexine, accompanied and usually masked by narrow elevated lips, 0.5–2 μ wide, 10–26 μ high, extending on to the exoexinal extension, frequently reaching the equatorial margin and occasionally separating equatorially. Intexine 1–4 μ thick, finely infra-granulate. Exoexine 2–4 μ thick, infra-granulate, proximal surface laevigate, distal surface sculptured with cones and spines of variable shape, 3–6 μ wide basally, 3–10 μ high, the cones are often flask-shaped, and may possess a small bifurcate tip. The cones and spines are often more concentrated on the exoexinal extension.

Dimensions. (Twenty-three specimens) Diameter of exoexine 67–90 μ (mean 75 μ); diameter of intexine 54–66 μ (mean 59 μ).

Holotype. Preparation KA 281/5, 55.3 98.8, K850, N354.

Loca. Esteriahugen, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Emsian.

Description. Holotype circular, exoexine diameter 71 μ, intexine diameter 55 μ. Laureae indistinct, raised lips 1.5 μ wide, 8 μ high, separating equatorially and extending to the equatorial margin. Distal spines and cones 3–5 μ wide, 3–6 μ high; few cones have a small bifurcate tip.

Remarks. Grandispora dianphida sp. nov. resembles species of Calyptosporites Richardson 1962 in having cones and spines with bifurcate tips; but is here assigned to Grandispora Hoffmeister, Staplin, and Malloy on the basis of its smaller size and circular outline.
Comparison. *Hymenozyonotriletes polyacanthus* Naumova 1953 (p. 41, pl. 4, figs. 11, 12) has similar ornament, but appears to possess a bizonate cingulum.

Occurrence. Upper Reatnersklaffjellet Sandstone, and Lower Mimer Valley Series; Emsian and Eifelian.

*Grandispora inculta* sp. nov.

Plate 103, figs. 7-9

Diagnosis. Microspores trilete; cavate; amb and intine outline subcircular to rounded triangular. Laesurae indistinct, length \( \frac{1}{2} \) intine radius, accompanied and frequently masked by smooth, narrow lips, total width 1-4 \( \mu \), 2-6 \( \mu \) high, extending one-third to full radius of the exoexine. Intine 1.5-3 \( \mu \) thick, infra-granulate, laevigate, rarely folded; exoexine 1-3 \( \mu \) thick, homogeneous to infra-granulate, often folded. Proximal surface laevigate, distal surface densely covered with cones 1-2 \( \mu \) in height and basal diameter. Minor folds frequent on the exoexine.

Dimensions. (212 specimens) Diameter of exoexine 51-86 \( \mu \) (mean 70 \( \mu \)); diameter of intine 34-63 \( \mu \) (mean 49 \( \mu \)).

Holotype. Preparation KA 261/4, 39.6 68-8, K891, N359.

Loca typica. Esthariahaugen, Central Dicksonland, Spitsbergen; Fiskekløfta Formation, Givetian.

Description. Holotype amb rounded triangular, exoexine diameter 72 \( \mu \), intine outline subcircular, diameter 42 \( \mu \). Laeuxare indistinct, lips individually 1-1.5 \( \mu \) wide, length of two lips one-third of exoexine radius, the third extending almost to the exoexinal margin. Distal cones 1-2 \( \mu \) in height and basal diameter.

Remarks. The section (Pl. 103, fig. 9) demonstrates the cavate nature of the exine, the approximately equal thickness of the exoexine and intine, and the exclusively distal ornament. The short laeuxare and infra-granulate nature of the intine is well seen in broken specimens or where the exoexine is removed.

Comparison. *Zonotriletes explanatus* Luber, in Luber and Waltz 1941 (p. 10, pl. 1, fig. 4) has 'the entire surface of the exine covered with small tubercles', but is otherwise similar, although it may not be cavate. *Hymenozyonotriletes brevimannus* Naumova 1953 (p. 39, pl. 4, fig. 3) has a verrucose ornament. Spore number 4 Apiculatozonales Group Thompson 1940, figured in Thompson 1952 (p. 10, fig. 14) is larger, and although the exine is clearly two-layered, it appears to have an equatorial flange.

Occurrence. Upper Mimer Valley Series; Givetian.

EXPLANATION OF PLATE 103

All figures \( \times 500 \) unless otherwise stated; from unretouched negatives.

Figs. 1-9. *Grandispora* spp. 1-6. *G. diamphita* sp. nov. 1, 2. Holotype, proximal and distal surfaces respectively; KA 281/5, 55.3 96-8, K880, N354, 3. Proximal surface; KA 281/5, 43.0 100-1, K880, N355, 4. Showing distal arcuate folds; KA 240/1, 39.6 98-7, K882, N356, 5-6. Sections showing raised lips and cavate exine. 5. KA 274/87, 25.6 103-7, K872, N357, 6. (\( \times \) 1000) KA 274/87, 43.4 88-9, K872, N358, 7-9. *G. inculta* sp. nov. 7, Holotype, sectional focus; KA 261/4, 39.6 88-8, K891, N359, 8. Distal surface; KA 261/4, 37.5 98-4, K891, N360, 9. Section showing cavate exine and exclusively distal sculpture; KA 290/S2, 59.3 95-3, K881, N361.

Figs. 10-11. *Calyptospora* protensis (Naumova) comb. nov. 10, distal surface; KA 290/1, 48.4 96-6, K881, N362, 11. Section showing cavate exine and exclusively distal sculpture; KA 290/S2, 34.5 91-6, K881, N363.
Genus Calyptosporites Richardson 1962

Type species. *Calyptosporites velatus* (Eisenack) Richardson 1962.

*Calyptosporites microspinosus* (Richardson) emend. Richardson 1962

1960 *Cosmosporites microspinosus* Richardson, p. 53, pl. 14, figs. 5, 6.
1962 *Calyptosporites microspinosus* Richardson, p. 192.

*Dimensions*. (Fifteen specimens) Diameter of exoexine 216–301 µ (mean 264 µ); diameter of intexine 70–120 µ (mean 100 µ).

*Remarks*. Occasionally one or more of the lips are absent, presumably the result of compression or corrosion. Cone coverage is never dense, but in some corroded specimens as few as two cones are present. None of the Spitsbergen specimens exhibit the bifurcate tips noted by Richardson (p. 53).

*Occurrence*. Fiskeløfta Formation; Givetian.

*Calyptosporites proteus* (Naumova) comb. nov.

Plate 103, figs. 10, 11

1953 *Hymenozonotriletes proteus* Naumova, p. 40, pl. 14, fig. 5.
1955 *Hymenozonotriletes proteus* Naumova var. *eximius* Kedo, p. 31, pl. 4, fig. 3.

*Description of specimens*. Miospores trilete; cavate, amb subtriangular with moderately to strongly convex sides and acute to well-rounded apices, intexine outline roundly triangular to subcircular. Laesurae often indistinct, straight, length half to full intexine radius, usually masked by smooth, elevated lips, individually 2–5–6 µ wide, 4–9 µ high, length half to full exoexine radius. Intexine distinct, 1–4 µ thick, infra-granulate, laevigate; exoexine 2–4 µ thick, infra-granulate. Proximal surface laevigate, distal surface sculptured with cones 3–5 µ wide, 3–7 µ high, the rounded apices frequently supporting a small spine. The ornament is usually sparse, but is occasionally more dense. Distal folding of the exoexine frequent.

*Dimensions*. (Twenty-three specimens) Diameter of exoexine 110–170 µ (mean 144 µ); diameter of intexine 58–100 µ (mean 79 µ).

*Remarks*. Sections demonstrate the cavate nature of the spore, the absence of a limbus, the approximately equal thickness of the two exine layers, and the infra-granulate intexine.

*Comparison. Calyptosporites velatus* (Eisenack) Richardson 1962, p. 192, in Richardson 1960 (p. 52, pl. 14, fig. 4, text-fig. 3) has very similar dimensions, but has an ornament of much smaller cones, which have acute rather than rounded apices. *Hymenozonotriletes ventosus* Kedo 1957 (pl. 3, fig. 1) is much smaller. *Calyptosporites microspinosus* Richardson 1962 (p. 192) in Richardson 1960 (p. 53, pl. 14, figs. 5, 6) is considerably larger (the mean of the Spitsbergen specimens of *C. microspinosus* being over 100 µ greater than the mean of *C. proteus*).

*Occurrence*. Minner Valley Series; Givetian and probably Upper Eifelian.
Calyptosporites optivus (Chibrikova) comb. nov.

Plate 104, figs. 1–4

1959 Archaeosporites optivus Chibrikova, p. 60, pl. 7, fig. 9.
1960 Russtrotrilites sp. Taugourdeau-Lantz, p. 145, pl. 1, fig. 5.
1964 Biharispores spissbergensis Vigran, p. 12, pl. 2, figs. 1–4.

Description of specimen. Megaspores trilette; cavitate; amb and inteixine outline subcircular to roundly triangular, with convex sides and rounded apices. Lenticulae straight, often indistinct, length three-quarters to full inteixine radius, accompanied by smooth, elevated lips, individually 6–17 μ wide, 7–30 μ high, extending on to the exosporal extension, and occasionally on to the equatorial margin. Inteixine 2–5 μ thick, homogeneous, laevigate; exossorxine 3–5 μ thick, infra-granulate. Contact areas laevigate, proximo-equatorial and distal surfaces support an ornament of cones of very variable size and distribution 1–10 μ wide, 2–8 μ high; the ornament may be sparse, or closely packed and with polygonal bases, often supporting a small apicall spine or cone. Arcuate folds 7–20 μ wide are usually present, which separate the raised contact area from the proximo-equatorial region; the inteixine is positioned within this raised central region.

Dimensions. (Forty-five specimens) Diameter of exossorxine 160–384 μ (mean 273 μ); diameter of inteixine 112–230 μ (mean 160 μ).

Remarks. The section (Pl. 104, fig. 4) demonstrates the cavate nature of the spore, but not the proximal arcuate folds. This species is included within Calyptosporites on the basis of its large size, ornament of cones, and approximately equal thickness of the two exine layers. Biharispores Potonié 1956 includes specimens with a very thin, membranous inteixine (mesosporum).

Comparison. Triletes sp. A. Winslow 1962 (p. 38, pl. 19, fig. 10) is clearly very similar, but there is no mention of an inteixine, and the exine is considerably thicker. Biharispores subalpinus McGregor 1960 (p. 33, pl. 11, fig. 16, pl. 12, figs. 1–3) is larger, lacks the prominent arcuate folds and raised contact area, and has a much thinner inteixine.

Occurrence. Upper Mimer Valley Series; Givetian.

EXPLANATION OF PLATE 104

All figures ×500 unless otherwise stated, from unretouched negatives.

Figs. 1–4. Calyptosporites optivus (Chibrikova) comb. nov. 1, (×200) Proximal surface; KA 269/M1, 48:8 104:1, K538, N364. 2, (×200) the same. 3, (×1000) Showing cones with papililate apices; KA 242/M1, 32:7 98:2, K772, N365. 4, Section showing the cavate nature of the exine; KA 203/S2, 50:8 105:1, K555, N366.

Figs. 5–12. Rhodospores spp. 5–8. R. cymatius sp. nov. 5, 6, Holotype, proximal and distal surfaces respectively; KA 274/2, 21:9 104:2, K872, N372. 7, Distal surface; KA 274/2, 51:6 93:5, K872, N373. 8, Section, showing cavate exine and folded exosporus; KA 251/S2, 57:5 88:4, K905, N374. 9–12. R. secalis sp. nov. 9, 10, Holotype, proximal and distal surface respectively; KA 290/2, 38:7 100:0, K681, N369. 11, Section, very compressed; the cavate nature of the exine is not clearly seen; KA 290/S2, 29:8 91:6, K681, N370. 12, Distal surface showing numerous folds; KA 290/4 37:8 100:3, K681, N371.
Calyptosporites indolatus sp. nov.

Plate 106, figs. 1, 2

Diagnosis. Megaspores trilete; cavate; amb irregular, subcircular to roundly triangular, occasionally oval or roundly rectangular. Laesurae straight, length $\frac{2}{3}$–$\frac{3}{3}$ intexine radius, frequently obscured by smooth lips, individually 2–5 $\mu$ wide, extending half to full spore radius. Intexine approximately 6–12 $\mu$ thick, laevigate, outline usually indistinct; exoeine 2–4 $\mu$ thick, infra-granulate, with a sparse distal ornament of cones and spines, 2–10 $\mu$ wide, 5–24 $\mu$ high. Exoeine strongly folded.

Dimensions. (Twenty-seven specimens) Diameter of exoeine 156–540 $\mu$ (mean 290 $\mu$); diameter of intexine 90–278 $\mu$ (mean 155 $\mu$).

Holotype. Preparation KA 235/M1, 45-7 104-1, K590, N367.

Locus typicus. Gonvillebreen–Hortyesbreen Col, Central Dicksonland, Spitsbergen; Lower Minner Valley Series, Lower Eifelian.

Description. Holotype diameter 408 $\mu$, exoeinal extension 98 $\mu$. Laesurae indistinct, elevated lips totalling 7 $\mu$ wide. Distal cones and spines 2–10 $\mu$ wide, 5–24 $\mu$ high. Exoeine with irregular prominent folds.

Remarks. Sections of this species appear to be zonate and prove to be somewhat confusing: evidence from broken and dissected specimens, from excentric intexines, and from independent cross-folding on the exoeinal extension, demonstrate that the spore is clearly cavate. It would appear that specimens are sometimes so compressed, that there has been fusion of the equatorial exoeine; even the spore cavity (Pl. 106, fig. 2) is represented only by a faint line.

Occurrence. Upper Minner Valley Series; Givetian.

Genus Rhabdosporites Richardson 1960

Type species. Rhabdosporites rhagii (Eisenack) Richardson 1980.

Rhabdosporites scannus sp. nov.

Plate 104, figs. 8–12

Diagnosis. Miospores trilete; cavate; amb and intexine outline roundly triangular to circular. Laesurae straight, length two-thirds to full intexine radius, accompanied by low thickened lips, 1–2 $\mu$ wide, frequently extending beyond the laesurae on to the exoeinal extension. Intexine distinct, 1–5–4 $\mu$ thick, homogeneous, laevigate; exoeine 1–5–3 $\mu$ thick, infra-granulate, sculptured with a dense ornament of minute granules. Distal surface with a distinctive, variable distribution of muroid folds, frequently three in number, radially directed and usually situated inter-radially, but occasionally with a more comprehensive pattern. Short minor folds particularly on the equatorial exoeine are common.

Dimensions. (Fifty-eight specimens) Diameter of exoeine 54–119 $\mu$ (mean 82 $\mu$); diameter of intexine 42–84 $\mu$ (mean 60 $\mu$).

Holotype. Preparation KA 290/2, 38-7 100-0, K681, N369.
Locus typicus. West Lagercrantzberget, Central Dicksonland, Spitsbergen; Upper Minsker Valley Series; Givetian.

Description. Holotype roundly triangular, exochine diameter 80 µ, intine diameter 58 µ. Exochine and intine of approximately equal thickness. Three large distal inter-radial murioid folds present.

Remarks. The section (Pl. 104, fig. 11) demonstrates the two-layered exine, both layers of approximately equal thickness. Because of strong compression, the cavate nature of the equatorial exine is not clearly seen.

Comparison. Comptozonotileta velatus (Waltz) Playford 1963 (p. 645, pl. 93, figs. 1-3) closely resembles Rhabdosporites scumus sp. nov. Sections of C. velatus (Waltz) Playford, in Dettmann and Playford 1962 (p. 680, pl. 96, figs. 10-12) are clearly similar, and are probably cavate, as they have tentatively suggested. However, R. scumus sp. nov. lacks the ‘spanner like’ lips, and except in a few specimens, also lacks the more comprehensive distal folding. Rhabdosporites langi (Eisenack) Richardson 1960 (p. 54, pl. 14, figs. 8-9) is larger, and lacks lips. Rhabdosporites parvulus Richardson 1965, is of similar size, but lacks major folding so prominent in R. scumus sp. nov. Naumova (1953) assigned to Archaeozonotileta and Hymenozonotileta probable cavate forms, several of which exhibit major distal folding. Archaeozonotileta notatus Naumova 1953 (p. 84, pl. 13, fig. 12) and Hymenozonotileta angulatus Naumova 1953 (p. 65, pl. 8, fig. 21) both have three major radially directed distal folds, but are considerably smaller. Naumova has clearly misinterpreted the radially directed folds as the ‘bordered aperture of the perispore’, and the real trilete mark as the ‘aperture of the spore body’ only. Size alone is not usually a criterion for specific separation, but insufficient details of the exact construction of A. notatus Naumova and H. angulatus Naumova makes closer comparison impossible. Hymenozonotileta faceta Archangelskaya 1963 (p. 28, pl. 15, figs. 5, 6) has murioid folds proximally and lacks the major distal folds.

Occurrence. Upper Minsker Valley Series; Givetian.

Rhabdosporites cymatilus sp. nov.

Plate 104, figs. 3-8

Diagnosis. Miospores trilette; cavate; amb and intine outline roundly triangular, subcircular to oval, undulating. Laesurae often indistinct, straight, 1-2 spore radius, frequently accompanied and often obscured by sinuous lips, individually 1-3 µ wide, 5-10 µ high. Intine indistinct, 1-3 µ thick, infra-granulate, unfolded; exochine

EXPLANATION OF PLATE 105
All figures × 500 unless otherwise stated; from unretouched negatives.
Figs. 1-6. Auscoptosis spp. 1-3. A. alicius gen. et sp. nov. 1, Holotype, proximal surface: KA 206/M1, 63-1 98-8, K519, N375. 2, Section, showing cavate exine and exclusively distal sculpture: KA 240/S1, 37-6 101-6, K582, N376. 3, (× 1000) Details of distal sculpture: KA 206/M3, 36-7 91-2, K519, N377. 4-6. A. vitabilis sp. nov. 4, Holotype, proximal surface (× 250); KA 243/M1, 30-3 94-5, K767, N378. 5, (× 1000) Details of the cristate-reticulate ornament; KA 243/M1, 41-0 100-2, K767, N379. 6, Section, showing sharp raised lips, and intine; KA 243/S4, 40-7 100-4, K767, N380.
2–4 μ thick, coarsely infra-granulate, laevigate, with a regular pattern of slightly sinuous muroid folds, 2–8 μ wide, 2–4 μ high, more or less radially directed (at least equatorially), and frequently absent from the contact areas.

Dimensions. (Twenty-four specimens) Diameter of exoxine 64–172 μ (mean 112 μ); diameter of intexine 68–92 μ (mean 79 μ).

Holotype. Preparation KA 274/4, 219 104-2, K872, N372.

Locus typicus. Reuterskioldfjellet, Central Dicksonland, Spitsbergen; Reuterskioldfjellet Sandstone, Emsian.

Description. Holotype subcircular, exoxine diameter 64 μ, intexine diameter 58 μ. Laesurne simple, straight, length approximately half intexine radius. Exoxine and intexine of approximately equal thickness. Muroid folds confined to the proximo-equatorial and distal surfaces, being very sinuous in the distal polar region, and being straighter and radially directed equatorially.

Remarks. The majority of the specimens are dark; and it is often difficult to see details of the intexine. Further maceration fails to clear the spores; however, even in dark specimens the regularly undulating exoxinal margin, the result of the radially directed folds, is an easily recognizable feature. Sections are difficult to cut from spores in this low horizon, but Plate 104, fig. 8 shows clearly the intexine and the folded exoxine.

Comparison. Rhabdosporites langii (Eisenack) Richardson 1960 (p. 54, pl. 14, figs. 8, 9, text-figs. 4, 6b) lacks the intricate and regular fold pattern, a feature present in all specimens of Rhabdosporites cymathus sp. nov.; a distinctive diagnostic feature justifying its specific separation.

Occurrence. Reuterskioldfjellet Sandstone, and Lower Mimer Valley Series; Siegenian, Emsian and probably Lower Eifelian.

Genus AULICOSPORITES gen. nov.

Type species. Aulicosporites aulicus sp. nov.

Diagnosis. Megaspores trilete; cavate; amb circular to roundly triangular. Intexine and exoxine of approximately equal thickness, intexine laevigate, exoxine sculptured at least distally with a cristate or cristo-reticulate ornament, with cones or occasional spines.

Discussion. Differs from both Calyptosporites Richardson 1962 and Biharisporites Potonié 1956, in having a cristate or cristo-reticulate ornament.

Derivation of name. Gr. aulakos—with small furrows.

Aulicosporites aulicus sp. nov.

Plate 105, figs. 1-3

Diagnosis. Megaspores trilete; cavate; amb and intexine outline circular, subcircular to roundly triangular. Laesurneae distinct, straight, length one-third to full radius of the intexine, accompanied by conspicuous, smooth, elevated lips, 5–12 μ wide, 6–10 μ high, length three-quarters to full spore radius. Intexine 6–9 μ thick, infra-granulate; exoxine
7–12 µ thick, coarsely infra-granulate, proximally laevigate, distally sculptured with cones, variable both in size and distribution. The cones (6–40 µ wide, 6–24 µ high) have rounded apices, occasionally supporting a very small cone or spine; usually more densely packed in the distal polar region, where they are fused basally or have a polygonal outline. Distally the exooxinal extension is often laevigate.

**Dimensions.** (Thirty-eight specimens) Diameter of exooxine 180–306 µ (mean 217 µ); diameter of intine 90–190 µ (mean 146 µ).

**Holotype.** Preparation KA 209/M1, 63:3-98.8, K519, N575.

**Locus typicus.** Odelljejileit, North Dicksonland, Spitsbergen; Lower Miner Valley Series, Lower Eifelian.

**Description.** Holotype diameter of exooxine 208 µ, diameter of intine 120 µ. Laesurae approximately half intine radius. Lips each 8–10 µ wide, extend almost to the equatorial margin. Distal cones 6–12 µ wide, 6–10 µ high, with both separate polygonal and fused bases, and occasionally with small apical spines. Small folds present on exooxinal extension.

**Remarks.** The section (Pl. 105, fig. 2) demonstrates the cavate nature of the spore, the thick intine, and the exclusively distal sculpture of cones.

**Occurrence.** Dicksonfjorden Sandstone, Upper Reuterskioldjileit Sandstone, and Lower Miner Valley Series; Emsian and Eifelian.

*Alulicosporites vitabilis* sp. nov.

**Plate 105, figs. 4-6**

**Diagnosis.** Megaspores trilete, amb circular to roundly triangular with convex sides and broadly rounded apices. Laesurae straight, length 1–4 µ spore radius, accompanied and often obscured by acute, thickened lips, individually 5–25 µ wide, 25–44 µ high at the proximal pole, 16–26 µ high equatorially. Intine seen only in sections, approximately 5 µ thick, homogeneous, laevigate; exooxine 8–10 µ thick (excluding ornament), infrapunctate. Contact areas occupying most of the proximal surface, laevigate or punctate, except adjacent to the lips, where they may support an ornament of cones; contact areas bounded by curvatures, up to 20 µ wide, formed by a fusion of cones. Distal surface cristo-reticulate, with cones and occasional spines 6–12 µ wide, 7–20 µ high.

**Dimensions.** (Seventeen specimens) Diameter of exooxine 265–364 µ (mean 322 µ); diameter of intine approximately 70 µ.

**Holotype.** Preparation KA 243/M1, 30:3-94-5, K767, N378.

---

**Explanations of Plate 106**

All figures × 500 unless otherwise stated; from untouched negatives.

Figs. 1–2, *Calycatosporites ledebouri* sp. nov. 1, Holotype (× 250), proximal surface: KA 235/M1, 45-7 104-1, K590, N367. 2, Compressed section: KA 235/S1, 49-7 105-0, K590, N368.

Figs. 3–4, *Rhizalesia sp.* 3, KA 251/1, 18-9 94-1, K505, N381. 4, (×1000) the same.

Figs. 5–7, *Anacystispora longii* (Taugourdeau-Lantzi) comb. nov. 5, Distal surface: KA 243/3, 47-7 92-1, K767, N386. 6, 7, Sections, showing the raised lips, equatorial flange, and intine: KA 243/S8, 52-3 104-6, K787, N387 and KA 243/S8, 33-9 103-4, K767, N388, respectively.
K. C. Allen: Lower and Middle Devonian Spores

Locality. East Munindalen, Central Dicksonland, Spitsbergen; Planteklofta Conglomerate, probably Upper Givetian.

Description. Holotype subcircular, exoexine diameter 296 μ, intexine not seen. Laesurae straight, length four-fifths spore radius, accompanied by lips each up to 24 μ wide. Contact areas large, except for an ornament of cones adjacent to the lips. Distal cristotriculatum well developed.

Remarks. The section (Pl. 105, fig. 6) clearly shows the intexine, the raised sharp lips formed by an upward extension and thickening of the exoexine, the infra-punctate (here corroded) nature of the exoexine, and the homogeneous sculptural elements.

Comparison. Biharisporites ellesmerensis Chaloner 1959 (p. 322, pl. 55, fig. 2, text-fig. 1) is smaller, and has smaller sculptural elements, which are not fused basally. No intexine appears to be present, but this feature is very indistinct in Aulicosporites vitabilis sp. nov.

Occurrence. Planteryggen Sandstone, and Planteklofta Conglomerate; probably Upper Givetian.

TURMA ALETES Ibrahim 1933
Subtura AZONALETES (Luber) Potonié and Kremp 1954
Infraturra RETICULONAPITI (Erdtmann) Vimal 1952
Genus RETIALETES Staplin 1960

Type species. R. radforthi Staplin 1960.

Retialetes sp.

Plate 106, figs. 3, 4

Description of specimens. Spores alete, ellipsoidal. Exine (excluding ornament) thin, 1-5 μ or less, finely sculptured with low, narrow muri, 1 μ or less wide, 0-5-2 μ high. Lumina uniform, usually polygonal, small, typically 2-4 μ wide (range 1-8 μ). Exine strongly plicated with major folds.

Dimensions. (Seven specimens) 40-61 μ (mean 51 μ) by 31-44 μ (mean 38 μ).

Comparison. Retialetes radforthi Staplin 1960 the only other species recorded for this genus, is considerably larger.

Occurrence. Lower Forerskoldfjellet Sandstone; Siegenian.

Previous records. The genus has previously been recorded only from the Lower Carboniferous.

INCERTAE SEDIS
Genus NIKITINSPORITES Chaloner 1959

Type species. Nikitinispores canadensis Chaloner 1959.

Nikitinispores spitsbergenics sp. nov.

Plate 108, figs. 1-5

Diagnosis. Megasporis trilete, amb subtriangular to subcircular. Laesurae obscured by greatly elevated lips (sometimes broken), individually 7-15 μ wide, 74-160 μ high. Exine

\[ \text{c} \]
two layered; intexine 2–4 μ thick, homogeneous, closely appressed to the exoexine, and seen only in sections; exoexine 18–45 μ thick, coarsely infra-granulate. Contact areas laevigate, proximo-equatorial and distal surfaces supporting thick, more or less parallel-sided spines, structurally composed of rod-shaped elements parallel to the long axis; apically the spines narrow abruptly, ending with an homogeneous granell-tip, this tip is never wider than the main shaft of the spine; typically the spines are 100–50 μ long (range 48–250 μ), typically 40–60 μ wide (range 14–80 μ wide) the equatorial margin supports 8–20 spines. A pseudoflange up to 80 μ wide, formed by the fused bases of the spines, is occasionally present.

Dimensions. (Twenty-four specimens) Equatorial diameter (excluding spines) 240–440 μ (mean 342 μ); polar diameter (including apical prominence) 240–416 μ (mean 303 μ).

Holotype. Preparation KA 203/M4, 30.4 1071, K555, N382.

Locus typicus. North ridge of Kinanderfjellet, Central Dicksonland, Spitsbergen; Upper Mimer Valley Series, Givetian.

Description. Holotype equatorial and polar diameter (excluding elevated lips) both 256 μ, elevated lips 160 μ. Spines 28–40 μ wide, 80–240 μ long, only a few with the granell-tips preserved, basal fusion of spines (pseudoflange) up to 20 μ wide.

Remarks. Sections (Pl. 108, figs. 4, 5) show the very thick exoexine, and very thin closely appressed intexine; the spore cavity appears somewhat irregular in shape. This species is included within Nikitiin sporites Chaloner 1959, primarily on the shape and structure of the granell-tipped spines. Large size and greatly elevated lips, are features of Nikitiin sporites which are also seen in some species included within Hystricosporites McGregor 1960 and Ancyrospora Richardson 1960 emend Richardson 1962. For example Hystri cosporites porrectus (Balme and Hassell) comb. nov. (Pl. 95, figs. 1–3) has elevated lips, but the spines are homogeneous throughout, and with their large granell-tips, are clearly different from the spines of Nikitiin sporites which are homogeneous only at the very apex, with a small granell tip never exceeding the diameter of the main shaft of the spine. A pseudoflange (also present in some species of Ancyrospora) may be absent, partially developed or strongly developed (Pl. 108, fig. 2) in otherwise identical specimens, and Nikitiin sporites Chaloner 1959 is therefore included within Incertae sedis.

Comparison. Nikitiin sporites sp. Vigran 1964 (p. 20, pl. 2, figs. 11–13) has a variable sculpture of conical-based spines, coni and verrucae. Nikitiin sporites canadensis Chaloner 1959 (p. 328, pl. 55, fig. 5, text-fig. 4) is circular, and is considerably larger. Dicerospora sp. Winslow 1962 (p. 55, pl. 10, figs. 1 and 1a) illustrated but not described, is probably assignable to N. spitsbergenensis sp. nov.

Occurrence. Fiskekletta Formation and Planterggen Sandstone; Givetian.

EXPLANATION OF PLATE 107

All figures × 500 unless otherwise stated; from unretouched negatives.

Figs. 1–6. Ancyrospora spp. 1. A. trocha sp. nov., Holotype, proximal surface; KA 209/M6, 39:2 103:3, K519, N389. 2–5. A. reita sp. nov. 2. Holotype, lateral view; KA 209/A4, 34:0 88:1, K519, N390. 3, 4. Sections, showing equatorial flange and thick exine; KA 204/S1, 21:0 90:4, K838, N391 and KA 204/S1, 62:0 105:5, K838, N392. 5. (× 1000) Details of granell-tipped spines; KA 204/M2, 32:3 106:6, K838, N393. 6. A. sp. (× 250) Proximal surface; KA 242/M1, 33:2 95:1, K772, N394.
K. C. Allen: Lower and Middle Devonian Spores

Genus Ancyrospora Richardson 1960 emend Richardson 1962

Type species, Ancyrospora grandispinosa Richardson 1960 emend Richardson 1962.

Ancyrospora langii (Taugourdeau-Lantz) comb. nov.

Plate 106, figs. 5-7

1960 Archaeotriletes langii Taugourdeau-Lantz, p. 145, pl. 3, figs. 33, 34, 39.
1964 Ancyrospora cf. simplex Vignan, p. 26, pl. 6, figs. 1-3.

Dimensions. (Twenty specimens) Overall equatorial diameter 66-140 μ (mean 86 μ); central area diameter 40-81 μ (mean 55 μ); equatorial flange (excluding ornament) 12-48 μ wide. Grapel-tipped spines typically 12-25 μ long (range 8-38 μ), typically 7-12 μ wide basally (range 5-20 μ).

Remarks. The spines narrow gradually from the base to the apex, ultimately widening into a grapel-tip. The spines except for the homogeneous grapel-tip, are infra-granulate. Sections (Pl. 106, figs. 6, 7) demonstrate the elevated membranous lips, thin intine, and equatorial flange composed of exoexine. In Archaeotriletes (Naumova) Potonié 1958 the spines are confined to the central area, and are absent from the flange.

Comparison. Hymenozonotriletes incus Naumova 1953 (p. 68, pl. 9, fig. 11) is similar, and should this species prove to have grapel-tipped spines, then it would be conspecific.

Occurrence. Upper Minor Valley Series; Givetian.

Ancyrospora trocha sp. nov.

Plate 107, fig. 1

Diagnosis. Miopsores trilete; amb and central area outline circular to subcircular. Laesurae straight, length three-quarters to full central area radius, accompanied and often obscured by sinuous, membranous, elevated lips, individually 2-4 μ thick, usually closely appressed to the exoexine, but occasionally separated and folded; exoexine coarsely infra-granulate 7-20 μ thick centrally, extending as an equatorial flange, typically 20-32 μ wide (range 15-50 μ). Contact areas occupy most of the proximal surface inside the flange, and support an ornament of low, broad, flat-topped radial muri, 6-13 μ wide, 4-12 on each contact area; proximo-equatorial and distal surfaces sparsely sculptured with short spines, typically 15-30 μ long (range 10-58 μ), the majority with large bulbous bases, 10-24 μ wide.

Dimensions. (Twenty-five specimens) Overall equatorial diameter (excluding spines) 154-272 μ (mean 189 μ).

Holotype. Preparation KA 209/M6, 39-2 103-3, K519, N389.

Locus typicus. Odellfjellet, North Dicksonland, Spitsbergen; Lower Minor Valley Series, Lower Eifelian.

Description. Holotype circular, diameter 178 μ. Laesurae straight, length equals full intine radius, elevated lips 16 μ high. Intine 3 μ thick, folded; exoexine 16 μ thick, equatorial flange 22 μ wide. Radial muri 8-13 μ wide, 6-8 on each contact area; proximo-
Equatorial and distal spines sparse, short, 14-18 μ high, frequently with the grapnel tip broken.

Comparison. Ancyrospora grandispinosa Richardson 1960 emend Richardson 1962 (p. 175, pl. 27, figs. 3-5, text-fig. 4) is clearly similar, but lacks the proximal radial muri. Hystericosporites porcatus comb. nov. has longer spines, a curvilinear ridge formed in part from the bases of the spines (zonarial ridge of Winslow 1962, p. 52), and lacks the membranous equatorial flange.

Occurrence. Upper Reuterskioldjellet Sandstone, and Lower Mimer Valley Series; Emsian and Eifelian.

Ancyrospora reuta sp. nov.

Plate 107, figs. 2-5

Diagnosis. Miospores trilete; amb and central area outline circular to subcircular. Laesurae indistinct, length half to full radius of the central area, occasionally accompanied by smooth lips, individually 1-3 μ wide. Exine two-layered; intexine infra-granulate 1-4 μ thick; exoxine infra-granulate 7-15 μ thick, extending as an equatorial flange, typically 25-40 μ wide (range 14-54 μ); proximal surface laevigate, distal surface densely covered with short grapnel-tipped spines, 6-20 μ long, frequently with large bulbous bases, 6-10 μ wide.

Dimensions. (Sixteen specimens) Overall equatorial diameter 111-180 μ (mean 151 μ); central area diameter 83-128 μ (mean 96 μ).


Locus typicus. Oddfelljellet, North Dicksonland, Spitsbergen; Lower Mimer Valley Series, Lower Eifelian.

Description. Holotype in oblique aspect, subcircular, overall equatorial diameter 128 μ, central area diameter 100 μ. Laesurae indistinct. Exine 10 μ thick centrally, equatorial flange 14-22 μ wide. Distal spines 6-10 μ long, only a few grapnel-tips being preserved.

Remarks. Specimens are very dark, and difficult to macerate, tending to break down with increased maceration, rather than becoming lighter in colour. Frequently, the grapnel-tip is not preserved. The sections (Pl. 107, figs. 3, 4) demonstrate the equatorial flange and thick exine. No intexine is seen in this specimen.

Comparison. Ancyrospora grandispinosa Richardson 1960 emend Richardson 1962 (p. 175, pl. 27, figs. 3-5, text-fig. 4) is considerably larger, and has much longer spines. Ancyrospora trocha sp. nov. (Pl. 107, fig. 1) has proximal radial muri.

Occurrence. Dicksonfjorden Sandstone, Upper Reuterskioldjellet Sandstone, and Lower Mimer Valley Series; Emsian to Eifelian.

Explanations of Plate 108

All figures ×200 unless otherwise stated; from unretouched negatives.

Figs. 1-5. Nichinosporites spitzbergensis sp. nov. 1, Holotype, lateral view; KA 203/M4, 304 107-1, K555, N382. 2. Proximal surface showing pseudoflange; KA 282/M2, 339 96-4, K854, N383. 3. (×1000) bifurcate tipped spine from the holotype. 4. 5, Sections showing the thick exoxine and thin intexine. 4, (×500) KA 235/817, 432 99-4, K590, N384. 5, (×1000), KA 235/811, 207 106-0, K590, N385.
Description of specimens. Megaspores trilete; amb triangular to roundly triangular, deeply incised, central area outline triangular. Laesurae indistinct, straight, length two-thirds to full spore radius, accompanied by smooth elevated lips, individually 4-12 μ wide, 10-40 μ high. Exine two-layered; intexine approximately 3 μ thick, closely appressed to the exoexine and usually indistinct; exoexine infra-granulate, centrally 15-20 μ thick, thinning and extending equatorially as a pseudoflange up to 60 μ wide. Proximal surface laevigate; equatorially and distally sculptured with flexuous spines, 40-100 μ long, basally 10-40 μ wide, each narrowing gradually towards the apex, where it widens slightly into a grappnel-tip. The spines, except for the homogeneous grappnel-tip, are infra-granulate.

Dimensions. (Six specimens) Overall equatorial diameter (excluding spines) 222-80 μ; central area diameter 120-44 μ.

Remarks. Structurally the spines are similar to those in Nikinisporites Chaloner 1959, but differ in sculpture.

Comparison. Archaeotriletes villosus Chibrikova 1959 (p. 44, pl. 2, fig. 1) is clearly similar, and may prove to be identical, but the sculpture is reduced in size towards the distal pole, and there is no evidence of grappnel-tips to the spines, although this may be due to preservation.

Occurrence. Fiskeløfta Formation, Plantebygen Sandstone, and Plantekefta Conglomerate; probable Middle and Upper Givetian.

SOME GENERAL COMMENTS

The Spitsbergen successions is one of the few Devonian continental successions which extends from the Lower Devonian into the Middle Devonian without a stratigraphical break.

Botanical affinities can tentatively be suggested on the basis of spores of similar construction found in situ in Devonian and Carboniferous plants, but many species, including those with proximal radial muri, grappnel-tipped spines, and patinate thickenings which are restricted to, or abundant in, the Devonian, are as yet unassigned to any plant group.

Dispersed spores of diverse construction, included within the Infraflora Laevigatii, Apiculati, Muromati, Tricerassati, Cingulati, Patinati, and many cavate forms are described from the Lower Devonian. The majority of Lower Devonian plants described by Høeg (1942) from Spitsbergen are assignable to the Psilophytales, and from the evidence of spores in situ described from the Devonian, the majority of Psilophytales produced simple laevigate or apiculate forms. This diversity of dispersed spores recovered from the Lower Devonian, suggests that the hallmark must have been a greater diversity of parent plants than have as yet been described from, or preserved in, the Lower Devonian of Spitsbergen or elsewhere.
REFERENCES


K. C. Allen: Lower and Middle Devonian Spores


—— 1965. Middle Old Red Sandstone Spore Assemblages from the Orceadian Basin, North-East Scotland. Ibid. 7, 559-605.


K. C. ALLEN
Department of Geology,
Sedgwick Museum,
Cambridge

Manuscript received 30 October 1964
ALLEN. Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miiospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN. Lower and Middle Devonian miospores
ALLEN, Lower and Middle Devonian miospores
ALLEN, Middle Devonian megaspores