70-38

GEOLOGICAL
SURVEY
OF
CANADA

DEPARTMENT OF ENERGY,
MINES AND RESOURCES

PAPER 70-38

MIOSPORES FROM THE MIDDLE AND EARLY UPPER DEVONIAN ROCKS OF THE WESTERN QUEEN ELIZABETH ISLANDS, ARCTIC ARCHIPELAGO

(Report, 15 figures and 28 plates)

Bernard Owens

Price, $3.50

1971

GEOLOGICAL SURVEY
OF CANADA

PAPER 70-38

MIOSPORES FROM THE MIDDLE AND EARLY UPPER DEVONIAN ROCKS OF THE WESTERN QUEEN ELIZABETH ISLANDS, ARCTIC ARCHIPELAGO

Bernard Owens

DEPARTMENT OF ENERGY, MINES AND RESOURCES

Available by mail from *Information Canada*, Ottawa

from the Geological Survey of Canada
601 Booth St., Ottawa

and

Information Canada bookshops in

HALIFAX - 1735 Barrington Street
MONTREAL - 1182 St. Catherine Street West
OTTAWA - 171 Slater Street
TORONTO - 221 Yonge Street
WINNIPEG - 499 Portage Avenue
VANCOUVER - 657 Granville Street

or through your bookseller

Price: $3.50 Catalogue No. M44-70-38

Price subject to change without notice

Information Canada
Ottawa
1971

CONTENTS

Illustrations

ABSTRACT

Seventy three forms of miospores are recorded from the Weatherall and Griper Bay Formations, of Middle and early Upper Devonian age, from the western Queen Elizabeth Islands, Arctic Archipelago. Thirty seven of the species described are new, twenty three are records of previously described species although ten of these have been reassigned to different genera, the remaining thirteen forms are described as spore types. Two new genera are proposed, *Verruciretusispora* n. gen. and *Contagisporites* n. gen. and the concept of one genus *Geminospora* Balme 1960 emended. The problems of generic assignment of the large numbers of specimens found in most of the samples which resemble forms assigned by Russian palynologists to *Archaeozonotriletes* sensu Naumova are discussed, and the relationship between *Archaeozonotriletes* sensu Naumova and *Archaeozonotriletes* (Naumova) Allen and between *Archaeozonotriletes* sensu Naumova and *Geminospora* Balme emend. is considered in detail. The composition of the assemblages from both formations is discussed and the value of the assemblages for stratigraphic correlation purposes is assessed. Direct comparisons are made between the Weatherall and Griper Bay Formation assemblages and those of similar Middle and early Upper Devonian age from the U.S.A., Spitsbergen, England, Scotland, Belgium, France, Australia and various regions of the U.S.S.R. Certain broad stratigraphical conclusions are proposed particularly between the Canadian assemblages and those from Scotland, France and certain parts of the U.S.S.R.

MIOSPORES FROM THE MIDDLE AND EARLY UPPER DEVONIAN ROCKS OF THE WESTERN QUEEN ELIZABETH ISLANDS, ARCTIC ARCHIPELAGO

INTRODUCTION

This study was undertaken in order to investigate in detail the dispersed microfloral assemblages from the Middle and early Upper Devonian rocks of the western Queen Elizabeth Islands and to assess the value of the assemblages for correlation purposes.

Although considerable advances have been made in recent years concerning the nature and distribution of dispersed Devonian spores in various parts of the world, relatively little is known of their occurrence in northern Canada. Chaloner (1959) has described several species of megaspores from Ellesmere Island, and McGregor (1960) has described megaspores and miospores from a coal horizon in the Griper Bay Formation of Melville Island and (*in* Kerr, McGregor and McLaren, 1965) has also reported on three miospore assemblages from the Griper Bay Formation of northeastern Bathurst Island and northern Helena Island. This report, however, constitutes the first detailed description of Middle and early Upper Devonian spore assemblages of the Canadian Arctic from a relatively long stratigraphic sequence which includes a variety of sedimentary environments. It deals only with some of the more distinctive miospores.

Although broad stratigraphic conclusions based on the evidence presented in this report may be proposed at the present time, the detailed correlation of the assemblages must await the description of the remainder of the assemblages and the examination of additional material in order to ascertain whether or not the apparent differences in the stratigraphical distribution of the various species are the result of progressive change in the composition of the microflora and not a reflection of the control exerted on the composition of the assemblages by differences in sedimentary environment.

Stratigraphy

The Middle and Upper Devonian stratigraphy of the Melville and Prince Patrick Islands region of the western Queen Elizabeth Islands has been dealt with in detail by Tozer and Thorsteinsson (1964). It is however pertinent to review it briefly here.

The Weatherall Formation of eastern Melville Island overlies conformably the Blue Fiord Formation and is broadly divisible into two units. In the section on the south limb of the Robertson Point Anticline (8 miles northeast of Beverley Inlet), the Weatherall Formation is represented by approximately 2,900 feet of sediments. The lower unit, which is about 1,400 feet thick, consists predominantly of medium-bedded, grey, fine-grained sandstones which are interbedded with grey shales, silty shales and siltstones commonly rich in carbonaceous material. Marine horizons in the lower 800 feet of this unit have yielded brachiopods, pelecypods and trilobites. From GSC Locality 37171, D.J. McLaren (*in* Tozer and Thorsteinsson, 1964, p. 74) has identified *Emanuella* cf. *E. meristoides* (Meek) which suggests a Middle Devonian (probably Givetian) age. McLaren has also identified Middle Devonian (probably Givetian) faunules from the portion of this unit from sections east of Weatherall Bay, 11 miles east of Rae Point and on the east side of Liddon Gulf,

north of Chevalier Bay (*see* Tozer and Thorsteinsson, 1964, pp. 73, 74). The upper 600 feet of beds in this unit as exposed in the Robertson Point Anticline are unfossiliferous.

The upper unit of the Weatherall Formation in the Robertson Point Anticline section is similar in lithology to that of the lower unit, consisting of interbedded sandstones, shales and siltstones all of which are commonly highly carbonaceous. Thicker beds of light grey, yellowish brown weathering sandstone appear in the upper part of this unit, probably representing the gradual change in the sedimentary regime which culminates with the appearance of the thick white sandstones of the overlying Hecla Bay Formation. The two-fold division of the Weatherall Formation in western Melville Island where the formation is considerably thicker, is not so readily recognized. Middle Devonian (probably Givetian) faunules have been identified by D.J. McLaren from the Weatherall Formation at several localities in western Melville Island (*see* Tozer and Thorsteinsson, 1964, pp. 76-81).

The Hecla Bay Formation conformably overlies the Weatherall Formation and is 2,600 feet thick in its type section on the south limb of the Robertson Point Anticline (7 miles northeast of Beverley Inlet) in eastern Melville Island. It is composed of thick beds of white, fine- to medium-grained sandstones with very occasional thinly bedded, sometimes carbonaceous sandstone units. No fossils other than carbonized plant fragments are known from the Hecla Bay Formation which is considered by Tozer and Thorsteinsson (1964) to represent a nonmarine, deltaic deposit. The precise age of the formation is difficult to determine but as it overlies the Weatherall Formation which contains Middle Devonian (probably Givetian) fossils in its lower part and is overlain by the Griper Bay Formation which contains Frasnian and Famennian fossils, it is considered to be either late Middle Devonian or early Upper Devonian in age.

The Griper Bay Formation, which conformably overlies the Hecla Bay Formation and constitutes the youngest Devonian rocks exposed in the western Queen Elizabeth Islands, is approximately 3,000 feet thick in eastern Melville Island. It consists mainly of sandstones, shales and siltstones but thin coal seams and conglomerate beds are also represented. Tozer and Thorsteinsson (1964, p. 83) have suggested that much of the Griper Bay Formation was deposited in nonmarine conditions although marine fossils do occasionally occur in thin bands. From an horizon near to the top of the section of this formation exposed on the south limb of the Robertson Point Anticline 6 miles northeast of Beverley Inlet(top of unit 8, Tozer and Thorsteinsson, 1964, p. 84), D.J. McLaren (*in* Kerr, McGregor and McLaren, 1965, p. 417) has identified *Acanthatia* sp., *Pliochonetes* sp., *Ptychomaletoechia*? sp., and *Cyrtospirifer* sp. and has suggested an early Famennian age for the deposits. The Griper Bay Formation outcrops extensively in southern and southwestern Melville Island but paleontological data from these localities is inconclusive. Lambe (1910) has recorded the occurrence of *Lingula melvillensis* Lambe and *Estheria canadensis* Lambe, and Wann Langston Jr. has identified fragmentary remains of *Bothriolepis* from the southwestern part of the Dundas Peninsula (*see* Tozer and Thorsteinsson, 1964, pp. 85-86). McGregor (1960) has described an assemblage of miospores and megaspores from a coal seam exposed near Stevens Head on the north side of Purchase Bay and has also reported on the fragmentary plant remains and made preliminary comments on the miospore assemblage obtained from a grey shale horizon exposed north of Murray Inlet (*see* Tozer and Thorsteinsson, 1964, p. 87) and M.J. Copeland (1962) has identified several species of *Conchostraca* from the sections exposed near Kelly Point at the entrance of Purchase Bay (*see* Tozer and Thorsteinsson, 1964, p. 88).

On Prince Patrick Island the Griper Bay Formation is up to 4,500 feet thick and outcrops extensively in the southeastern part of the island. The upper portion (unit 3, Tozer and Thorsteinsson, 1964, p. 90) of the sequence is approximately 1,200 feet thick and is composed of light coloured, thickly bedded sandstones with occasional thin carbonaceous shale, coal and

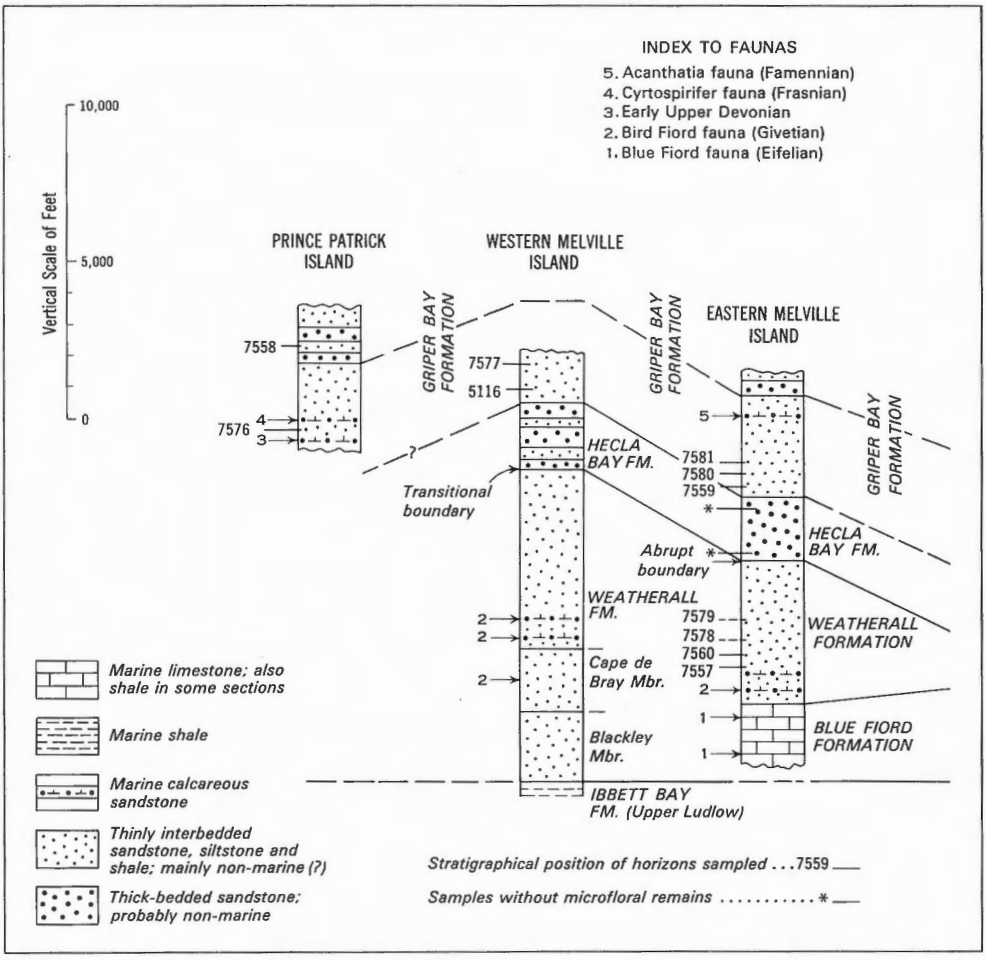


Figure 1. Stratigraphic position of samples examined (modified from Tozer and Thorsteinsson, 1964).

conglomerate horizons whereas the lower portions (units 1 and 2, Tozer and Thorsteinsson, 1964, p. 91) are composed predominantly of green, commonly carbonaceous sandstones interbedded with grey, friable silts and carbonaceous shales. From the Griper Bay Formation of Prince Patrick Island D.J. McLaren has identified three faunules (*see* Tozer and Thorsteinsson, 1964, p. 68, and pp. 91-92), the oldest contains *Schizophoria* cf. *S. athabaskensis* Warren, *Eostrophalosia* sp., *Devonoproductus* sp., *Allanaria* cf. *A. allani* (Warren), *Eleutherokomma* cf. *E. leducensis* Crickmay, *Phacellophyllum* sp., *Thamnopora* sp. and *Alveolites* sp. McLaren has suggested an early Upper Devonian age for this faunule. The younger faunules include one with *Douvillinella* sp., *Nervostrophia* sp., *Warrenella* sp., *Cyrtina* sp., *Leiorhynchus* sp. and *Eoreticularia* sp. and another with *Atrypa* ex gr. *A. devoniana* Webster and *Cyrtospirifer* ex gr. *C. verneuili* (Murchison). They have been dated by McLaren as early Frasnian (*see* Tozer and Thorsteinsson, 1964, p. 68). These marine fauna are unknown in the Griper Bay Formation of Melville Island.

D.C. McGregor (*in* Kerr, McGregor and McLaren, 1965, pp. 424-430) has recorded microfloral assemblages from three horizons in the Griper Bay Formation of northeastern Bathurst Island and Helena Island, one of the assemblages being from sediments associated with the early mid-Famennian marine invertebrate faunule described by McLaren (*in* Kerr, McGregor and McLaren, 1965, p. 415). The microfloral evidence supports the early to mid-Famennian age assigned to the marine invertebrates from northeastern Bathurst Island whilst it favours a late Frasnian age for the sample from the Griper Bay Formation of northern Helena Island.

Data on samples studied

The following is an index to the plant locality numbers, samples and palynological preparations dealt with in this report.

Weatherall Formation

Lower member

7557	Southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 73). Brown bioclastic limestone. Field No. TE 79c.
7560	Southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 73). Grey and fawn, fine, micaceous sandstone with disseminated carbonaceous debris. Field No. TE 79b.

Upper member

7578	Southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 74). Fawn, fine-grained sandstone with carbonized plant debris on the bedding planes. Field No. TE 80a.

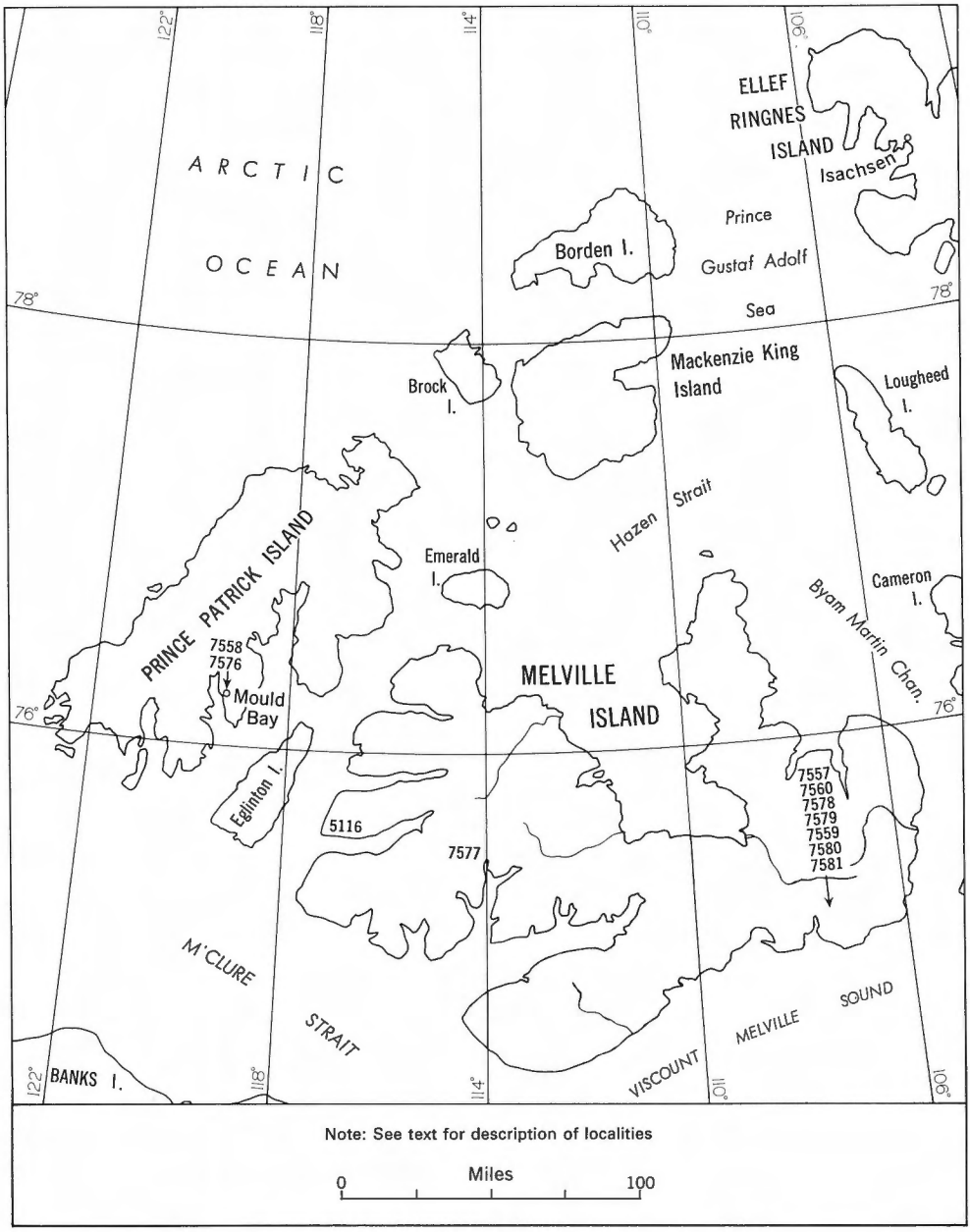


Figure 2. Geographic distribution of samples examined (modified from Tozer and Thorsteinsson, 1964).

7579 Southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 74). Grey siltstone with abundant carbonaceous debris on the bedding planes. Stratigraphically above 7578. Field No. TE 80d.

Hecla Bay Formation

7845 Southern limb of the Robertson Point Anticline, 7 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 75). Fawn, medium- to fine-grained sandstone. Field No. TE 81a. (No spores.)

7846 Southern limb of the Robertson Point Anticline, 7 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 75). Fawn, fine-grained sandstone. Field No. TE 81b. (No spores.)

Griper Bay Formation

7559 Southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 84, lower part of unit 6, approximately 1,835 feet below early Famennian faunule). Thinly laminated coal, 1 foot thick. Field No. TE 82d.

7580 Southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 84, unit 7, approximately 1,800-1,835 feet below early Famennian faunule). Fawn sandstone with abundant disseminated carbonaceous debris. Field No. TE 82e.

7581 Southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 84, lower part of unit 8, approximately 1,800 feet below early Famennian faunule). Grey-green, fine-grained sandstone with abundant disseminated plant debris and occasional small, thin coal lenticles. Field No. TE 83a.

5116 1 mile north of Stevens Head, west coast of Melville Island, Northwest Territories. Collected by E.T. Tozer, 1954 (G.S.C. Mem. 332, p. 88). Grey, fine-grained sandstone with indeterminable plant casts and abundant disseminated carbonaceous debris. Field No. 54-3-8.

5116 1 mile north of Stevens Head, west coast of Melville Island, Northwest Territories. Collected by E.T. Tozer, 1954 (G.S.C. Mem. 332, p. 88). Fragments of coal collected from stream talus. Field No. 54-3-8.

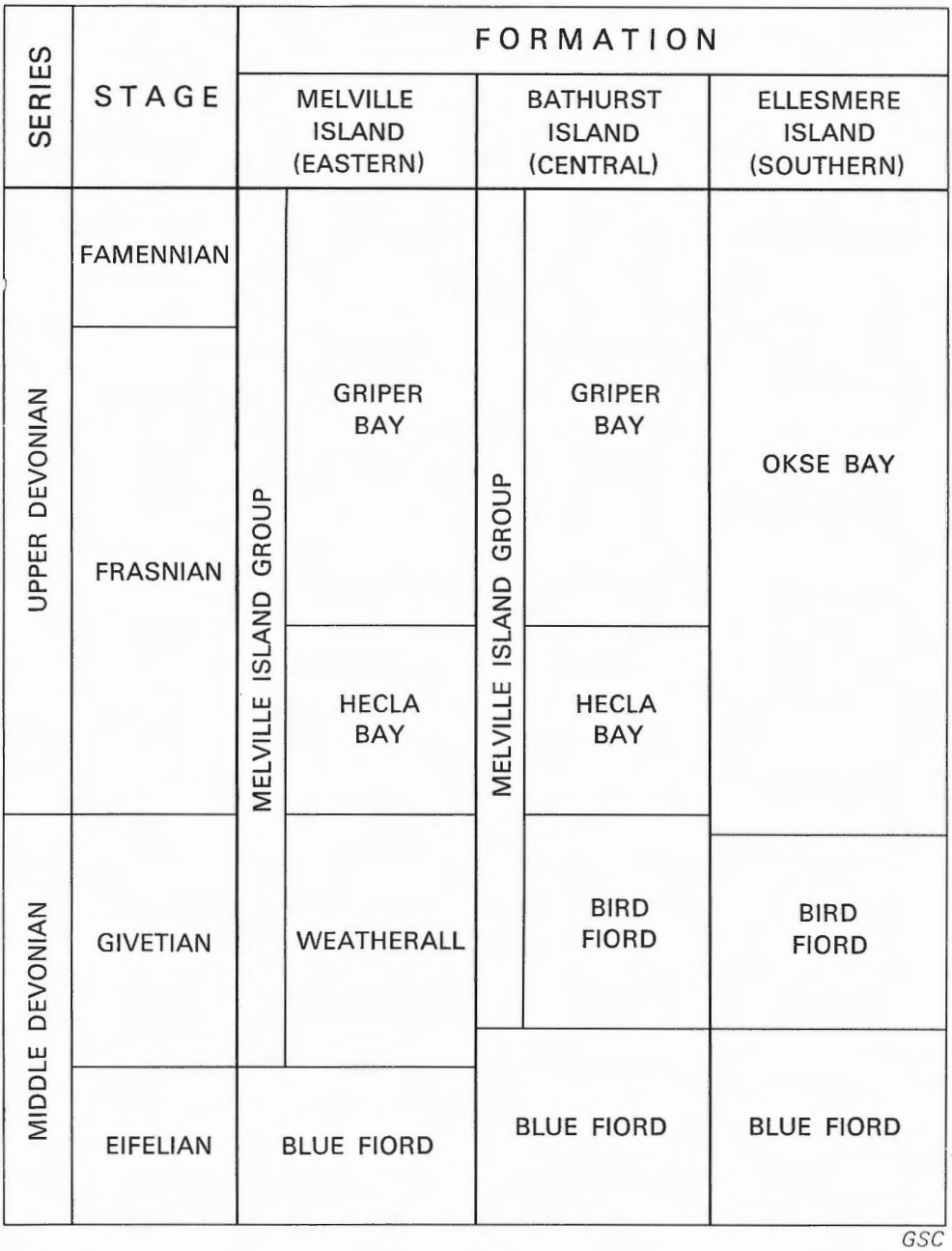


Figure 3. Table of formations, central Arctic Archipelago.

7577	Head of western arm of Murray Inlet, west coast of Melville Island, Northwest Territories. Collected by E.T. Tozer, 1958 (G.S.C. Mem. 332, p. 86). Loose fragments of coal, up to 4 inches thick. Field No. TE 73a.
7558	Locality 61, west side of Mould Bay, Prince Patrick Island, Northwest Territories. Collected by E.T. Tozer, 1954 (G.S.C. Mem. 332, p. 92). Coal and carbonaceous shale from horizon immediately above sandstone containing *Bothrodendron*. Field No. 54-5-3b.
7576	East side of graben (5 miles southwest of Mould Bay Weather Station), west coast of Mould Bay, Prince Patrick Island, Northwest Territories. Collected by E.T. Tozer, 1954 (G.S.C. Mem. 332, p. 93). Dark, carbonaceous shale with plant impressions and abundant fine, disseminated carbonaceous debris. Field No. 54-5-12a.

The extraction of the microfloral assemblages from the various samples was accomplished by using conventional palynological techniques employing hydrochloric and hydrofluoric acids, Schulze's reagent and weak solutions of either potassium or ammonium hydroxides. The spores were normally well preserved, showing little indication of corrosion. After extraction all the assemblages were passed through a 250-mesh-size sieve in order to separate the miospores from the megaspores. The latter are excluded from this report but will be described in detail in a later publication.

Residues were mounted in glycerine jelly. Several assemblage slides which were covered with cover slips and sealed with lacquer, were prepared from each assemblage for systematic microscope examination. Open assemblage mounts were also prepared from each assemblage and from these several hundred specimens were picked off and mounted individually. Single grained mounts were sealed in beeswax.

Each type or figured specimen has been allocated a number in the Geological Survey of Canada Type Series and stored in the Geological Survey of Canada Paleobotanical Slide Collection in Ottawa. Most are mounted on single grain slides. The remainder are clearly located on covered assemblage slides. The specimens here described have been given the numbers 15489-15697 in the Geological Survey of Canada Plant Type Series.

Acknowledgments

This work was carried out in the laboratories of the Geological Survey of Canada during the tenure of a postdoctorate fellowship awarded by the National Research Council of Canada. Grateful acknowledgment is here made to both institutions. The writer also wishes to express his sincere thanks to E.T. Tozer who readily made available the material examined during this study, to M.S. Barss for discussions concerning the morphological interpretation of several of the genera recorded, and in particular to D.C. McGregor for valuable discussions and suggestions during all phases of the work and for making available material for comparison from other localities in the Arctic Archipelago and Eastern Canada.

SYSTEMATIC PALYNOLOGY

Anteturma *SPORITES* H. Potonié 1893

Turma *TRILETES* Reinsch 1891

Suprasubturma *ACAMERATITRILETES* Neves and Owens 1966

Subturma *AZONOTRILETES* Luber 1935

Infraturma *LAEVIGATI* (Bennie and Kidston) Potonié and Kremp 1954

Genus *PUNCTATISPORITES* (Ibrahim) Potonié and Kremp 1954

Type species: *Punctatisporites punctatus* Ibrahim 1933

Punctatisporites glabrimarginatus n. sp.

Plate I, figures 1-3

Description. Spores radial, trilete. Colour yellow. Amb subcircular. Trilete mark distinct; laesurae simple, straight, length 1/2 to 2/3 of the spore radius. Exine between the angles of the laesurae thickened, forming a dark triangular area, the corners of which may coincide with the ends of the laesurae. Maximum degree of thickening developed adjacent to the laesurae where it may simulate thickened lips. Surface of the exine of the darkened triangular area pitted. Exine 1.5-2μ thick. Most of the proximal surface bears a densely distributed ornament of small grana (approximately 0.5μ in basal diameter); the equatorial region and the entire distal surface of the exine laevigate. Taper-pointed compression folds common on the distal surface.

Dimensions (31 specimens measured). Maximum equatorial diameter 59.4-82.5μ (mean 69.3μ).

Types. Holotype, GSC No. 15489; paratypes, GSC Nos. 15490, 15491.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7580.

Comparisons. Although several species assigned to the genus *Punctatisporites* are comparable in size, shape and the nature of the laesurae, *Punctatisporites glabrimarginatus* n. sp. may be readily distinguished by the darker triangular area of exine in the angles between the laesurae and by the distinctive distribution of the fine granular ornament on the more polar portions of the proximal surface of the spore.

Genus *RETUSOTRILETES* (Naumova) Streel 1964

1955 *Phyllothecotriletes* Luber 1935, p. 37

Type species: *Retusotriletes simplex* Naumova 1953

Remarks. In emending the genus *Retusotriletes* Naumova 1953, Streel (1964, pp. 6-7) restricted its circumscription to include only smooth forms with a circular or subtriangular equatorial outline and distinct contact faces delimited by curvaturae. This emendation validates similar suggestions by

Potonié (1958) and Chaloner (1963). Streel also suggested that subsequent subdivision of the ornamented members of the genus (sensu Naumova) should be made on the basis of the character of the exine ornamentation.

Prior to the emendation of the genus *Retusotriletes* Naumova by Streel, all azonate forms which possessed contact faces delimited by curvaturae were assigned to that genus regardless of the wide range in exine ornamentation that they exhibited. This resulted in a form genus being established that could not be accommodated in the suprageneric catagories of any morphological classification due to the wide range of morphological characters involved and the loose circumscription of the genus. The genus as emended by Streel however now may be accommodated satisfactorily in the Infraturma Laevigati (Bennie and Kidston) Potonié (1956). Ornamented forms may be assigned to separate Infraturmae on the basis of their exine ornamentation.

For the purpose of the present investigation, the term "curvaturae" is interpreted as being a positive structural feature on the proximal surface of the spore, occurring at the equatorial margin of the contact areas as a clearly defined line of varying width which results from either an abrupt change in exine thickness from the thinner contact areas to the remainder of the spore or as a ridge-like elevation of variable width and height. This feature frequently coincides with a marked change in the distribution of the exine ornamentation, because usually the ornament is absent from the contact areas. This restriction of the ornament emphasizes the structure but is in no way responsible for its formation.

Although the emended concept of the genus as proposed by Streel is accepted here in full, it is perhaps relevant to consider the alternatives that could have been proposed to deal with the generic assignment of spores possessing well-developed curvaturae. First, the presence of contact areas and curvaturae could be ignored as a feature worthy of generic status, and the species of the genus *Retusotriletes* Naumova reallocated to existing genera of the Infraturmae Laevigati and Apiculati (Bennie and Kidston) Potonié (1956) etc. according to the character of the exine ornamentation. The principal objection to this alternative would depend on the degree of importance that is attached to the presence of curvaturae. Although stratigraphical distribution and possible phylogenetic significance must not influence the formulation of a morphological classification, the abundance of this type of spore in the Devonian and Lower Carboniferous assemblages has resulted in its being accorded considerable stratigraphical significance. It would therefore be unfortunate if this group of spores were to be reallocated to the existing genera of the Infraturmae Laevigati and Apiculati etc., the overall stratigraphic distribution of which is of little importance.

Several workers (Potonié, 1958; Chibrikova, 1959; Chaloner, 1963; and Playford, 1964) have suggested either directly or indirectly that contact areas and well-defined curvaturae are features worthy of suprageneric status in the morphological classification. If contact areas and well defined curvaturae were restricted to the Subturma Azonotriletes Luber this would perhaps be an ideal solution. However, these features are now known to be present in other Subturmae as well, and to utilize them as characters of suprageneric significance would necessitate doing so at a very high level in the classification framework.

Streel's proposals for the generic assignment of the azonate forms that possess curvaturae are accepted in the present paper (although this does not imply that this group of spores should be given Infraturma status). On the other hand, camerate and zonate species possessing curvaturae are assigned to existing genera on the basis of their structural and sculptural features, ignoring the significance of curvaturae above specific level. Although such an approach is not entirely satisfactory, it obviates the necessity of proposing a large number of new suprageneric taxa and mono- or bispecific genera in which the presence of curvaturae is a feature of major significance. It should

however be noted that if curvaturae are to be given suprageneric significance in Azonotriletes, there is no alternative but to give them similar significance in the other Subturmae.

Comparisons. *Apiculiretusispora* Streel (1964, p. 7) and *Verruciretusispora* n. gen. are readily distinguished from *Retusotriletes* (Naumova) Streel by the possession of an ornamented exine. *Leiotriletes* (Naumova) Potonié and Kremp (1954) and *Punctatisporites* (Ibrahim) Potonié and Kremp (1954) are distinguished by the absence of contact faces and curvaturae.

In discussing the genus *Phyllothecotriletes* Luber (1955, p. 37), Potonié (1958, p. 17), Staplin (1960, p. 8) and Streel (1964, p. 4) have placed considerable significance on the darkened proximal polar region of the exine surface in the angles between the laesurae. Observations made during the present investigation suggest that this feature may result from a slight thickening of the exine and an intensification of the infrastructure. Although such a feature may be of value at specific level, it is not in the opinion of the author of any significance at the generic level. Because this is the only feature which has been utilized to distinguish *Phyllothecotriletes* from *Retusotriletes* (sensu Streel), the two are here considered synonymous.

Retusotriletes distinctus Richardson 1965

Plate I, figures 4-7

Retusotriletes distinctus Richardson, 1965, pp. 565-566, Pl. 88, figs. 7,8, text fig. 2.

Retusotriletes cf. *R. distinctus* Richardson *in* McGregor and Owens, 1966, Pl. XV, figs. 1,2.

Description of specimens. Spores radial, trilete. Colour orange to brown. Amb rounded triangular, subcircular or occasionally circular. Trilete mark distinct; laesurae straight, simple or accompanied by low, narrow lips up to 1.5μ wide, extending between 3/4 and the full spore radius. Exine 4.5-11μ thick (measured at the equatorial margin), surface smooth or slightly roughened due to fine, dense infrapunctation. The exine between the angles of the laesurae is slightly darker, forming a small triangular area which is frequently characterized by an intensification of the infrastructure. The ends of the laesurae are connected by slightly elevated and thickened curvaturae which show marked invagination in the radial position, and which are normally coincident with the equatorial margin of the spore along part of their length.

Dimensions (31 specimens measured). Maximum equatorial diameter 85.8-115.5μ (mean 98.5μ).

Types. Hypotypes, GSC Nos. 15492, 15493, 15494, 15495. (GSC Loc. 7559)

Comparisons. The Canadian specimens are closely comparable to the Scottish material from the Middle Old Red Sandstone described by Richardson (1965), although they are somewhat smaller than the size range quoted by Richardson (113-218μ). *Retusotriletes laevis* Chibrikova (1959, p. 57, Pl. 6, fig. 13) from the Takata beds of western Bashkiria bears a superficial resemblance in overall shape, and by possessing long laesurae and an equatorial "frill" which may be only apparently equatorial because of the thick exine. It differs however by being smaller (65-75μ), and by lacking well-defined curvaturae and the darkened triangular area in the angles between the laesurae. *R. raisae* Chibrikova (1962, p. 402, Pl. 4, fig. 5) is smaller in size (50-100μ) and possesses an apparently thin exine, shorter laesurae and much smaller contact areas. *R. obliteratus* Chibrikova (1962, pp. 399-400, Pl. 3, figs. 7-8) from the Eifelian (Calceola series) of western Bashkiria, although larger than the Canadian specimens of *R. distinctus* (120-170μ), is comparable in size to

the Scottish specimens. It may however be distinguished by possessing thinner exine over the contact areas than over the remainder of the spore, by poorly defined curvaturae and by the lack of the darkened triangular area in the angles between the laesurae.

Retusotriletes dubius (Eisenack) Richardson 1965

Plate I, figures 8-10

Type D, Lang 1925, Pl. 1, fig. 8

Triletes dubius Eisenack 1944, p. 115, Pl. 2, fig. 7, text fig. 14

Retusotriletes dubius (Eisenack) Richardson 1965, p. 564, Pl. 88, figs. 5-6

Description of specimens. Spores radial, trilete. Colour orange to brown. Amb subcircular to broadly rounded triangular. Trilete mark distinct; laesurae simple, straight, length 2/3 to 3/4 of the spore radius; ends of the laesurae are connected by clearly defined curvaturae which commonly pass over the equator of the spore or are coincident with it for the majority of their length. Exine thick (3-6μ at the equatorial margin), laevigate or finely infrapunctate. Contact areas slightly thinner than the remainder of the spore, their surface bearing numerous fine, densely distributed, radially orientated, convolute ridges (normally less than 0.5μ wide) which are finest and most densely distributed in the polar region and slightly coarser, less convolute and less densely distributed in the equatorial region. Exine between the laesurae commonly darker (? as a result of greater thickness or an intensification of the infrastructure) and forming a triangular area.

Dimensions (15 specimens measured). Maximum equatorial diameter 54.9-81.3μ (mean 66.9μ).

Types. Hypotypes, GSC Nos. 15496, 15497, 15498. (GSC Loc. 7560)

Remarks. The Canadian specimens appear identical to those described by Richardson (1965) from the Middle Old Red Sandstone of Scotland.

Retusotriletes politus n. sp.

Plate II, figures 1, 2

Description. Spores radial, trilete. Colour pale yellow to orange. Amb rounded triangular to subcircular. Exine 1-2μ thick. Trilete mark distinct; laesurae simple, straight, varying in length between 1/3 and 3/4 of the spore radius, sometimes accompanied by low narrow lips. The exine between the laesurae may be slightly thickened in the polar region to form a dark triangular area. Ends of the laesurae are joined by distinct curvaturae which may mark a slight change in thickness of the exine. Exine laevigate or with very fine infrastructure. Secondary peripheral compression folds common.

Dimensions (10 specimens measured). Maximum equatorial diameter 49.5-76μ (mean 65μ).

Types. Holotype, GSC No. 15499; paratype, GSC No. 15500.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7560.

Comparisons. *Retusotriletes incohatus* Sullivan (1964, pp. 1251-1252, Pl. 1, figs. 5-7) from the Lower Tournaisian of Gloucestershire, England is comparable to this species with respect to shape, size and the character of the

exine but may be readily distinguished by the folds or lips associated with the laesurae, by the absence of the darkened triangular area in the proximal polar region and by the less distinct curvaturae or curvaturae imperfectae. *R. raisae* Chibrikova (1962, p. 402, Pl. 4, fig. 5) from the lower Frasnian of western Bashkiria is larger (50-100μ) and possesses a thin, slightly shagreen exine, but is otherwise closely comparable. *R. translaticius* Chibrikova (1959, p. 54, Pl. 6, fig. 7) from the Middle Devonian of western Bashkiria, is similar in overall construction possessing curvaturae and a darkened triangular area in the angles between the laesurae but is considerably smaller and has a shagreen or fine granular surface.

Infraturma *APICULATI* (Bennie and Kidston) Potonié 1956

Genus *CYCLOGRANISPORITES* Potonié and Kremp 1954

Type species: *Cyclogranisporites leopoldi* (Kremp) Potonié and Kremp 1954

Cyclogranisporites amplus McGregor

Cyclogranisporites amplus McGregor 1960, p. 29, Pl. 11, fig. 8

Dimensions (9 specimens measured). Maximum equatorial diameter 75.9-93μ (mean 82.2μ).

Genus *APICULATISPORIS* (Ibrahim) Potonié and Kremp 1956

Type species: *Apiculatisporis aculeatus* (Ibrahim) Potonié 1956

Apiculatisporis microconus Richardson 1965

Plate II, figures 3,5

Apiculatisporis microconus Richardson 1965, p. 566, Pl. 89, fig. 3

Description of specimens. Spores radial, trilete. Colour yellow. Amb subcircular to circular. Trilete mark distinct to indistinct; laesurae straight, simple or accompanied by low narrow thickened lips (individually up to 2μ wide), extending between 1/2 to 3/4 of the radius of the spore. Exine thin, commonly folded, contact areas smooth, remainder of the surface of the exine bearing a fine, densely distributed ornament of cones, spines and occasionally short, squat bacula with rounded or truncated terminations. Sculptural elements normally discrete, up to 2μ high (commonly 1μ) and 0.5-1μ in basal diameter. Some of the cones and spines bear minute papillate terminations.

Dimensions (19 specimens measured). Maximum equatorial diameter 105.6-151.8μ (mean 122.1μ).

Types. Hypotypes, GSC Nos. 15501, 15502. (GSC Loc. 7560)

Remarks. The Canadian specimens are closely comparable to the Scottish material described by Richardson from the Middle Old Red Sandstone (upper Eifelian and Givetian).

Apiculatisporis microechinatus n. sp.

Plate II, figures 4, 6, 7

Description. Spores radial, trilete. Colour yellow to orange. Amb circular, subcircular to broadly rounded triangular. Trilete mark distinct; laesurae simple or accompanied by narrow thickened lips which may be elevated and slightly flexuous in the polar region, straight, extending between 1/3 and 3/4 of the spore radius. Exine thin, thickness at the equatorial margin up to 2.5μ (commonly 1-2μ), contact areas laevigate, remainder of the spore densely ornamented with minute, discrete coni, spinae and occasionally squat bacula and pila. Elements up to 1.5μ high and about 0.5μ in diameter. Exine commonly bears taper-point compression folds.

Dimensions (21 specimens measured). Maximum equatorial diameter 68.8-89.1μ (mean 76.5μ).

Types. Holotype, GSC No. 15505; paratypes, GSC Nos. 15503, 15504.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7560.

Comparisons. *Apiculatisporis microconus* Richardson (1965, p. 566, Pl. 89, fig.3) is larger and possesses slightly coarser coni, spinae and bacula, many of which bear minute papillate terminations. *Punctatisporites grandis* Hoffmeister, Staplin and Malloy (1955a, p. 393, Pl. 36, fig. 7) is also larger (92-120μ) and possesses a thicker exine and a less densely distributed conate ornament. The specimen described by Turnau in Birkenmajer and Turnau (1962, p. 57, Pl. 1, figs. 1-2) as *Lophotriletes*? sp. A. appears superficially similar but is larger (108-122μ) and possesses a thicker exine which bears a densely distributed ornament of minute grana. *Lophotriletes vulgaris* Kedo (1957, p. 18, Pl. 1, fig. 22) possesses a less densely distributed ornament of fine warts (? grana) but is otherwise similar.

Genus *APICULATASPORITES* Ibrahim 1933 (sensu Potonié 1960)

Type species: *Apiculatasporites spinulistratus* (Loose) Ibrahim 1933

Apiculatasporites cf. *dilucidus* McGregor (1960) 1964

Plate III, figures 1, 4, 5

?"Spore-type E" Lang, 1925, p. 256, Pl. 1, fig. 9

?*Azonotriletes punctulatus* Waltz (pars), in Luber and Waltz, 1941, p. 14, Pl. 2, figs. 16a, 16b

?*Trachytriletes punctulatus* (Waltz) Ishchenko (pars), 1952, p. 21, Pl. 4, figs. 35-37

Planisporites dilucidus McGregor, 1960, p. 30, Pl. 11, fig. 10

Apiculatisporis elegans McGregor, 1960, p. 30, Pl. 11, fig. 12

Apiculatasporites dilucidus McGregor, 1964, pp. 13-15, Pl. 2, figs. 12-14

Description of specimens. Spores radial, trilete. Colour pale yellow. Amb circular to subcircular. Trilete mark distinct; laesurae simple, straight, extending 1/2 to 3/4 of the spore radius. Exine 1.5-3μ thick at the

equatorial margin. Surface of the exine densely ornamented with small cone-like elements less than 1μ high. Taper-point compression folds frequently developed on the surface of the exine.

Dimensions (12 specimens measured). Maximum equatorial diameter 49.5-92.4μ.

Types. Hypotypes, GSC Nos. 15506, 15507, 15508. (GSC Loc. 5116)

Remarks. The specimens described here appear to be closely comparable to *Apiculatasporites* (*Planisporites*) *dilucidus* McGregor (1960, 1964) which was originally described from a coal seam assemblage obtained from Stevens Head on the west coast of Melville Island, and was subsequently recorded by McGregor (1964) from the Yahatinda (Ghost River) Formation of Alberta. Because certain minor differences exist between the present specimens and those described by McGregor, the present specimens are only referred conditionally to this species. The present specimens have a larger size range (McGregor, 1960, 51-67μ; 1964, 50-69μ), a thicker exine which frequently develops secondary compression folds, and lack the low lips accompanying the laesurae.

Comparisons. McGregor, 1964 (pp. 14-15) has dealt extensively with the possible synonomy of other forms with *A. dilucidus*. It is of interest to note however that *A. dilucidus* may form part of a morphological series in which *Planisporites minimus* McGregor, 1960 (pp. 29-30, Pl. 11, fig. 9) and *Apiculatisporis elegans* McGregor, 1960 (p. 30, Pl. 11, fig. 12) are the end members. Examination of the holotypes of both of the latter species has revealed close morphological similarities between them and *A. dilucidus*. They appear to form a morphological series in which the size of the ornament increases in relation to increases in the overall size of the spore (*P. minimus*, 32-44.5μ; *A. dilucidus*, 50-69μ; *A. elegans*, 67-85μ). McGregor (pers. comm.) has explained that the small numbers of specimens used in the original description of the three species did not permit any comment to be made on possible morphological intergradations. The present specimens appear to occur between the *A. dilucidus* and *A. elegans* members of the series but closer to the former to which they are therefore referred.

Genus *APICULIRETUSISPORA* Streel 1964

Type species: *A. brandtii* Streel 1964

Apiculiretusispora granulata n. sp.

Plate III, figures 2, 3, 6, 8

Description. Spores radial, trilete. Colour yellow. Amb broadly rounded triangular to subcircular. Trilete mark distinct; laesurae straight, extending 2/3 to 4/5 of the spore radius, accompanied by narrow lips that are slightly elevated in the polar region (height 4μ) but taper gradually to the equator. At the extremities of the laesurae, the lips are fused laterally into the narrow, slightly thickened curvaturae. Exine of the contact areas is slightly thinner than that of the remainder of the spore and its surface is minutely roughened by a very fine infrastructure, probably infragranulation. Remainder of the proximal surface and the entire distal surface bears a densely distributed ornament of minute, discrete grana, about 0.5-1μ in diameter and almost imperceptible as projections at the equatorial margin. Exine 3-4.5μ thick at the equator. In some specimens it is possible to distinguish a thin, frequently folded inner layer (intexine) which is separated to varying degrees from the outer layer (exoexine).

Dimensions (14 specimens measured). Maximum equatorial diameter 72.6-92.4μ (mean 79.8μ).

Types. Holotype, GSC No. 15510; paratype, GSC No. 15509.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. The presence of distinct curvaturae and a fine granular ornament renders appropriate the assignment of this species to the genus *Apiculiretusispora*. The clearly recognizable inner layer in some of the specimens is however a feature not normally associated with the genus. Its presence may necessitate the transfer of the species to another genus when more is known of its significance. In some specimens it is sufficiently regular to warrant it being referred to as a "body", whereas in others it is irregular in form and may simply represent a partial separation of the two layers of the exine that are normally closely appressed.

Comparisons. *Retusotriletes communis* Naumova var. *modestus* Chibrikova (1962, p. 399, Pl. 3, figs. 1-6) from the Eifelian (Calceola series) deposits of western Bashkiria is closely comparable to *Apiculiretusispora granulata* n. sp. It has a broader size range (40-90μ) and the form and extent of the curvaturae are similar, but it may be distinguished by the more flexuous laesurae, the lack of a granular ornament and the lack of evidence to suggest any separation of the component layers of the exine. *Retusotriletes verrucosus* Naumova, which was first formally described by Kedo (1955, p. 22, Pl. 1, fig. 17) from the Middle Devonian of the Byelorussian SSR, also shows some similarity to this species in size (60-90μ) and general construction but differs according to Kedo's description, by possessing an ornament of fine, densely distributed, round tubercles and laesurae which may be accompanied by thickened lips. More detailed comparison is not possible, owing to inadequate description of the Russian species, but comparison with Kedo's illustration suggests that the two species may be in part synonymous. *Retusotriletes subgibberosus* Naumova (1953, pp. 29-30, Pl. 2, fig. 11) differs by possessing a coarser tubercular ornament and stronger, thicker lips accompanying the laesurae. The specimen of this species illustrated by Chibrikova (1959, Pl. 4, fig. 9) appears however to possess a fine tubercular ornament and is closely comparable to *A. granulata* n. sp., although it may be distinguished by possessing thickened lips which are expanded before becoming fused with the curvaturae. *Retusotriletes greggsii* McGregor (1964, pp. 8-10, Pl. 1, figs. 1-12) from the Yahatinda (Ghost River) Formation of Alberta has a broader size range (60-113μ), longer laesurae (at least 4/5 of the spore radius), thicker and wider curvaturae and a more variable ornament.

Apiculiretusispora apsoga (Chibrikova 1962) n. comb.

Plate III, figure 7

Retusotriletes apsogus Chibrikova, 1962, p. 405, Pl. 5, fig. 3

Description of specimens. Spores radial, trilete. Colour orange. Amb broadly rounded triangular to subcircular. Trilete mark distinct; laesurae straight, extending between 2/3 and 3/4 of the spore radius, accompanied by thickened lips individually up to 6μ wide. At the ends of the laesurae, the lips are fused laterally with the slightly thickened, ridge-like curvaturae which are up to 7μ wide. The inner margin of the curvaturae is sharply defined, corresponding with an abrupt change in exine thickness. Exine of the contact areas thinner than that of the remainder of the spore, its surface finely infrapunctate. Remainder of the proximal surface and the entire distal surface bears densely distributed, fairly coarse grana and coni with subcircular, subpolygonal or irregular bases and rounded or bluntly pointed profiles.

Elements 1.5-3μ in diameter, up to 2.5μ high, so densely distributed that the narrow channels of thinner exine between them simulates a negative reticulum. Thickness of the exine at the equator 7.5μ.

Dimensions (2 specimens only). 165 x 125.4μ and 187.5 x 165μ.

Type. Hypotype, GSC No. 15511. (GSC Loc. 7559)

Remarks. *Retusotriletes apsogus* Chibrikova (1962, p. 405, Pl. 5, fig. 3) which was originally described from the Eifelian (Calceola series) of western Bashkiria, is here transferred to the genus *Apiculiretusispora* since it possesses an ornament that Chibrikova described as consisting of closely set tubercles. Examination of Chibrikova's illustration of the species suggests however that the densely distributed ornament is composed of grana, coni and possibly microverrucose elements. The Canadian specimens assigned to this species are closely comparable to the specimen illustrated by Chibrikova. The only noticeable difference is that the Canadian specimens appear to possess wider, more prominent curvatural ridges.

Comparisons. *Retusotriletes parvimammatus* Naumova var. *major* Chibrikova (1959, p. 49, Pl. 4, fig. 11) also figured by Andreyeva 1962 (p. 200, Pl. 3, fig. 7) and *Retusotriletes subgibberosus* Naumova var. *capitellatus* Chibrikova (1962, p. 395, Pl. 1, figs. 13-14) are both smaller and have a finer, densely distributed tubercular ornament. In the latter species, the ornament appears from the illustration to be composed of very small, densely distributed grana, coni, bacula and pila.

Apiculiretusispora nitida n. sp.

Plate III, figures 9-11

Description. Spores radial, trilete. Colour yellow. Amb circular, subcircular to broadly rounded triangular. Trilete mark distinct; laesurae straight, extending 1/2 to 3/4 of the spore radius, frequently accompanied by narrow, slightly elevated lips which are up to 3μ high at the proximal pole and individually up to 2μ wide. Ends of the laesurae are connected by curvaturae which are defined by an abrupt change in the exine thickness and by restriction in the distribution of the ornament. Exine of the contact areas thin, surface smooth. Remainder of the proximal surface and the entire distal surface bears small, densely distributed coni and grana, 0.5-1μ in diameter. Thickness of the exine at the equator 1.5μ. Secondary folds common.

Dimensions (41 specimens measured). Maximum equatorial diameter 36-66μ (mean 44.6μ).

Types. Holotype, GSC No. 15512; paratypes, GSC Nos. 15513, 15514.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. Representatives of this species are frequently preserved in lateral or oblique compression and commonly occur in large sporangial masses. Narrow lips accompanying the laesurae and secondary taper-point compression folds are developed to varying degrees even in the spores from any one sporangial mass.

Comparisons. *Retusotriletes aculeolatus* Chibrikova (1962, p. 401, Pl. 4, figs. 1-3) from the Eifelian (Calceola series) of western Bashkiria is very similar to this species and may be in part be synonymous with it. It possesses similar laesurae, curvaturae and exine ornamentation and is distinguishable only by its larger size range (40-90μ) and the absence of lips accompanying the laesurae. *Retusotriletes brevidenticulatus* Chibrikova (1962, p. 407, Pl. 5, fig. 7) is also similar but possesses a less densely distributed

ornament of short spines and no lips accompany the laesurae which sometimes appear to be slightly flexuous. *Apiculiretusispora brandtii* Streel (1964, pp. 8-10, Pl. 1, figs. 6-10, text fig. 2) from the lower Givetian of Belgium is closely comparable in general organization and in exine ornamentation, but is larger (60-101μ). *Retusotriletes subattenuatus* Chibrikova (1962, pp. 394-395, Pl. 1, figs. 11-12) from the Givetian of western Bashkiria, possesses a similar ornament of small, densely distributed cones but may be readily distinguished by its smaller size (25-35μ), the thicker exine which appears to form a ? limbate equatorial margin, the curvaturae imperfectae and the relatively darker or lighter triangular area at the proximal pole. *Retusotriletes sterlibaschevensis* Chibrikova var. *denticulatus* Chibrikova (1962, pp. 406-407, Pl. 5, fig. 5) from the Eifelian deposits of western Bashkiria possesses a similar fine conate ornament, but has shorter laesurae, an apparently thicker exine that forms a narrow ? limbate margin at the equator and a dark triangular area in the angles between the laesurae. *Retusotriletes rarus* Kedo (1957, p. 16, Pl. 1, figs. 11-12) from the Famennian of the Byelorussian SSR may be in part synonymous with this species. Although the specimens illustrated by Kedo are closely comparable in size (40-50μ), shape, general organization and exine ornamentation, one of the specimens (fig. 12) possesses flexuous curvaturae and curvaturae imperfectae.

Apiculiretusispora sp. A.

Plate IV, figure 1

Description. Spores radial, trilete. Colour orange. Amb subcircular. Trilete mark distinct; laesurae straight, 2/3 of the spore radius in length, accompanied by relatively narrow, low lips, up to 4μ wide. The ends of the laesurae are connected by thickened, ridge-like curvaturae which are only slightly invaginated in the radial positions. The curvaturae are sharply defined on their inner sides but merge gradually into the exine on the equatorial sides. Contact areas bear minute grana. Remainder of the proximal surface and the entire distal surface bear densely distributed discrete grana or small coni, the height and basal diameter of which do not exceed 2μ. Ornament barely perceptible at the equatorial margin. Thickness of the exine at the equator 4.5-6μ. There is no apparent difference between the thickness of the exine of the contact areas and that of the remainder of the spore. Compression folds may occur on the distal surface.

Dimensions (2 specimens). 207 x 180μ and 255 x 217μ.

Type. Hypotype, GSC No. 15515. (GSC Loc. 7559)

Comparisons. This form is readily distinguished from all predescribed species of *Apiculiretusispora* Streel and *Retusotriletes* (sensu Naumova), but it does resemble several of the larger representatives of the genus *Retusotriletes* (sensu Naumova) described by Chibrikova (1959 and 1962). *Retusotriletes parvimammatus* Naumova var. *major* Chibrikova (1959, p. 49, Pl. 4, fig. 11) from the Takata beds of the Devonian of western Bashkiria is similar in general appearance but is smaller (110-150μ) and has coarser tubercles. *Retusotriletes obliteratus* Chibrikova (1962, pp. 399-400, Pl. 3, figs. 7-8) from the Eifelian (Calceola series) of western Bashkiria is also similar but is smaller (120-170μ), has longer, simple laesurae, and a coarsely shagreen exine. *Retusotriletes aculeolatus* var. *major* Chibrikova (1962, p. 401, Pl. 4, fig. 4) also from the Eifelian of western Bashkiria is smaller (65-140μ) and has a rounded triangular amb, wider and thicker lips accompanying the longer laesurae, and thicker, broader, more prominent curvaturae. It does however possess a similar fine granular ornament.

Apiculiretusispora sp. B.

Plate IV, figure 2

Description. Spores radial, trilete. Colour amber brown. Amb broadly rounded triangular to subcircular. Trilete mark distinct; laesurae straight, 2/3 to 4/5 of the spore radius in length, accompanied by thickened lips, individually 1.5-4.5μ wide, which are slightly elevated in the polar region. Ends of the lips fuse laterally with the thickened ridge-like curvaturae which are slightly invaginated in the radial positions. The inner margin of the curvaturae is sharply defined whereas the outer is transitional with the rest of the exine. Exine of the contact areas slightly thinner than that of the remainder of the spore, surface minutely roughened due to very dense, fine infrastructure. Exine of the remainder of the proximal surface and the entire distal surface densely ornamented with minute, discrete grana and spinae. Thickness of the exine at the equator 6.7-10μ.

Dimensions (2 specimens). 165 x 138μ and 201.3 x 194.7μ.

Type. Hypotype, GSC No. 15516. (GSC Loc. 7559)

Remarks. In both of the specimens there is evidence of the separation of the two layers of the exine. An indistinct, sometimes folded inner layer was observed in both although the degree of separation of the two layers was variable in either spore.

Comparisons. This form differs from all previously described species of the genus *Retusotriletes* (sensu Naumova) in its large size and minute granular or spinose ornament. *Retusotriletes aculeolatus* var. *major* Chibrikova (1962, p. 401, Pl. 4, fig. 4) from the Eifelian deposits of the western slopes of the southern Urals, is smaller (65-140μ), lacks the strong ridge-like curvaturae and possesses an apparently coarser, conate ornament although no actual measurements are available for comparison. *Retusotriletes asperellus* Chibrikova (1962, p. 403, Pl. 4, fig. 8), also from the Eifelian deposits of the southern Urals, may be distinguished by its smaller size (125-150μ) and lack of strong ridge-like curvaturae, but in addition it differs by possessing shorter laesurae and a shagreen exine which lacks positive ornament. *Retusotriletes ambagiosus* Chibrikova (1962, pp. 395-396, Pl. 2, figs. 1-3) is smaller (100-150μ) and possesses a shagreen exine with scattered small cones and spines, a wide limbate-like equatorial margin, slightly flexuous laesurae and no strong ridge-like curvaturae.

Genus *VERRUCOSISPORITES* (Ibrahim) Smith and Butterworth 1967

Type species: *Verrucosisporites verrucosus* Ibrahim 1932

Verrucosisporites confertus n. sp.

Plate IV, figures 3-6

Description. Spores radial, trilete. Colour orange to brown. Amb circular to subcircular. Trilete mark distinct; laesurae straight or slightly flexuous, simple or with very narrow lips, extending between 2/3 and the full spore radius. In some specimens the laesurae are of unequal length and the shortest are about 1/2 of the spore radius in length. Exine bears a densely distributed ornament of large verrucae with circular, subcircular, polygonal or irregular basal outlines and either rounded or flat tops. Smaller elements with circular basal outlines occur in the spaces between the larger elements. The elements, which are separated by narrow channels of thinner exine, are normally discrete although basal coalescence between adjacent elements may

occur. Ornament reduced or absent on the contact faces. Diameter of verrucae 3-12μ (commonly 6-10μ), height 3-6μ. Exine thick, producing a pseudolimbate margin. Exine thickness in the equatorial plane difficult to determine due to densely distributed projecting ornament.

Dimensions (16 specimens measured). Maximum equatorial diameter 73.4-108.9μ.

Types. Holotype, GSC No. 15517; paratypes, GSC Nos. 15518, 15519.

Type locality. Griper Bay Formation, west side of Mould Bay, Prince Patrick Island, Northwest Territories, GSC Loc. 7558.

Comparisons. *Lophozonotriletes evlanensis* Naumova (1953, p. 77, Pl. 11, fig. 15) from the upper Frasnian of the USSR appears superficially closely comparable to this species. However it is smaller (60-65μ) and possesses shorter laesurae and a finer but equally densely distributed verrucose ornament. It is also assumed from Naumova's assignment of this species to the genus *Lophozonotriletes* that it possesses some form of thickened equatorial structure although none is mentioned in her description of the species. *Lophozonotriletes macrogrumosus* Kedo (1957, p. 33, Pl. 4, figs. 21-22) from the Tournaisian of the Pripyat Depression, Byelorussian SSR, possesses a thickened equatorial structure and a finer, less densely distributed verrucose ornament. *Verrucosisporites eximius* Playford (1962, p. 587, Pl. 80, figs. 5-8, text fig. 5d) from the Lower Carboniferous of Spitsbergen is similar although slightly smaller (52-88μ), but possesses wide conspicuous lips accompanying the laesurae and a densely distributed verrucose ornament, the elements of which may be slightly larger but appear to be more constant in size on each specimen. *V. venustus* Artuz (1957, pp. 243-244, Pl. 2, figs. 11a, b) from the Naumurian of the Zonguldak Coalfield, Turkey is larger (110-165μ) and possesses a finer verrucose ornament. *V. kaipingiensis* Imgrund (1960, pp. 162-163, Pl. 14, fig. 51, Pl. 15, fig. 59) is larger and possesses a more variable, verrucose ornament which is frequently finer than that of *V. confertus* n. sp. *V. ovimammus* Imgrund (1960, p. 162, Pl. 14, figs. 49,50) is similar in size but has a finer verrucose ornament of more varied and irregular form.

Verrucosisporites variabilis McGregor, 1960

Plate IV, figure 9

Dimensions (9 specimens measured). Maximum equatorial diameter 46-67μ.

Type. Hypotype, GSC No. 15520. (GSC Loc. 5116)

Genus *Verruciretusispora* n. gen.

Type species: *Verruciretusispora robusta* n. sp.

Diagnosis. Spores radial, trilete; amb subcircular to rounded triangular. Laesurae usually distinct, commonly accompanied by elevated lips or folds of the exoexine, with clearly defined low and narrow, or wide and ridge-like, curvaturae connecting the ends of the laesurae. Exine of the contact areas smooth or bearing a reduced ornament, exine of the remainder of the proximal surface and the entire distal surface verrucose. The verrucae may be surmounted by small mammoid cones and spines.

Comparisons. *Retusotriletes* (Naumova) Streel (1964) possesses a laevigate exine, and *Apiculiretusispora* Streel (1964) possesses a spinose, conate or granular exine. Both are otherwise similar in construction to

Verruciretusispora. *Verrucosisporites* (Ibrahim) Smith and Butterworth (1967) possesses a similar ornament but lacks clearly defined curvaturae and the consistent reduction or absence of the ornament in the contact areas. *Cymbosporites* Allen (1965) appears superficially similar but may, according to Allen's description be distinguished by the patinate character of the equatorial and distal portions of the exoexine and by the conate, granular or spinose ornament. Detailed examination of the illustration of the type species *C. cyathus* Allen (1965, Pl. 101, figs. 8-11) suggests, however, that the apparent patinate structure of the exoexine may be the result of a pronounced reduction in thickness of the exoexine over the contact areas. There appears to be some evidence to suggest that the contact areas are bounded by broad, low, ridge-like curvaturae which are clearly invaginated in the radial positions and which are accentuated by a more densely distributed granular, conate or spinose ornament. Further detailed comparison is needed before the precise relationships between *Cymbosporites* and the *Apiculiretusispora* and *Verruciretusispora* complex of spores can be fully established.

Verruciretusispora robusta n. sp.

Plate IV, figures 7,8, 10,11

Retusotriletes sp. *in* McGregor and Owens 1966, Pl. IX, figs. 3, 4

Description. Spores radial, trilete. Colour yellow to orange brown. Amb rounded triangular to subcircular. Trilete mark distinct; laesurae straight, extending between 2/3 and 7/8 of the radius of the spore, commonly open and frequently accompanied by low, narrow folds which may be up to 3μ high at the proximal pole. Ends of the laesurae are connected by distinct curvaturae which are commonly coincident at least, over part of their length, with the equator of the spore. Contact areas clearly defined, laevigate, exine slightly thinner than over the remainder of the spore. In the angles between the laesurae the exine is darker (? thicker) and forms a straight sided triangular area, the radii of which extend 1/3 to 2/3 of the length of the laesurae. Exine of the remainder of the proximal surface and the entire distal surface laevigate to finely infrapunctate and bearing large verrucae which are subcircular in basal outline and rounded or hemispherical in profile. Diameter of the verrucae 1.5-9.2μ, height 2-4.6μ. The verrucae are loosely distributed over the entire distal surface and may also occur on the proximal surface, particularly where the curvaturae are invaginated. Thickness of the exine at the equator 1-1.5μ.

Dimensions (9 specimens measured). Maximum equatorial diameter 59.4-75.9μ (mean 65.9μ).

Types. Holotype, GSC No. 15521; paratypes, GSC Nos. 15522, 15523, 15524.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7557.

Remarks. Although only 9 specimens of this species have been recorded, the distinctive exine ornamentation together with the presence of curvaturae are considered sufficient justification for them being given specific status. Considerable variation was observed in the size of the ornament, but the elements on any one specimen were nearly constant in size. Marginal compression folds were commonly observed.

Comparisons. This species is distinguishable from all previously described species of the genus *Retusotriletes* (sensu Naumova) and of

Verrucosisporites (Ibrahim) Smith and Butterworth (1967) by the globular character of the verrucose ornament, a feature unknown in the former genus, and the presence of curvaturae, a feature unknown in the latter genus.

Lophotriletes macrotuberculatus described by Kedo (1963, p. 51, Pl. 4, fig. 83) from the Tournaisian sediments of the Pripyat Depression of the Byelorussian SSR, resembles this species in some respects but lacks curvaturae and possesses a narrow thickened equatorial margin. There are several species of the genus *Lophozonotriletes* (Naumova) Potonié (1958) which possess an ornament similar to that of *Verruciretusispora robusta* n. sp., i.e. *Lophozonotriletes retusus* Naumova (1953, p. 75, Pl. 11, fig. 9), *L. torosus* Naumova (1953, p. 76, Pl. 11, fig. 12), *L. tylophorus* Naumova (1953, p. 76, Pl. 11, fig. 13), *L. lebedianensis* Naumova (1953, p. 119, Pl. 17, fig. 42, and p. 132, Pl. 19, figs. 32-34) and *L. concessus* Naumova (1953, p. 75, Pl. 11, figs. 7,8), but all are cingulate and lack curvaturae. *Verruciretusispora robusta* n. sp. is similar to the specimen illustrated in McGregor and Owens (1966, Pl. VI, fig. 2) as *Verrucosisporites* sp. from the Battery Point Formation, eastern Gaspé Peninsula, Quebec. McGregor (pers. comm.) regards the figured specimen as being close to the upper limit of the size range (75-135μ) of this group of spores from the Battery Point Formation. The Gaspé specimens appear to differ from *V. robusta* only with respect to size.

Verruciretusispora magnifica (McGregor) n. comb. var. *magnifica*, emend.

Plate V, figures 1-6

Lycospora magnifica McGregor, 1960, p. 35, Pl. 12, fig. 5 and Pl. 13, figs. 2-4
Lycospora magnifica McGregor, *in* Playford, 1964, p. 34, Pl. 10, figs. 1-4
Hymenozonotriletes acerosus Archangelskaya, 1963, p. 25, Pl. 10, figs. 1-5
cf. *Lycospora magnifica* McGregor, *in* McGregor and Owens, 1966, Pl. XV, figs. 8,9

Description. Spores radial, trilete. Amb rounded triangular to almost circular. In laterally compressed specimens the proximal surface is flattened or low pyramidal, the distal surface hemispherical. Laesurae straight or slightly sinuous, 2/3 to 3/4 of the spore radius in length, frequently accompanied by elevated slightly thickened lips, 2-6μ in overall width. Ends of the laesurae are connected by thickened arcuate ridges or curvaturae which, if located on or close to the equatorial margin of the spore, may simulate an ill-defined cingulum. Inner margin of the curvaturae distinct, corresponding with an apparent change in the thickness of the exine of the proximal surface, outer margin poorly defined and commonly gradational with the exine of the remainder of the spore. Curvaturae 4-10μ wide, slightly invaginated in the radial position. Exine of the contact areas thin, scabrate to distinctly infrapunctate. Exine of the remainder of the proximal surface, including the curvaturae and the entire distal surface also infrapunctate and bears a sparsely to densely distributed verrucose ornament. Verrucae circular, subpolygonal or irregular in basal outline, rounded in profile and normally terminated by a small, cone-like mammoid projection, diameter 3-5μ, height up to 3μ. Small, scattered coni and grana may occur between the verrucae. Elements normally discrete although basal coalescence between adjacent elements may occur, particularly on or adjacent to the curvaturae where the verrucae are more densely distributed. Small, scattered verrucae may sometimes be observed on the proximal surface in the angles between, and closely adjacent to, the laesurae.

Dimensions (172 specimens measured). Maximum equatorial diameter 69.3-122.1μ (mean 102.3μ).

Types. Hypotypes, GSC Nos. 15525, 15526, 15527, 15528, 15529, 15530, 15531, 15532, 15533. (GSC Loc. 5116)

Remarks. *Verruciretusispora magnifica* (McGregor) n. comb. var. *magnifica* emend. is the dominant component in a complex of spores which is particularly abundant in certain coal seam assemblages examined during the present investigation. This complex of spores which ranges from *V.* (*Lycospora*) *pallida* (McGregor) n. comb., emend. (size 64-82μ, with a granular or fine verrucose ornament) through *V. magnifica* var. *magnifica* (size 69-119μ, with a verrucose ornament) to *Verruciretusispora* (*Verrucosisporites*) *grandis* (McGregor) n. comb., emend. (size 98-150μ, with a coarse verrucose ornament), forms an intergrading morphological series with respect to both size and the nature of the ornamentation. Although it is possible to recognize specimens that are closely comparable to the respective holotypes, it is almost impossible to define the limits of specific variation within the three component species of the complex. Although this complete morphological intergradation could be considered sufficient justification for the combination of the three species into one large specific unit, such a step is not proposed here, because it would result in one species whose range of morphological variation is greater than is desirable for specific status. It is considered preferable to retain the identity of the three species and accept that more or less complete morphological intergradation exists between them.

Detailed examination of several hundred specimens, including representitives of all three component species in the complex, has shown that they possess certain fundamental morphological features which justify their transfer to the present genus. The original assignment of *V. magnifica* var. *magnifica* and *V. pallida* to *Lycospora* by McGregor (1960) was based principally on his interpretation of the thickened ridge-like curvaturae, which commonly occur at the equatorial margin, as a cingulate structure. This interpretation is not accepted for two reasons. Firstly, in laterally and obliquely compressed specimens as well as those in proximal-distal compression, the thickened curvaturae are clearly observed to be invaginated in the radial positions. Although this character is typical of forms belonging to the genus *Retusotriletes* (sensu Naumova), it is unknown in truly cingulate genera i.e. *Densosporites*, *Lycospora* or *Stenozonotriletes*. Secondly, if McGregor's interpretation were correct, it would be anticipated that the cingulate structure would to some extent control the orientation of the spore during compression. Several workers have pointed out that cingulate spores are most frequently compressed in proximal-distal orientation, and that specimens in lateral compression are rare. In the case of the spores of this complex, laterally and obliquely compressed specimens occur with almost equal frequency in some assemblages to those in proximal-distal orientation.

With respect to the *V. grandis* (McGregor) n. comb. members of the complex, the original assignment of this species to the genus *Verrucosisporites* by McGregor (1960) was based on the nature and the distribution of the ornament. All of the specimens observed during the current investigation and which are assigned to this species are characterized not only by the distinctive ornamentation, but also by well-developed curvaturae similar to those of *V. magnifica* var. *magnifica* and *V. pallida*. Examination of the holotype (McGregor, 1960, Pl. 11, fig. 11) has revealed the presence of curvaturae. Specimens of *V. grandis* from the type material illustrated by Smith (1964, Pl. 1, figs. 8 and 11) also show the development of curvaturae and the reduced granular ornament on the contact areas.

Because well-developed curvaturae and a verrucose ornament that may be reduced or absent on the contact faces are features that have been used in the circumscription of *Verruciretusispora* n. gen., the entire complex is transferred to that genus. Transfer to the genus *Verrucosisporites* was considered but rejected because prominent, thickened curvaturae are atypical of that genus. *Dibolisporites* Richardson, 1965 (p. 568) was also rejected because,

although the spores of this complex possess a similar ornament of biform elements (verrucae terminated by small, mammoid, cone-like projections), they also possess curvaturae, a character that has not so far been associated with that genus.

Comparisons. *V. pallida* (McGregor) n. comb. has a finer ornament of grana and small verrucae. *V. grandis* (McGregor) n. comb. has a coarser verrucose ornament and, a larger size range. *Hymenozonotriletes acerosus* Archangelskaya (1965, p. 25, Pl. 10, figs. 1-5) from the Middle Devonian deposits of the Russian Platform appears closely comparable to, and may be completely synonymous with *V. magnifica* var. *magnifica*. It possesses a similar densely distributed ornament of verrucae, each surmounted by a small, mammoid conate projection, which are absent from the contact areas, and also possesses similar well-developed curvaturae. *Cymbosporites cyathus* Allen (1965, pp. 725-726, Pl. 101, figs. 8-11), described from the Givetian deposits of Vestspitsbergen, also appears superficially similar. Allen has interpreted the exine, which is thin over the contact areas and much thicker over the remainder of the spore, as patinate in character. He apparently did not recognize the presence of clearly defined contact areas surrounded by thickened curvaturae, although such structures appear to be present on the specimens illustrated (particularly on Pl. 101, fig. 10). The curvaturae, which appear from Allen's description and illustrations to result from an abrupt change in exine thickness, are invaginated in the radial positions where they also become fused with the lips accompanying the laesurae, and are apparently accentuated by a concentration of the ornamentation elements on or adjacent to their margins. Although somewhat smaller (53-80μ) than *V. magnifica* var. *magnifica*, *C. cyathus* possesses a similar ornament composed predominantly of conate elements with small, mammoid, spinose terminations. Although the two species appear to be readily separable on the basis of size and the character of the ornamentation, complete morphological intergradation may exist between them which would necessitate the transfer of *C. cyathus* to *Verruciretusispora* n. gen.

Previous records. *V. magnifica* var. *magnifica* was originally described by McGregor from talus coal fragments of probable Frasnian age from Stevens Head on the west coast of Melville Island. The material utilized during the present investigation was probably obtained from the same horizon. Playford (1964) recorded this species from the Horton Group (Mississippian) of Nova Scotia.

Verruciretusispora magnifica var. *endoformis* (McGregor) n. comb.

Plate V, figure 7

Lycospora magnifica forma *endoformis* McGregor, 1960, p. 36, Pl. 12, figs. 9-10
Lycospora magnifica McGregor (pars) in Playford, 1964, p. 34, Pl. X, figs. 1-4

Dimensions (32 specimens measured). Maximum equatorial diameter 72-118.5μ.

Type. Hypotype, GSC No. 15534. (GSC Loc. 5116)

Verruciretusispora pallida (McGregor) n. comb., emend.

Plate VI, figures 1-4

Lycospora pallida McGregor, 1960, p. 36, Pl. 12, fig. 11 and Pl. 13, fig. 1

Description. Spores, radial, trilete. Colour pale yellow to orange. Amb subcircular to broadly rounded triangular. In laterally compressed specimens, proximal surface flat, distal surface hemispherical. Trilete mark distinct to

indistinct; laesurae straight to slightly flexuous, length 2/3 to the full spore radius, accompanied by low or slightly elevated narrow lips, overall width not exceeding 4.5μ. Ends of the laesurae are connected by thickened, arcuate, ridge-like curvaturae of variable width which may be located at or close to the equatorial margin. Inner margin of the curvaturae clearly defined and coincides with a marked change in exine thickness; outer margin frequently difficult to define due to gradual transition with the remainder of the exine. Curvaturae invaginated in the radial positions. Exine of the contact areas thin, densely infrapunctate. Over the remainder of the proximal surface and the entire distal surface, the exine, in addition to being infrapunctate, bears a granular or fine verrucose ornament. Elements round, ovoid or irregular in outline, 1-3μ in diameter, up to 1.5μ high, surmounted by a small apical cone. In some specimens the elements are discrete and fairly widely spaced; in others considerable basal coalescence between adjacent, densely distributed elements produces a rugose pattern. Some specimens bear verrucose elements on the proximal surface in the angles between the laesurae.

Dimensions (35 specimens measured). Maximum equatorial diameter 56.1-79.2μ. This therefore extends the lower limit of the size range of 64-82μ quoted by McGregor (1960).

Types. Hypotypes, GSC Nos. 15535, 15536, 15537, 15538. (GSC Loc. 5116)

Remarks. Although minor separation of the component layers of the exine was recorded in some specimens, the degree of separation was variable and did not justify varietal status.

Comparisons. *V. magnifica* var. *magnifica* may be distinguished by its larger size (69.3-122.1μ) and by its coarser verrucose ornament. Morphological intergradations do however exist between the two species.

Verruciretusispora grandis (McGregor) n. comb., emend.

Verrucosisporites grandis McGregor, 1960, p. 31, Pl. 11, fig. 11
Verrucosisporites grandis McGregor *in* Smith, 1964, p. 1073, Pl. 1, figs. 8-11

Description. Spores radial, trilete. Colour pale yellow to orange. Amb rounded triangular to circular. In laterally compressed specimens proximal surface either flattened or slightly pyramidal, distal surface hemispherical. Trilete mark normally distinct; laesurae straight, length 3/4 of the spore radius, accompanied by thin, elevated folds or lips which decrease in height and width towards the equator. Ends of the laesurae are connected by distinct or indistinct, slightly thickened, ridge-like curvaturae which coincide with a marked change in the thickness of the exine. The curvaturae, which at least in part occur at the equator of the spore, are most readily observed in lateral or oblique compressions. Inner margin of the curvaturae distinct, outer margin grades into the exine of the equatorial region of the proximal surface. Exine of the contact areas thin, densely infrapunctate and ornamented with fine, scattered grana, exine of the remainder of the spore also infrapunctate and in addition bears a coarse, densely distributed verrucose ornament. Verrucae rounded or irregular in shape, 3.5-7μ in diameter, rounded in lateral profile and terminated by a small mammoid cone or spine. The elements which are most densely distributed on or closely adjacent to the curvaturae are commonly fused at their bases to form short irregular ridges which may bear up to 5 small mammoid cones or spines. A thin, partly folded, inner body (intexine) variably separated from the outer layer of the exine (exoexine) was observed in some specimens.

Dimensions (17 specimens measured). Maximum equatorial diameter 89.1-132.2μ.

Remarks. McGregor (1960) described the verrucose ornament as being comprehensively developed over the entire surface of the spore although some of the elements on the proximal surface were smaller than those on the distal surface. Smith (1964, p. 1073) who examined additional specimens from the type material demonstrated the verrucose ornament to be absent from the proximal surface which is characterized by its dense infrapunctation and fine granular ornament. Neither McGregor nor Smith recognized the existence of curvaturae, although McGregor did comment that "there is usually a very slight elongation and fusion of the verrucae at the boundary of the contact faces". The possession of clearly defined curvaturae together with a verrucose ornament are considered sufficient justification for the transfer of this species to the genus *Verruciretusispora* n. gen.

Comparisons. This species is the end member of the *V. pallida* (McGregor) n. comb., emend., - *V. grandis* (McGregor) n. comb., emend. complex. It grades into *V. magnifica* (McGregor) n. comb. var. *magnifica* emend. by reduction in the size of the verrucose elements and the overall size of the spore. *Verrucosisporites ovimammus* Imgrund (1960, p. 162, Pl. 14, figs. 49-50) and *Verrucosisporites kaipingiensis* Imgrund (1960, pp. 162-163, Pl. 14, figs. 51, Pl. 15, fig. 59) both possess a superficially similar verrucose ornament but lack curvaturae and possess shorter laesurae and simple verrucose elements which lack the small mammoid terminations which characterize the ornament of *V. grandis*. *Verrucosisporites venustus* Artuz (1957, pp. 243-244, Pl. 2, fig. 11) from the Namurian of the Zonguldak Coalfield, Turkey, also differs by lacking curvaturae and also by possessing a verrucose ornament composed of discrete elements with a circular outline, which show no tendency to basal fusion with adjacent elements.

Genus *HYSTRICOSPORITES* McGregor 1960

Hystricosporites McGregor, 1960, p. 31
Dicrospora Winslow, 1962, pp. 49-52

Type species: *Hystricosporites delectabilis* McGregor 1960

Restated diagnosis. Radial, trilete, in part camerate miospores and megaspores. Amb circular, subcircular to broadly rounded triangular. Proximal surface commonly flattened, distal surface inflated or hemispherical. Exine thick, composed of two layers which are normally closely appressed, but which may be occasionally in part separated. Trilete mark normally distinct; laesurae commonly accompanied by thin, elevated, flexuous folds of the exoexine which may form an apical prominence. Contact areas normally distinct, delimited by variably defined curvaturae or by a marked change in the thickness of the exine. Contact areas may be ornamented with a variable number of radially orientated, thickened ribs. Remainder of the surface of the exoexine bears concentrically arranged, discrete, gently tapering processes with distinctive bifurcate terminations.

Remarks. Examination of the holotype (McGregor, 1960, Pl. 11, fig. 13) and of additional specimens from the type material has revealed the presence of well-defined contact areas bounded by indistinct curvaturae and ornamented by stout, radially orientated, rib-like thickenings. Because these features appear to be characteristic of all the species assigned to this genus, it is considered desirable to enlarge the original diagnosis accordingly.

In view of the increasing morphological complexity displayed by the processes of the various representatives of this genus, it is considered

desirable to propose a number of descriptive terms to standardize their description. The terms proposed are summarized diagrammatically in text figure 4.

Comparisons. The genus *Dicrospora* described by Winslow (1962, pp. 49-52) appears to be circumscribed by features almost identical with those utilized in the description of *Hystricosporites*. Winslow on her own admission (p. 5) did not consider the large amount of relevant taxonomic literature published after September 1955, and there would appear therefore to be no justification for the retention of *Dicrospora*, in the sense proposed by Winslow, as a separate genus. Most of the species of *Dicrospora* described by Winslow, can be satisfactorily accommodated within the emended concept of *Hystricosporites*, although the specimens described by her as *Dicrospora* sp. (p. 55, Pl. 12, fig. 1) and *Dicrospora* sp. C. (p. 55, Pl. 12, figs. 3 and 3a) may be more suitably accommodated in the megaspore genus *Nikitinsporites* Chaloner.

Considerable morphological variation is exhibited in the species of *Dicrospora* described by Winslow. In the majority of the species, the contact areas are clearly defined and in most cases are smooth, although in two of the species, *D. porrecta* (p. 52, Pl. 11, figs. 4-5a and Pl. 12, fig. 5) and *Dicrospora* sp. A. (pp. 54-55, Pl. 11, figs. 2-3a), they possess coarse, radially orientated, thickened ridges and small, irregular, hemispherical tubercles respectively on the surface of the contact areas. Considerable variation was also recorded in the form of the bifurcate terminations to the processes.

The megaspore genus *Nikitinsporites* Chaloner (1959) differs from *Hystricosporites* in its larger size, more pronounced development of a strong apical prominence, and lack of clearly defined contact areas. *Archaeotriletes* Naumova (1953) is a loosely defined "subgroup" which appears to accommodate spores of varied construction which possess processes with bifurcate terminations. As defined by Naumova, this subgroup may be distinguished from *Hystricosporites* by the lack of clearly defined contact areas, the possession of an equatorial flange, and the inconsistent distribution of the ornamentation elements which in some species appear to be restricted to the equatorial region whereas in others they appear to be developed over the entire surface of the spore.

Ancyrospora Richardson (1960) possesses a fundamentally similar type of ornamentation to *Hystricosporites* but may be distinguished by possessing an equatorial flange or "pseudoflange". Lang (1925) described a similar type of spore from the Middle Old Red Sandstone of Scotland which he referred to as "Spore Type G". Examination of the illustration of this spore (Lang, 1925, Pl. 1, fig. 13) suggests that the spore may possess an inner body surrounded by an equatorial flange, and would therefore be more suitably accommodated in *Ancyrospora*.

Hystricosporites delectabilis McGregor 1960

Plate VI, figures 5,6; text figure 5

Description. Spores radial, trilete, in part camerate. Colour orange brown. Amb, excluding projecting ornament, circular to subcircular; proximal surface flattened, distal surface inflated or hemispherical. Exine composed of two layers, the exoexine which is thick and is either minutely roughened or very finely, densely punctate, and the thinner intexine. The two layers are normally closely appressed, although occasionally they may be variably separated in the equatorial region and over part of the distal surface. Intexine may possess numerous, randomly orientated, taper-pointed compression folds on its distal surface. Trilete mark distinct; laesurae poorly defined, commonly obscured by elevated, flexuous folds of the exoexine which accompany the laesurae along their entire length and form an apical prominence up to 35μ high at the proximal pole. Contact areas indistinct, curvaturae poorly

developed, appearing in some specimens as low, slightly thickened ridges. Contact areas possess radially orientated, thickened ridges, up to 6μ wide at their equatorial extremity but tapering slightly towards the proximal pole. Exoexine of the equatorial portion of the proximal surface and the entire distal surface bears bulbous based processes, with bifurcate terminations, which are arranged in a concentric manner. The processes, variable in form, consist of a bulbous base, a shaft which commonly tapers markedly in its lower part but which is more or less parallel sided in its upper portion, and an expanded and reflexed bifurcate termination. Length of the processes 19-46μ, basal diameter 4.6-13μ.

Dimensions (19 specimens measured). Maximum equatorial diameter, excluding projecting ornament, 132-257μ (mean 183μ).

Types. Hypotypes, GSC Nos. 15539, 15540. (GSC Loc. 5116)

Remarks. Examination of the holotype (McGregor, 1960, Pl. 11, fig. 13) and of other specimens of this species from the type material by D.C. McGregor and the present writer has revealed the presence of radially orientated, thickened ridges on the surface of the contact areas, and folds of the exoexine, associated with the laesurae, which form an apical prominence. The circumscription of the species is here accordingly expanded. The size range recorded in the present investigation extends the lower size limit of the species. The lack of specimens with equatorial diameters in excess of 257μ recorded during the present investigation is considered to be the result of sieving the samples to separate off the "megaspore" fraction (in excess of 250μ) of the assemblage. Any specimens of this species which are present in the "megaspore" fraction will be recorded in a later publication.

Comparisons. *Hystricosporites costatus* Vigran (1964, pp. 14-15, Pl. 5, figs. 3-5) is similar but is smaller (75-165μ) and bears processes with bifurcate terminations which are more or less triangular and not extended and reflexed. *H. furcatus* n. sp. is also smaller but the processes bear bifurcate terminations which are usually extended. *H. reflexus* n. sp. is smaller and possesses processes which are shorter, more densely distributed and with more bulbous bases than those of *H. delectabilis*.

Hystricosporites furcatus n. sp.

Plate VI, figures 7-9; text figure 6

Description. Spores radial, trilete, in part camerate. Colour orange brown. Amb circular to subcircular; proximal surface flattened, distal surface inflated or hemispherical. Exine composed of two layers, closely appressed in some specimens but normally variably separated. Intexine thin, commonly highly folded. Exoexine thick, finely and densely punctate, granular or microvermiculate. Exoexine over the distal surface (measured on laterally compressed specimens) 4-7μ thick, increasing in the equatorial region to 7-16μ where it forms a shoulder between the proximal and distal surfaces. Trilete mark distinct; laesurae straight, extending 1/2 to 3/4 of the radius of the spore, commonly obscured by high, thin, finely punctate or granular, contorted folds of the exoexine which form an apical prominence 16.5-30μ high. Ends of the laesurae are connected by irregular, wide, ridge-like curvaturae. Contact areas distinct, possess numerous straight, radially orientated, coarse, thickened ridges. Exoexine of the equatorial portion of the proximal surface and the entire distal surface bears distinctive processes with bifurcate terminations. Each process consists of a bulbous base with a circular outline and a stout, gently tapering shaft with a slightly extended bifurcate termination. Processes are arranged concentrically with the greatest concentration occurring

on the more equatorial portions of the proximal and distal surfaces. Number of processes projecting at the equatorial margin 18-57. Length of the processes 15-46.2μ, basal diameter 4-12μ.

Dimensions (47 specimens measured). Maximum equatorial diameter, excluding projecting ornament 82.5-174.9μ (mean 108.9μ).

Types. Holotype, GSC No. 15541; paratypes, GSC Nos. 15542, 15543.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. The majority of specimens measured, fell into the 82.5-122μ size range and only occasional specimens were recorded in the 132-174.9μ range. Although a break in the size range exists between the two morphologically identical groups of spores, they are here retained within one species because it seems probable that intermediate members will be eventually found.

Comparisons. *Hystricosporites corystus* Richardson (1962, pp. 173-174, Pl. 25, figs. 1 and 2, text fig. 2) described from the Middle Old Red Sandstone (Givetian) of Scotland is larger (129-213μ), possesses a less densely distributed ornament of more slender elements with extended and reflexed bifurcate terminations, and lacks clearly defined contact areas ornamented with radially orientated, thickened ridges. *H. costatus* Vigran (1964, pp. 14-15, Pl. 5, figs. 3-5) described from the Devonian of Spitsbergen is closely comparable to *H. furcatus* n. sp. but has a rounded triangular equatorial outline and a more densely distributed ornament of processes with simple, triangular, bifurcate terminations. *H. delectabilis* McGregor (1960) emend. is larger and possesses a different type of bifurcate termination to the processes.

Hystricosporites reflexus n. sp.

Plate VII, figures 1-4; text figure 7

Description. Spores radial, trilete, in part camerate. Colour orange brown. Amb circular to subcircular; proximal surface flattened, distal surface inflated, hemispherical. Exine composed of two layers, intexine thin, exoexine thicker particularly in the equatorial region where it is slightly expanded to form a shoulder between the two surfaces. Thickness of the exoexine over the distal surface (measured on laterally and obliquely compressed specimens) 6-11μ. Two layers normally closely appressed, although in some specimens the intexine may be variably separated from the exoexine in the equatorial region and over part of the distal surface, resulting in a clearly defined inner body. Trilete mark distinct; laesurae normally obscured by thin, elevated, flexuous folds of the exoexine which form an apical prominence up to 30μ high at the proximal pole. Length of the laesurae difficult to determine, probably between 1/2 and 3/4 of the spore radius. The ends of the laesurae are connected by broad, thickened, curvatural ridges which are slightly invaginated in the radial positions. Contact areas ornamented with coarse, radially orientated, thickened ribs, normally 3-5 ribs occurring between each pair of laesurae. Ribs normally straight, 4-9μ wide adjacent to the curvaturae but tapering slightly towards the proximal pole. The exoexine of the remainder of the proximal surface and the entire distal surface is finely roughened or densely punctate. It also bears processes with bifurcate terminations which are arranged in a concentric manner, most densely distributed on the proximal surface between the curvaturae and the equator. The processes consist of a bulbuous base, a stout or relatively slender, gently tapering shaft and a reflexed bifurcate termination; 18-50 processes project at the equatorial margin. Length of the processes 9-35μ, diameter of the bulbous base 4-12μ.

Dimensions (91 specimens measured). Maximum equatorial diameter, excluding the projecting ornament, 92.4-158.4μ (mean 128.7μ).

Types. Holotype, GSC No. 15546; paratypes, GSC Nos. 15544, 15545, 15547.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. Considerable variation in the character of the ornamentation elements was recorded in the specimens assigned to this species. The size and profiles of the processes are constant on any one specimen, but considerable differences exist between specimens. Because no reliable criteria could be discovered which could be utilized for further subdivision, the species is here retained as one large unit.

Detailed examination of the coarse, radially orientated, thickened ribs which ornament the contact areas has suggested that some of them may possess a median depression. This feature was not recorded in all of the specimens examined, and it may therefore be a result of corrosion and overmaceration.

Comparisons. The distinctive ornamentation renders this species readily distinguishable from the other species assigned to this genus. *Hystricosporites delectabilis* McGregor (1960) is larger (132-257μ) and bears processes with bifurcate terminations which lack the distinctive reflexed character of those of *H. reflexus* n. sp. The bifurcate terminations in *H. delectabilis* are commonly more expanded and laterally extended. *H. grandis* n. sp. is also larger, and possesses stouter, longer and considerably less densely distributed processes with slightly reflexed or expanded, bifurcate terminations. *H. costatus* Vigran (1964) described from the Middle Devonian deposits of Spitsbergen possesses stouter and somewhat coarser processes with simple, triangular, bifurcate terminations. *H. corystus* Richardson (1962, pp. 173-174, Pl. 25, figs. 1, 2, text fig. 2) described from the Middle Old Red Sandstone of Scotland is larger (129-213μ) and although possessing processes with similar reflexed, bifurcate terminations, may be distinguished by the greater size of the elements (22-66μ) and the smaller number (5-10) that project at the equatorial margin.

Hystricosporites grandis n. sp.

Plate VII, figures 5, 6; text figure 8

Description. Spores radial, trilete, in part camerate. Colour orange to dark brown. Amb subcircular; in lateral compression, proximal surface flat or slightly pyramidal, distal surface hemispherical. Exine composed of two layers, intexine thin, exoexine considerably thicker and minutely roughened due to a very dense, fine punctation. Exoexine up to 17μ thick over the distal surface but much thinner over the contact areas of the proximal surface. Two layers commonly closely appressed although separation was recorded in the equatorial plane and over part of the distal surface of some specimens, resulting in the formation of an inner body with numerous, independent compression folds on its distal surface. Trilete mark indistinct; laesurae obscured by high, flexuous folds of the exoexine which form an apical prominence. Contact areas defined by an abrupt change in the exine thickness or less commonly, by poorly developed low, ridge-like curvaturae. Contact areas ornamented with closely spaced, coarse, radially orientated, thickened ribs, up to 17μ wide adjacent to the curvaturae, separated by narrow channels of thinner exine. The exoexine of the remainder of the proximal surface and the entire distal surface bears sparse, concentrically arranged processes with bifurcate terminations. Each process consists of a broad, bulbous base with a circular outline,

a stout, gently tapering or almost parallel-sided shaft, and an expanded, laterally extended and in part reflexed bifurcate termination. 8-25 processes project at the equatorial margin. Height of processes 33-76μ, basal diameter 12.4-19.8μ, span of bifurcate terminations 10.7-38.2μ.

Dimensions (7 specimens measured). Maximum equatorial diameter, excluding the projecting ornament, 122-240μ.

Types. Holotype, GSC No. 15549; paratype, GSC No. 15548.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7560.

Remarks. Although only seven specimens have been recorded, specific status for this group of spores is justified on the basis of the distinctive shape, size and distribution of the ornamentation elements and their bifurcate terminations. In some specimens elongate apertures are visible at the bases of some of the processes. This may indicate that the bases of the elements are hollow although the shafts and the bifurcate terminations are solid.

Hystricosporites gravis n. sp.

Plate VIII, figures 1-3; text figure 9

Description. Spores radial, trilete. Colour orange to brown. Amb circular, subcircular to broadly rounded triangular; in lateral profile the proximal surface is almost flat and the distal surface inflated hemispherical. Exine thick, not readily separable into component layers, surface roughened, commonly densely and finely punctate. Trilete mark normally indistinct; laesurae simple, straight, frequently obscured by elevated, flexuous folds which form an apical prominence up to 60μ high at the proximal pole. Laesurae and accompanying folds extend between 1/2 and 3/4 of the spore radius. The ends of the laesurae are connected by curvaturae which coincide with an abrupt reduction in the thickness of the exine between the contact areas and the remainder of the spore. Contact areas ornamented with coarse, densely distributed, radially orientated, thickened ribs which are up to 6μ wide adjacent to the curvaturae and which taper only slightly towards the proximal pole. Equatorial portion of the proximal surface and the entire distal surface ornamented with coarse processes with bulbous bases and bifurcate terminations, which are arranged in a concentric manner. The greatest concentration of processes occurs on the proximal surface between the curvaturae and the equator. Each process consists of a bulbous base, a long, gently tapering or almost parallel-sided shaft and a laterally extended and reflexed bifurcate termination. The basal portions of some of the processes possess several small, irregular slit-like apertures which suggest that they may be hollow. There is however no evidence to suggest that the shaft is hollow; 14-40 processes project at the equatorial margin. Length of the processes 26.4-89.1μ, basal diameter 7.6-19.9μ.

Dimensions (33 specimens measured). Maximum equatorial diameter, excluding projecting ornament, 92.4-171.6μ (mean 132μ).

Types. Holotype, GSC No. 15551; paratypes, GSC Nos. 15550, 15552.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7557.

Remarks. Considerable variation in the size of the bifurcate processes has been recorded in the specimens assigned to this species. However since all of the specimens are characterized by the same distribution and type of bifurcate termination to the processes, it is considered justifiable to retain them in one species.

Comparisons. *Hystricosporites delectabilis* McGregor (1960) is larger, possesses fewer thickened, radially orientated ribs on the contact areas and an ornament over the remainder of the exine composed of shorter processes with bifurcate terminations which are more constant in form than the variable terminations of *H. gravis* n. sp. *H. costatus* Vigran (1964, pp. 14-15, Pl. 5, figs. 3-5) from the Middle Devonian deposits of Spitsbergen is smaller and also possesses shorter processes which terminate with almost triangular bifurcate terminations. *H. furcatus* n. sp. is similar in size and general construction, but possesses fewer, somewhat wider, radially orientated, thickened ribs ornamenting the contact areas, and also shorter, more slender bifurcate processes over the remainder of the exine. *H. mitratus* Allen (1965, pp. 699-700, Pl. 95, figs. 7, 8) described from the Emsian and lower Eifelian deposits of north and central Vestspitsbergen is broadly comparable in size and general organization, but possesses laevigate contact areas and shorter, more slender processes which terminate in either a laterally extended bifurcate termination (Pl. 95, fig. 7) or a terminal knob (Pl. 95, fig. 8).

Hystricosporites harpagonis n. sp.

Plate IX, figure 1; text figure 10

Description. Spores radial, trilete. Amb circular to subcircular; in lateral profile, the proximal surface is flat or slightly convex, the distal surface is hemispherical. Trilete mark normally indistinct; laesurae rarely discernible, commonly obscured by high, flexuous folds which form an apical prominence up to 33μ high at the proximal pole. The contact areas, which are clearly defined in most specimens, are bounded by variably defined, low ridge-like curvaturae which result from an abrupt change in exine thickness. Contact areas ornamented by stout, radially orientated, thickened ribs (4-6μ in width) separated by narrow channels of thinner exine. Exine of the remainder of the proximal surface and the entire distal surface is thicker, is densely punctate or scabrate, and bears stout processes with bifurcate terminations. Each process consists of a bulbous base, a long, gently tapering or almost parallel-sided shaft and an expanded, extended and reflexed bifurcate termination. Elements are arranged in a loosely concentric manner with the greatest concentration occurring on the proximal surface adjacent to the margin of the contact areas; 21-52 processes project at the equatorial margin. Height of the processes 22.9-75.9μ, basal diameter 6.1-16.8μ, span of the bifurcate terminations 6.1-20μ.

Dimensions (18 specimens measured). Maximum equatorial diameter, excluding the projecting ornament 92.4-139μ (mean 115.5μ).

Type. Holotype, GSC No. 15555.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7560.

Comparisons. *Hystricosporites porcatus* (Winslow) Allen (1965, p. 699, Pl. 95, figs. 4-6) from the Givetian deposits of Vestspitsbergen has a slightly greater size range (84-164μ) but may be readily distinguished by its less densely distributed ornament (17-23 elements projecting at the equatorial margin) of shorter processes (10-45μ, commonly 15-30μ) which appear to have a simpler type of reflexed anchor-shaped bifurcate termination. *H. mitratus* Allen (1965, pp. 699-700, Pl. 95, figs. 7, 8) from the Emsian and lower Eifelian deposits of Vestspitsbergen is similar in size but possesses shorter processes (12-40μ, commonly 20-35μ) which have either a terminal knob-like projection or a laterally extended bifurcate termination, and unornamented contact areas. *H. porrectus* (Balme and Hassell) Allen (1965) in Balme and

Hassell (1962, p. 10, Pl. 5, figs. 1-4) from the Upper Devonian deposits of the Canning Basin, Western Australia is also distinguished by its shorter more slender processes. *H. delectabilis* McGregor (1960) is larger and bears shorter processes which are however similar in form. *H. reflexus* n. sp. is similar in size but possesses shorter, more slender processes with considerably more pronounced bulbous bases. *H. furcatus* n. sp. has a larger size range (82.5-174.9μ) and has shorter, slightly narrower processes which have expanded, slightly extended, triangular, bifurcate terminations. *Archaeotriletes hamulus* Naumova (1953, p. 52, Pl. 6, fig. 4) from the Middle and Upper Devonian of the Russian Platform and *A. ancylius* Naumova (1953) in Kedo (1955, p. 25, Pl. 2, fig. 10) from the Kaluga beds (Middle Devonian) of the Byelorussian SSR are both superficially similar to *H. harpagonis* n. sp. but the lack of adequate descriptions of these Russian species prevents detailed comparisons being made.

Hystricosporites sp. A.

Plate VIII, figure 4

Description. One laterally compressed specimen. Colour orange to dark brown. Proximal surface slightly convex, distal surface inflated, hemispherical. Details of the laesurae obscured by thin, elevated folds of the exoexine which accompany the laesurae and form an apical prominence up to 61μ high in the polar region. Exine thick, surface minutely roughened. Equatorial portion of the proximal surface and the entire distal surface ornamented with stout processes with bifurcate terminations. Each process consists of a swollen base 13.2-26.4μ wide, a gently tapering shaft and an expanded, triangular, bifurcate termination; 13 processes project at the equatorial margin. Length of the processes 39.6-56.4μ.

Dimensions (1 specimen). 116.2 x 92.4.

Type. Hypotype, GSC No. 15553. (GSC Loc. 7560)

Hystricosporites sp. B.

Plate IX, figure 2

Description. Spores radial, trilete. Colour amber to dark brown. Amb subcircular. Trilete mark indistinct or obscured. Laesurae which are obscured by thick, dark, flexuous folds, extend approximately 3/4 of the spore radius and are connected by ill-defined, ridge-like curvaturae resulting from a marked change in exine thickness. Contact areas ornamented with radially orientated, thickened ribs which are 15-17μ wide adjacent to the curvaturae but taper gently towards the proximal pole. Ribs are separated by narrow channels of thinner exine. Exine of the remainder of the proximal surface and the entire distal surface minutely roughened and bearing a scattered ornament of long, slender processes with bifurcate terminations. Each process consists of a long slender shaft with almost parallel sides, tapering only in the basal and terminal portions, and a laterally extended and slightly reflexed bifurcate termination; 11-13 processes project at the equatorial margin. Length of the processes 69.3-132μ, basal diameter 16.5-23.1μ, width of shaft immediately before bifurcate termination 4.6-6.6μ.

Dimensions (2 specimens). Maximum equatorial diameter, excluding projecting ornament 99 and 168.3μ.

Type. Hypotype, GSC No. 155560. (GSC Loc. 7560)

Comparisons. *Hystricosporites corystus* Richardson (1962, pp. 173-174, Pl. 25, figs. 1, 2; text fig. 2) has a larger spore body (129-213μ) and

fewer, more slender and shorter processes. *Dicrospora amherstensis* Winslow (1962, p. 53, Pl. 10, figs. 3-5d) from the Lower Mississippian of Ohio is superficially similar in appearance but is larger (spore body approximately 500μ in diameter) and bears stouter processes which are frequently in excess of 300μ in length. *Dicrospora* sp. Winslow (1962, p. 55, Pl. 11, figs. 1, 1a) is also superficially similar to *Hystricosporites* sp. B., but detailed comparison is not possible owing to the lack of adequate description of the American material. *Archeotriletes hamulus* Naumova var. *giganteus* Chibrikova (1959, p. 45, Pl. 3, fig. 3) from the upper Givetian and lower Frasnian deposits of western Bashkiria is comparable in size, and character of the processes, but owing to the lack of adequate description and illustrations it is not possible to draw any firm conclusions on their synonomy. *A. hamulus* var. *giganteus* does not appear to possess any ornamentation on the contact areas, and Chibrikova's illustration of the species suggests that the ornament of processes with bifurcate terminations is restricted to the equator.

Hystricosporites sp. C.

Plate VIII, figure 5

Description. Spore radial, trilete. Colour orange brown. Amb rounded triangular to subcircular. Exine thick, surface finely to minutely punctate. Trilete mark distinct; laesurae extend approximately 4/5 of the radius of the spore, frequently obscured by thin, elevated, flexuous folds which form an apical prominence. Contact areas distinct, delimited equatorially by low, thickened, ridge-like curvaturae. Contact areas ornamented with radially orientated, thickened ridges which are separated by narrow channels of thinner exine. Ridges adjacent to the curvaturae are up to 10μ wide but taper slightly towards the proximal pole. Many of the thickened ridges appear to possess a median depression. The equatorial portion of the proximal surface and the entire distal surface of the exine is ornamented with processes with distinctive bifurcate terminations. The processes are arranged in a concentric manner with the greatest concentration occurring on or closely adjacent to the curvaturae. Each process consists of an expanded, slightly bulbous base, a slender, gently tapering shaft and a small, slightly expanded bifurcate termination. Approximately 50 processes project at the equatorial margin. Length of the processes 15-22.5μ, basal diameter 6-7.6μ.

Dimensions (1 specimen only). Equatorial diameter 115 x 99μ.

Type. Hypotype, GSC No. 15554. (GSC Loc. 7559)

Comparisons. Archaeotriletes conspicuus Naumova (1953, p. 51, Pl. 6, fig. 2) possesses broadly similar types of bifurcate processes, but has a membranous frill which appears to connect the processes. There is also no indication, from either Naumova's description or from interpretation of the illustrated specimen, of the development of clearly defined curvaturae or ornament on the contact areas. *Archaeotriletes incompositus* Chibrikova (1959, Pl. 3, fig. 1) described from the Givetian deposits of western Bashkiria, is slightly smaller (65-85μ) but possesses a similar type of ornamentation although individual elements appear to be slightly stouter, particularly in the basal portion. There is however no indication of curvaturae or of ornamentation in the contact areas.

Infraturma *MURORNATI* Potonié and Kremp 1954

Genus *CONVOLUTISPORA* Hoffmeister, Staplin and Malloy 1955

Type species: *Convolutispora florida* Hoffmeister, Staplin and Malloy 1955

Convolutispora subtilis n. sp.

Plate IX, figures 3-6

Description. Spores radial, trilete. Colour yellow to orange. Amb circular to subcircular. Trilete mark distinct; laesurae straight, simple or accompanied by low, wide, thickened lips (individually 2-7μ wide), extending between 1/2 and slightly more than 3/4 of the radius of the spore, length variable even on one specimen. Ends of the laesurae may show minor terminal bifurcation. Exine thick, uniformly ornamented with low, narrow, densely packed, convolute ridges which show considerable fusion, resulting in a fine net-like appearance. The ridges, which are 1-2.5μ wide and up to 2μ high, are rounded in profile and are separated by short, narrow, irregular channels of thinner exine that may superficially resemble a foveolate sculpture. Ornament reduced or absent in the contact faces. Thickness of the exine at the equator 3-6μ.

Dimensions (29 specimens measured). Maximum equatorial diameter 49.5-76.5μ (mean 66.9μ).

Types. Holotype, GSC No. 15557; paratypes, GSC Nos. 15558, 15559, 15560.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7580.

Comparisons. Convolutispora fromensis Balme and Hassell (1962, p. 8, Pl. 1, figs. 14-16) appears in part similar to *C. subtilis* n. sp. but possesses slightly coarser convolute ridges (2-4μ wide) on both proximal and distal surfaces of the spore, and a thinner exine. *C. paraverrucata* McGregor (1964, p. 17, Pl. 2, figs. 9-11) described from the Yahatinda (Ghost River) Formation in Alberta, also possesses a thinner exine but in addition possesses a fine, densely distributed, sometimes anastomosing verrucose or rugulose ornament in which the elements rarely exceed 7μ in length and are up to 4μ high. *Verrucosisporites mucronatus* Streel (1964, p. 12, Pl. 1, fig. 11) appears superficially similar but is readily distinguished by its small, closely spaced verrucae with minute, papillate terminations. *Foveosporites insculptus* Playford (1962, p. 601, Pl. 85, figs. 3-5) differs by possessing a negative sculpture of sharply defined, irregularly distributed punctae and very narrow grooves.

Genus *ACINOSPORITES* Richardson 1965

Type species: *Acinosporites acanthomammillatus* Richardson 1965

Acinosporites acanthomammillatus Richardson 1965

Plate X, figure 1

Acinosporites acanthomammillatus Richardson, 1965, pp. 577-578, Pl. 91, figs. 1, 2, text fig. 6.

Description of specimens. Spores radial, trilete. Colour orange.

Amb subtriangular, apices rounded, sides slightly convex. Exine composed of two layers, the thick exoexine and the thin intexine. In some specimens the intexine is closely appressed to the exoexine, whilst in others it may be variably separated, forming an indistinct inner body. Trilete mark distinct; laesurae completely obscured by thickened, elevated, flexuous folds of the exoexine which extend, decreasing in height, to the equator of the spore. Intexine thin, laevigate. Exoexine thick, proximal surface smooth and infrapunctate, distal surface bearing coarse, densely distributed, convolute ridges, up to 6μ wide which bear numerous rounded verrucose or rounded conate projections 3-5μ high, surmounted by slender, sharply pointed cones and spines 2-5μ high and 1-4μ in diameter.

Dimensions (4 specimens measured). Maximum equatorial diameter 105.6-124.3μ.

Type. Hypotype, GSC No. 15561. (GSC Loc. 7557)

Remarks. The Canadian specimens appear identical to those described by Richardson (1965) from the Middle Old Red Sandstone (Givetian) of Scotland.

Subturma *ZONOTRILETES* Waltz 1935

Infraturma *CINGULATI* Potonié and Klaus 1954

Genus *STENOZONOTRILETES* (Naumova) Potonié 1958

Type species: *Stenozonotriletes conformis* Naumova 1953

Stenozonotriletes notatus n. sp.

Plate X, figures 2, 5, 9

Description. Spores radial, trilete. Colour orange to brown. Amb subcircular to broadly rounded triangular. Exine composed of two layers, the intexine which forms a subtriangular inner body with straight or slightly convex sides and bluntly pointed or truncated apices and the exoexine which appears to be of more or less uniform thickness over the entire surface of the spore and which is extended in the equatorial plane to produce a cingulum of constant thickness but of variable width. Trilete mark distinct; laesurae simple, straight, extending 3/5 to almost the entire radius of the inner body. Ends of the laesurae may be connected by low, narrow curvaturae which are coincident with the equator of the spore along most of their length. Intexine thin, laevigate. Exoexine thicker, surface very finely and densely punctate. Extension of the exoexine in the equatorial plane beyond the margin of the inner body variable in width, in the interradial positions 6-15μ and in the radial positions 3-7.6μ. Surface of the exoexine in the angles between the laesurae ? thickened to form an ill-defined, darker, triangular area, the radii of which may coincide with the extremities of the laesurae. The ? thickening is most pronounced adjacent to the laesurae where it may simulate low, thickened lips. Surface of the exoexine of the darker triangular area is more coarsely punctate than the remainder of the exoexine.

Dimensions (9 specimens measured). Maximum equatorial diameter of the spore 66-89.1μ (mean 79.2μ), maximum diameter of the inner body 55.1-72.6μ.

Types. Holotype, GSC No. 15562; paratypes, GSC Nos. 15563, 15564.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. The distinctive triangular form of the inner body and the variation in width of the cingulum between the radial and the interradial margins serve to distinguish this species from all other species of *Stenozonotriletes*. Although only nine specimens were recorded, specific status has been given to this group of spores on the grounds of their distinctive appearance. The assignment of this group of spores to the genus *Camarozonotriletes* (Naumova) Potonié (1958) was considered but rejected because the cingulum was, although variable in width, always a continuous structure around the equator of the spores and was never reduced to the level of being an interradial crassitude, a feature which is characteristic of spores assigned to *Camarozonotriletes*.

Stenozonotriletes inspissatus n. sp.

Plate X, figures 3, 6, 10

Description. Spores radial, trilete. Colour orange. Amb circular to subcircular. Exine composed of two layers, the intexine which is thin and forms a subcircular inner body and the exoexine which is thickened and extended in the equatorial plane to form an undifferentiated cingulum of more or less uniform width and thickness. Trilete mark distinct; laesurae simple or with low, narrow lips, straight, extending between 2/3 and the entire radius of the inner body. Laesurae frequently accompanied by slightly elevated folds of the exoexine which decrease in height towards the equatorial margin of the spore. Intexine laevigate. Exoexine of both the proximal and the distal surfaces ornamented with small, densely distributed grana which are barely perceptible at the equatorial margin of the spore. Cingulum 4-12.5μ wide.

Dimensions (15 specimens measured). Maximum equatorial diameter of the spore 62.7-99μ (mean 75.9μ).

Types. Holotype, GSC No. 15565; paratypes, GSC Nos. 15566, 15567.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. This species is closely comparable, in size and general construction, to several species previously assigned to the genus *Stenozonotriletes*. However, it cannot satisfactorily be accommodated in any of them because of the fine granular ornament that is developed over the entire surface of the exoexine. *Stenozonotriletes extensus* Naumova var. *major* Naumova (1953, p. 37, Pl. 3, fig. 20) which was subsequently recorded by other Russian workers (Tuzova, 1959, Pl. 7, fig. 4, Pl. 13, fig. 1, Ozolin'a, 1960, Pl. 2, fig. 5, 1961, Pl. 5, fig. 10, and 1963, Pl. 7, fig. 12) from the Devonian of the USSR, and by Hacquebard (1957, Pl. 2, fig. 20) and Playford (1964, Pl. 8, fig. 14) from the Horton Group (Mississippian) of Nova Scotia, is smaller and possesses a narrower cingulum and an unornamented exoexine. *Stenozonotriletes clarus* Ishchenko (1958, p. 86, Pl. 11, fig. 136) originally described from the Lower Carboniferous of the Dneiper-Donetz Basin and later recorded from the Lower Carboniferous of Spitsbergen by Hughes and Playford (1961, Pl. 3, figs. 1, 2) and Playford (1962, Pl. 86, figs. 4, 5) is similar in size but possesses a narrower cingulum and a laevigate exoexine. *Stenozonotriletes granulatus* Guennel (1963, fig. 9) possesses a similar granular ornament on the surface of the exoexine but is smaller (23-26μ) and has a very narrow cingulum. *Stenozonotriletes stenozonalis* (Waltz) Ishchenko (1958, p. 86, Pl. 10, fig. 135) is smaller and, although possessing a fine granular ornament on the intexine, differs by the absence of a granular ornament on the exoexine.

Infraturma *PATINATI* Butterworth and Williams 1958

Genus *ARCHAEOZONOTRILETES* (Naumova) Allen 1965

Type species: *Archaeozonotriletes variabilis* (Naumova) Allen 1965

Archaeozonotriletes variabilis (Naumova) Allen 1965

Plate X, figures 4, 7, 8, 11, 12

Archaeozonotriletes variabilis Naumova, 1953, p. 30, Pl. 2, figs. 12, 13, Pl. 12, figs. 8-11, p. 83, Pl. 13, figs. 7-9.

Archaeozonotriletes variabilis Naumova *in* Kedo, 1957, p. 27, Pl. 3, figs. 16, 17.

Archaeozonotriletes variabilis Naumova *in* Potonié, 1958, p. 28, Pl. 2, fig. 22.

Archaeozonotriletes variabilis Naumova *in* Tuzova, 1959, p. 124, Pl. 4, fig. 18, Pl. 11, fig. 6.

Archaeozonotriletes variabilis Naumova *in* Ozolin'a, 1961, Pl. 4, fig. 3.

Archaeozonotriletes variabilis Naumova *in* Ozolin'a, 1963, Pl. 6, fig. 1.

?Archaeozonotriletes variabilis Naumova *in* Kerr, McGregor and McLaren, 1965, Pl. 4, fig. 13.

Archaeozonotriletes variabilis (Naumova) Allen, 1965, pp. 721-722, Pl. 100, figs. 3-6.

Archaeozonotriletes variabilis Naumova *in* McGregor and Owens, 1966, Pl. XXVI, fig. 36.

Description of specimens. Spores radial, trilete. Colour orange to brown. Amb circular, subcircular, rounded triangular or subrectangular, distal surface hemispherical, proximal surface flat or slightly convex. Exine composed of two or sometimes three layers. The intexine, which forms a distinct circular to subcircular inner body, is surrounded except in the polar regions of the proximal surface by a variably thickened exoexine forming a patinate structure. In some specimens the entire spore may be surrounded by a third thin "perispore"-like layer which is apparently closely appressed to the exoexine over the distal surface but is characteristically folded over the proximal surface. Trilete mark distinct; laesurae straight, simple, extending between 3/4 and the entire radius of the inner body. Intexine thin, laevigate, occasionally partly withdrawn from the exoexine in the equatorial plane. Exoexine laevigate to very finely granular, variably thickened, forming a patinate structure which is thickest in the distal polar region and which thins gradually to the equatorial margin and abruptly onto the proximal surface, onto which it transgresses a considerable distance, particularly in the interradial positions. Patina terminated with a sharply defined, irregular edge. Maximum thickness of the patina over the distal polar region (measured on obliquely and laterally compressed specimens) 21.5µ, thickness of the patina over the proximal surface 2-3µ. "Perispore"-like layer less than 1µ thick, characteristically plicated over the proximal surface of the spore into numerous, randomly orientated, narrow, wrinkle-like folds of variable length.

Dimensions (23 specimens measured). Maximum equatorial diameter 56.1-92.4µ (mean 79.2µ), maximum equatorial diameter of the inner body 36.1-66µ (mean 49.5µ).

Types. Hypotypes, GSC Nos. 15568, 15569, 15570, 15571, 15572. (GSC Loc. 5116)

Remarks. The description of the Canadian specimens agrees closely with that of the Vestspitsbergen specimens described by Allen, although the Vestspitsbergen specimens are smaller (42-60μ). The most significant difference between the two groups is the presence in the Canadian specimens of a third, outer, "perispore"-like layer of the exine, no trace of which was recorded in the Vestspitsbergen specimens. It is of interest to note however that although there is no specific mention of the existence of a similar "perispore"-like layer in any of the specimens described by Naumova (1953), one of the specimens that she illustrated (Pl. 13, fig. 7) show some features which could be interpreted as minor, wrinkle-like folds on the central portion of the proximal surface. McGregor (1960) recognized a similar "perispore"-like layer in *Tholisporites tenuis* McGregor (1960, p. 38, Pl. 13, fig. 9) and *Tholisporites densus* McGregor (1960, pp. 37-38, Pl. 13, figs. 6, 7) and suggested that the "thin, transparent, veil-like structure" which extended over the proximal surface was an "extension of the outer part of the distal patina". This explanation cannot however be accepted in the case of the Canadian specimens of *Archaeozonotriletes variabilis* because the patinate structure of the exoexine extends a considerable distance onto the proximal surface and is clearly overlain over the entire surface of the spore by the thin, folded, "perispore"-like layer.

Allen (1965), in comparing *Archaeozonotriletes* with *Tholisporites* Butterworth and Williams (1958, pp. 381-382) comments that the latter genus may be distinguished from *Archaeozonotriletes* by its patina which according to Butterworth and Williams is thickest in the equatorial region whilst that of *Archaeozonotriletes* is either of uniform thickness or is thickest in the distal polar region. Although such a distinction may be of considerable importance at a specific level its value at the generic level seems in the opinion of the present author to be doubtful, particularly because the generic circumscription of *Tholisporites* was based on only one species. For determination of variation in the thickness of the patina in either of the two genera one must rely heavily on observations made on obliquely or laterally preserved specimens, in which considerable distortion may occur due to the extremely thick nature of the patina. Detailed examination and comparison of all the species so far assigned to *Tholisporites* and *Archaeozonotriletes variabilis* may therefore justify *Tholisporites* being placed in the synonomy of *Archaeozonotriletes*.

Comparisons. Tholisporites densus McGregor (1960) is similar in size (45-89μ) and construction but has a thinner (up to 11μ thick) patina which is of more or less uniform thickness over the distal surface and which thins abruptly at the outer margin of the proximal surface. *Tholisporites tenuis* McGregor (1960) possesses a considerably thinner patina (up to 3μ thick). *Archaeozonotriletes sarus* Allen (1965, p. 723, Pl. 100, fig. 7) described from the Givetian deposits of Vestspitsbergen is smaller (42-57μ) and possesses shorter laesurae and a considerably thinner patinate exoexine. *Archaeozonotriletes columnus* Allen (1965, pp. 723-724, Pl. 100, figs. 8-10) described from the Upper Givetian deposits of Vestspitsbergen is in part larger (76-145μ) and possesses a patinate exoexine that is sometimes thicker (8-28μ) but shows no indication of abrupt thinning on the proximal surface and no evidence for the existence of a thin, outer "perispore"-like layer. *Tholisporites scoticus* Butterworth and Williams (1958, p. 382, Pl. 13, figs. 48-50) described from the Limestone Coal Group (Namurian A) of the Midland Valley of Scotland is smaller (30-55μ) and possesses a thinner patina (4-9μ thick) which is thickest in the equatorial region.

Infraturma *TRICRASSATI* Dettmann 1963

Genus *CAMAROZONOTRILETES* (Naumova) Potonié 1958

Type species: *Camarozonotriletes devonicus* Naumova 1953

Discussion. *Craspedispora* Allen (1965, pp. 709-710) may be distinguished by its narrow zona surrounding the subcircular to rounded triangular spore body in the interradial positions. The precise relationships between *Camarozonotriletes* and *Rotaspora* Schemel (1950, pp. 241-242) are not fully known. Detailed comparison of the two genera may result in *Camarozonotriletes* being placed in synonomy with *Rotaspora*.

Camarozonotriletes parvus n. sp.

Plate XI, figures 1-4

Camarozonotriletes sp. cf. *C. breviculus* Ishchenko 1958, in McGregor and Owens, 1966, Pl. IX, fig. 5.

Description. Spores radial, trilete. Colour yellow to orange brown. Amb subtriangular with rounded apices and slightly concave or, more commonly, slightly convex interradial margins. Amb of the spore body subtriangular, apices rounded, interradial margins concave. Exine composed of two layers, the intexine forming the wall of the spore body, and the exoexine, which is thickened in the equatorial plane, forming an undifferentiated interradial crassitude. Trilete mark distinct; laesurae simple, straight, commonly open, extending between 2/3 and 3/4 of the radius of the spore body. Surface of the exine in the angles between the laesurae is in most specimens slightly darker (? thicker) and forms a triangular area, the apices of which may extend to the ends of the laesurae. Intexine thin, laevigate. Exoexine thickened in the equatorial plane and forms an interradial crassitude of almost uniform thickness, 3-4μ wide in the interradial positions, 1-2μ wide or almost absent in the radial positions. Exoexine of the proximal surface laevigate but over the distal surface bearing densely distributed grana and small coni, up to 1.5μ (commonly less than 1μ) high and approximately 0.5μ in diameter. Ornament projects at the equatorial margin in the interradial positions but is reduced or absent in the radial positions. In some specimens the ornament may transgress onto the equatorial portions of the proximal surface in the radial positions.

Dimensions (63 specimens measured). Maximum equatorial diameter 24-41.3μ (mean 33μ).

Types. Holotype, GSC No. 15573; paratypes, GSC Nos. 15574, 15575, 15576.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7560.

Remarks. There is no evidence to suggest that the interradial crassitude overlaps significantly onto either the proximal or distal surfaces of the spore body as is suggested to occur in *Camarozonotriletes circumligus* Staplin (1960, p. 23, Pl. 4, figs. 31, 35). It is also of interest to note that overlap of the conate ornament onto the radial margins of the proximal surface in some specimens produces a structure that is analogous to the unexplained structure on a specimen figured by Butterworth and Williams (1958, Pl. 3, fig. 19), which they assigned to *Rotaspora fracta* Schemel.

Comparisons. Although McGregor (1967) recorded *Camarozonotriletes* cf. *C. obtusus* Naumova from the Hecla Bay Formation in the Canadian Arctic, the present record constitutes the first systematic description of specimens of this genus from the Devonian of North America. Staplin (1960) has recorded the genus from the Golata Formation (Mississippian) of Alberta. There are several species of this genus, described from the Givetian and Frasnian deposits of the USSR, which appear to closely resemble *C. parvus* n. sp. *C. obtusus* Naumova (1953, p. 89, Pl. 14, fig. 9a) originally described from the Middle Frasnian deposits of the Russian Platform and later figured by Kedo (1955, p. 42, Pl. 6, fig. 9) from the same horizon in the Byelorussian SSR, appears to differ by possessing a slightly coarser "tubercular" ornament, longer laesurae, a triangular spore body with straight sides, and by the lack of the darker triangular area in the angles between the laesurae. *C. mosolovicus* Naumova, first formally described by Kedo (1955, p. 42, Pl. 6, fig. 8) lacks the darker triangular area in the angles between the laesurae, and according to Kedo's description possesses laesurae which extend to the equator of the spore body. Examination of the specimen illustrated by Kedo suggests however that the laesurae extend, at least in some specimens, no more than 2/3 of the radius of the spore body. The fine "tubercular" ornament of *C. mosolovicus* may be slightly coarser than the conate ornament of *C. parvus* n. sp. *C. paraxenus* Chibrikova (1962, p. 445, Pl. 15, fig. 7) possesses a bizonate interradial crassitude, and elevated lips accompanying the laesurae.

Infraturma *ZONATI* Potonié and Kremp 1954

Genus *SAMARISPORITES* Richardson 1965

Type species: *Samarisporites (Cristatisporites) orcadensis* (Richardson) Richardson 1965

Samarisporites tozeri n. sp.

Plate XI, figures 6-10

Description. Spores radial, triletė. Colour orange to brown. Amb subcircular to broadly rounded triangular. Exine composed of two layers, the intexine which forms a distinct, rounded triangular inner body, and the differentially thickened exoexine which completely surrounds the inner body. The exoexine is extended in the equatorial plane to form a wide, bizonate cingulum consisting of a dark, thicker, inner zone and a lighter, thinner, outer zone. The intexine and exoexine are normally closely appressed but there is minor separation adjacent to the equatorial margin of the inner body in some specimens. Trilete mark distinct; laesurae straight, simple or accompanied by low, narrow lips, extending to the equatorial margin of the inner body, sometimes obscured by high, flexuous folds of the exoexine which extend, decreasing in height, to the equator of the spore. Intexine thin, laevigate. Exoexine of the proximal surface thick, surface minutely roughened by very fine, dense infrapunctation. Over the distal surface of the inner body the exoexine is much thickened, with the zone of maximum thickness occurring closely adjacent to, and extending some distance beyond, the equatorial margin of the inner body, producing the inner, thicker zone of the cingulum. Beyond the equatorial margin of the inner, thicker zone of the cingulum, the exoexine thins abruptly and is extended to form the outer zone. Exoexine of the proximal surface unornamented, exoexine of the distal surface and the equator densely ornamented with mammoid, verrucose elements which are arranged concentrically. Due to compression there may be an apparent concentration of the elements adjacent to the junction between the two zones of the cingulum. Elements normally discrete, although basal coalescence involving

groups of two or three elements, resulting in the formation of rudimentary cristate processes, may be commonly observed. Elements are 3-7μ high (commonly 3.5-4.5μ) and 3-6μ in basal diameter. Each consists of a verrucose or boss-like base surmounted by a slender, sharply pointed, frequently bent, conate or spinose termination.

Dimensions (36 specimens measured). Maximum equatorial diameter of the spore 99-128.7μ (mean 122.1μ).

Types. Holotype, GSC No. 15581; paratypes, GSC Nos. 15578, 15579, 15580.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. The central portion of the exoexine of the proximal surface (proximal plate of Staplin and Jansonius (1964, p. 98) may in some specimens be absent, revealing the thin intexine and the laesurae accompanied by low narrow lips.

Comparisons. *Cristatisporites echinatus* Playford (1963, pp. 637-638, Pl. 91, figs. 1-4) originally described from the Lower Carboniferous of Spitsbergen and later recorded from the Horton Group (Mississippian) of Nova Scotia (Playford, 1964, pp. 36-37, Pl. 10, fig. 10) is closely comparable in structural organization. However it is smaller (63-100μ), has thickened ridge-like folds of the exoexine which accompany the laesurae, and possesses a densely distributed ornament composed of simple, somewhat smaller coni, which are however similarly concentrated in the equatorial region where the bases of many elements are fused. *Densosporites devonicus* Richardson (1960, pp. 57-58, Pl. 14, figs. 10, 11, text fig. 7) described from the Middle Old Red Sandstone (Lower Givetian) of Scotland is structurally closely comparable but possesses smaller coni and spinae which commonly support minute, bifurcate terminal projections. *Samarisporites inaequus* (McGregor) n. comb. possesses a less densely distributed ornament composed of coarser, considerably larger conate and spinose elements.

Samarisporites praetervisus (Naumova) Allen 1965

Plate XI, figure 5

Hymenozonotriletes praetervisus Naumova 1953, p. 40, Pl. 4, fig. 8.

Samarisporites praetervisus (Naumova) Allen 1965, p. 714, Pl. 98, figs. 9, 10.

Description of specimens. Spores radial, trilete. Colour orange. Amb subcircular. Exine composed of two layers, the intexine forming the subcircular inner body, completely surrounded by the differentially thickened exoexine which is extended in the equatorial plane to form a wide bizonate flange. Trilete mark distinct; leasurae straight, more or less simple, extending to or almost to the equatorial margin of the inner body, commonly partly obscured by prominent, thin, elevated, slightly flexuous folds of the exoexine (up to 8μ high at the proximal pole) which extend, decreasing in height, to the equator of the spore. Intexine thin, laevigate, partially obscured by the thicker exoexine, concentrically arranged compression folds commonly developed at the equator, suggesting that at least in the equatorial region and over the equatorial portions of the distal surface the exoexine is separated from the intexine. Exoexine differentially thickened, with the maximum thickness developed distally in the region closely adjacent to the equator of the inner body, forming the inner thicker zone of the flange. Beyond the margin of the inner thicker zone of the flange the exoexine thins abruptly, producing the thinner, outer zone of the flange. Surface of the exoexine finely

infragranulate, proximal surface smooth, distal surface bears conate elements. The coni are most densely distributed in the region underlying the inner body, individual elements have rounded apices, and commonly support small, slender, sharply pointed, conate or spinose, papillate terminations. Height of the elements 2-6μ, basal diameter 2-5μ. The elements located in the equatorial region may be slightly smaller than those at the distal pole where there is a tendency toward basal fusion between the bases of adjacent elements. Up to 33 elements project at the equatorial margin.

Dimensions (3 specimens measured). Maximum equatorial diameter 85-93.2μ.

Type. Hypotype, GSC No. 15577. (GSC Loc. 7559)

Samarisporites inaequus (McGregor) n. comb.

Plate XII, figures 1, 2, 4

Hymenozonotriletes inaequus McGregor 1960, p. 37, Pl. 13, fig. 5

Description. Spores radial, trilete. Colour yellow to orange brown. Amb subcircular to broadly rounded triangular. Exine composed of two layers, the intexine which forms an inner body, conformable in outline with the amb of the spore, and the differentially thickened exoexine which completely surrounds the inner body and is extended in the equatorial plane to form a bizonate flange. Exoexine and intexine normally closely appressed although minor separation may occur in the equatorial plane and over part of the distal surface. Trilete mark distinct; laesurae straight, extending to the equator of the inner body, accompanied and frequently obscured by elevated flexuous folds of the exoexine which extend decreasing in height, to the equator of the spore. Intexine thin, smooth, with numerous taper-pointed compression folds on the more equatorial portions of the distal surface. Exoexine of the portion of the proximal surface overlying the inner body thin and finely punctate, whereas that of the corresponding region of the distal surface is considerably thicker. Maximum thickness of the exoexine developed in a narrow zone adjacent to and extending in the equatorial plane a short distance beyond the equatorial margin of the intexine. Zone is developed principally on the distal surface although a minor zone may be developed on the proximal surface. Beyond the margin of the thicker zone, the exoexine thins abruptly to form the outer, thinner zone of the flange. Exoexine of the distal surface punctate and bears coarse conate and spinose elements which support small, mammoid, apical projections. Elements, which are arranged subconcentrically, may be more densely distributed in the equatorial region where considerable fusion between the bases of adjacent elements may occur. In the polar region the elements are commonly smaller and discrete. Elements consist of broad-based coni and spinae with gently tapering sides and small, mammoid, papillate, or bifurcate apical projections. Elements located at the equator are up to 15μ high and 6-10μ in basal diameter, whereas those in the polar regions are 3-7μ high and 4-6μ in basal diameter.

Dimensions (51 specimens measured). Maximum equatorial diameter 82.5-115.5μ (mean 92.4μ).

Types. Hypotypes, GSC Nos. 15582, 15583, 15584.

Comparisons. One of the specimens of *Hymenozonotriletes argutus* Naumova (1953, pp. 67-68, Pl. 9, fig. 9) which was described from the lower Frasnian deposits of the Russian Platform, appears to be closely comparable in general construction and in ornamentation with *Samarisporites inaequus* (McGregor) n. comb. Although detailed comparison is not possible due to the lack of detail in the description of the Russian species, the two forms may be synonymous. The other specimen of *H. argutus* illustrated by Naumova (1953, Pl. 4, fig. 10) which

was described from the upper Givetian of the Russian Platform, differs considerably from *S. inaequus* by possessing densely distributed, small, sharply pointed cones and spines. *Hymenozonotriletes spinuliferus* Naumova (1953, pp. 41-42, Pl. 4, fig. 13) may also be in part synonymous with *S. inaequus*. The specimen illustrated by Naumova appears to be similar in size and general construction and differs only by the possession of a more slender conate-spinose ornament, the elements of which normally have bluntly pointed or truncated spines and show no evidence of terminal modification. *Hymenozonotriletes polyacanthus* Naumova (1953, p. 41, Pl. 4, figs. 11, 12) originally described from the upper Givetian and lower Frasnian deposits of the Russian Platform and subsequently recorded by Kedo (1955, p. 29, Pl. 3, figs. 5, 6) from the Middle Devonian deposits of the Byelorussian SSR, is also superficially similar although some of the specimens recorded by Kedo are smaller (50-85μ). The specimens illustrated by Naumova appear to be similar in general construction but possess more densely distributed, slender, broad-based spinae and coni which normally have blunted terminations and rarely possess any form of terminal projection. One of the specimens illustrated by Kedo (1955, Pl. 3, fig. 6) also appears similar in construction but possesses smaller, simple cones and spines. *Densosporites devonicus* Richardson (1960, pp. 57-58, Pl. 14, figs. 10, 11, text fig. 7) is in part larger (87-159μ) and although similar in general construction, may be readily distinguished by its more densely distributed ornament of small cones and spines which are commonly terminated by minute bifurcate projections. *Samarisporites praetervisus* (Naumova) Allen (1965, p. 714, Pl. 98, figs. 9, 10) described from the Givetian deposits of Vestspitsbergen possesses a more densely distributed ornament of smaller coni.

Samarisporites galeatus n. sp.

Plate XII, figures 3, 5, 6

Description. Spores radial, trilete. Colour orange to brown. Amb excluding projecting equatorial ornament, rounded triangular to subcircular. Exine composed of two layers, the intexine which forms a rounded triangular inner body, and the exoexine which completely surrounds the inner body and is extended in the equatorial plane beyond its margin to form a wide, bizonate flange. Trilete mark distinct; laesurae straight, normally simple, sometimes accompanied by low, narrow lips (individually up to 2.5μ wide), extending to and in some cases slightly beyond the margin of the inner body. Laesurae commonly partly obscured by thin, elevated folds of the exoexine which extend, decreasing in height, to the equator of the spore. Intexine 1.5-2μ thick, laevigate. Exoexine of variable thickness, surface velvety or minutely roughened as a result of a fine, dense punctation, proximal surface thin and of almost constant thickness, distal surface variable in thickness with the maximum thickness developed over the inner body and extending in the equatorial plane some distance beyond its margin, forming the inner, thicker zone of the flange. Beyond the equatorial margin of the inner, thicker zone, the exoexine thins abruptly and forms the outer zone of the flange which is of about the same width as the inner, darker zone. Distal surface of the exoexine bears concentrically arranged mammoid cones and tubercular processes. Over the polar portions of the distal surface the more densely distributed ornament is composed of both broad-based cones with sharply tapering sides and blunt terminations and broad bulbous - based tubercles, with a rounded profile, which are surmounted by small mammoid conate projections. Height of elements 3-7.6μ, basal diameter 3-7.6μ. In the equatorial regions, the ornament of the exoexine is less densely distributed but consists predominantly of broad-based cones, either blunt or terminated with a small, mammoid cone, that are 3-12μ high and 2.5-10μ in diameter. Fusion between the bases of adjacent elements to produce rudimentary cristae occurs infrequently and is normally restricted to the polar regions of the distal surface.

Dimensions (44 specimens measured). Maximum equatorial diameter of the spore 82.5-132μ (mean 99μ), maximum diameter of the inner body 49.5-69.3μ.

Types. Holotype, GSC No. 15585; paratypes, GSC Nos. 15586, 15587.

Type locality. Griper Bay Formation, west side of Mould Bay, Prince Patrick Island, Northwest Territories, GSC Loc. 7558.

Comparisons. *Hymenozonotriletes polyacanthus* Naumova (1953, p. 41, Pl. 4, figs. 11, 12) described from the upper Givetian and lower Frasnian deposits of the Russian Platform, is smaller (80-90μ) and possesses a larger inner body. The spinose ornament of the exoexine is composed of more slender, simple elements with blunt terminations and appears from the illustrations to be more densely distributed in the equatorial region. *Hymenozonotriletes deliquescens* Naumova var. *cinctus* Chibrikova (1959, p. 78, Pl. 13, fig. 6) is similar in size (90-100μ) and general construction but possesses smaller, commonly more densely distributed, simple, conate and spinose elements with blunt terminations. *Hymenozonotriletes argutus* Naumova (1953, pp. 67-68, Pl. 9, fig. 9) possesses a coarser ornament of broad-based cones and spines, many of which, particularly in the equatorial region, possess small bifurcate terminations. One of the specimens of *H. argutus* illustrated by Kedo (1955, Pl. 4, fig. 4) is more closely comparable to *S. galeatus* n. sp. in construction and overall appearance but due to the lack of precise data concerning the form and distribution of the ornament in Kedo's description (p. 32) it is not possible to make detailed comparisons.

Samarisporites concinnus n. sp.

Plate XII, figures 7-9

Plate XIII, figures 1-3

Description. Spores radial, trilete. Colour yellow to orange. Amb subcircular to broadly rounded triangular. In lateral profile the proximal surface is flat or slightly convex, the distal surface hemispherical. Exine composed of two layers, the intexine which forms a subcircular to rounded triangular inner body and the differentially thickened exoexine which completely surrounds the intexine and is extended in the equatorial plane to form a bizonate flange. Exoexine normally closely appressed to the intexine although minor separation may occur in the equatorial plane and over part of the distal surface. Trilete mark distinct; laesurae, which are sometimes obscured by elevated folds of the exoexine (up to 6μ high in the polar region), simple or accompanied by low, narrow, thickened lips, straight, extending to the equatorial margin of the intexine. Intexine thin, laevigate, may have taper-pointed compression folds on its distal surface; sometimes obscured by the thickness and the ornament of the exoexine. Exoexine differentially thickened, finely punctate. Exoexine of the proximal surface overlying the intexine thin and unornamented whereas the corresponding area of the distal surface is considerably thicker. Zone of maximum thickness of the exoexine located adjacent to and a short distance beyond the equator of the intexine, producing the inner, thicker zone of the flange. Beyond the margin of the inner, thicker zone of the flange, the exoexine thins abruptly to form the outer zone. Entire distal surface of the exoexine densely ornamented with broad-based conate and spinose elements which are commonly terminated by small, slender, conate or spinose projections. Elements are arranged in a loosely concentric manner, are normally discrete over the polar portion of the distal surface, but in the equatorial region particularly near the junction between the two zones of the flange there may be considerable basal coalescence between adjacent elements. Elements 3-7μ high and 2-4μ in basal diameter.

Dimensions (26 specimens measured). Maximum equatorial diameter 62.7-95.7μ (mean 72.6μ).

Types. Holotype, GSC No. 15590; paratypes, GSC Nos. 15588, 15589, 15591, 15592, 15593.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7579.

Comparisons. Although closely related to *Samarisporites (Hymenozonotriletes) inaequus* (McGregor) n. comb. in structure, *Samarisporites concinnus* n. sp. is smaller and bears a more densely distributed ornament of smaller conate elements which are terminated by small, slender, mammoid coni and spinae and never by small bifurcate projections. *Hymenozonotriletes polyacanthus* Naumova (1953, p. 41, Pl. 4, figs. 11, 12) described from the upper Givetian and lower Frasnian deposits of the Russian Platform, appears from interpretation of the illustrations to be closely comparable in structural organization but distinguishable by its coarser ornament. Of the two specimens of *H. polyacanthus* illustrated by Kedo (1955) from the Middle Devonian deposits of the Byelorussian SSR, one (Pl. 3a, fig. 6) appears closely comparable to *S. concinnus* n. sp. although the ornament in the polar regions of the distal surface is more sparsely distributed, whereas the other (Pl. 3, fig. 5) possesses an undifferentiated flange. *Hymenozonotriletes argutus* Naumova (1953, pp. 67-68, Pl. 9, fig. 9) from the lower Frasnian deposits of the Russian Platform is superficially similar but possesses larger conate elements which appear in some cases to have minor bifurcate terminations. The specimen of the same species illustrated by Kedo (1955) possesses an ornament which is more closely comparable with that of *S. concinnus* n. sp. *Densosporites devonicus* Richardson (1960, pp. 57-58, Pl. 14, figs. 10, 11, text fig. 2) is larger (87-159μ) and possesses smaller coni with variably developed bifurcate terminations. *Samarisporites senotus* Allen (1965, pp. 714-715, Pl. 98, fig. 11) described from the upper Givetian of Vestspitsbergen, is smaller (50-64μ) and possesses an ornament of smaller conate elements with a cingulum that is never distinctly bizonate.

Suprasubturma *CAMERATITRILETES* Neves and Owens 1966

Subturma *SOLUTITRILETES* Neves and Owens 1966

Infraturma *DECORATI* Neves and Owens 1966

Genus *CALYPTOSPORITES* Richardson 1962

Type species: *Calyptosporites velatus* (Eisenack) Richardson 1960

Calyptosporites velatus (Eisenack) Richardson 1962

Plate XIII, figures 4-7

Triletes velatus Eisenack, 1944, p. 108, Pl. 1, figs. 1-3.
Cosmosporites velatus (Eisenack) Richardson, 1960, p. 52, Pl. 14, fig. 4.
Calyptosporites velatus (Eisenack) Richardson, 1962, p. 192.
Calyptosporites velatus (Eisenack) Richardson *in* Piérart, 1964, p. 92, Pl. 6, fig. 27.
Calyptosporites velatus (Eisenack) Richardson *in* Richardson, 1965, p. 587, Pl. 93, fig. 4.
Calyptosporites velatus (Eisenack) Richardson *in* McGregor and Owens, 1966, Pl. VII, fig. 7, Pl. XI, fig. 1, Pl. XII, fig. 1.

Description of specimens. Spores radial, trilete, camerate. Colour pale yellow to orange. Amb rounded triangular to subcircular. Exine composed of two layers, the intexine which forms a rounded triangular inner body and the exoexine which completely surrounds the inner body and is attached to it only in the region of the laesurae, being widely separated from it over the remainder of the proximal surface and the entire distal surface. Trilete mark distinct; laesurae straight, extending to or almost to the equatorial margin of the inner body, simple, commonly obscured by elevated flexuous folds of the exoexine (up to 15μ high) which extend, decreasing in height, to the equator of the spore. Intexine thin, laevigate, with taper-pointed compression folds on its distal surface. Exoexine thin, laevigate, or with a very fine indeterminable infrastructure, up to 1.5μ thick at the equator. Proximal surface of the exoexine smooth, distal surface bears a scattered ornament of discrete, conate elements up to 4μ high (commonly 2-3μ) and up to 3μ in basal diameter. Elements are relatively broad-based and have either steeply tapering sides and a sharply pointed termination or are more or less parallel sided with a bluntly pointed termination. Exoexine commonly folded.

Dimensions (42 specimens measured). Maximum equatorial diameter of the spore 122.1-195μ (mean 145.2μ), maximum diameter of the inner body 59.4-108.9μ (mean 83.1μ).

Types. Hypotypes, GSC Nos. 15594, 15595, 15596, 15597. (GSC Loc. 7557)

Comparisons. Several species of *Hymenozonotriletes* described by Russian workers appear sufficiently similar to *Calyptosporites velatus* (Eisenack) Richardson to warrant comparison. Because of the generalized descriptions of these species, it is not possible to establish the precise nature of their relationships to *C. velatus*. The Russian workers consistently refer to the exoexine as the "perispore", and it is not possible from either the descriptions or the illustrations to determine whether the equatorial extension of the "perispore" is a solid flange or the result of the camerate nature of the spore.

Hymenozonotriletes proteus, described by Naumova (1953, p. 40, Pl. 4, fig. 5) from the upper Givetian deposits of the Russian Platform and subsequently recorded by Kedo (1955, Pl. 3, fig. 10), Tuzova (1959, Pl. 6, fig. 8; 1960, Pl. 1, fig. 24) and Andreyeva (1962, Pl. 4, fig. 4) from approximately the same horizon in other parts of the USSR, appears to be closely comparable in general construction and has a similar size range (collective size range of the specimens of all five authors 120-200μ). All five authors describe the ornament of the exoexine as being composed of small, scattered tubercles, although examination of their illustrations suggests that most of the elements are grana, not fine coni as in *C. velatus*. The specimens illustrated by both Naumova and Andreyeva differ further by possessing a considerably thickened intexine at the margin of the inner body. *Hymenozonotriletes proteus* Naumova var. *eximius* Kedo (1955, p. 31, Pl. 4, fig. 1) described from the Middle Devonian deposits of the Byelorussian SSR, is smaller (115-120μ) and lacks the elevated flexuous folds of the exoexine accompanying the laesurae. Examination of the specimen illustrated by Kedo suggests that the exoexine possesses a more prominent infrastructure and an ornament that may in part be composed of cones, although according to Kedo's description it is composed of small, scattered tubercles. *Hymenozonotriletes echiniformis* Kedo (1955, p. 31, Pl. 4, fig. 1) described from the uppermost Givetian deposits of the Byelorussian SSR, is probably at least in part synonymous with *C. velatus*. It is similar in size (130μ), in general construction and in the nature and form of the ornament of the exoexine, *Hymenozonotriletes tener* Chibrikova var. *concinnus* Chibrikova (1962), described from the Eifelian deposits of western Bashkiria, may also be in part synonymous with *C. velatus*. It differs from the specimens assigned to *C. velatus* during the present investigation by being smaller (90-120μ) and by possessing smaller scattered cones. It could however be accommodated within the limits of the species as defined by Richardson (1960).

Calyptosporites sp. A.

Plate XIII, figure 8

Description. Spores radial, trilete, camerate. Colour orange. Amb rounded triangular. Exine composed of two layers, the intexine which forms a subcircular inner body and the exoexine which completely surrounds the inner body but which is attached to it only on its proximal surface, probably in the region of the laesurae. Trilete mark distinct; laesurae obscured by elevated flexuous lips, individually up to 7μ wide, formed from folds of the exoexine which extend, decreasing in height, to the equator of the spore. Intexine thin, laevigate, with several concentric compression folds at its equatorial margin. Exoexine thin, finely infragranulate to laevigate, proximal surface smooth, distal surface bears distinctive broad-based rounded coni, some of which bear minute, mammoid, conate terminations. The elements are most densely distributed in the polar portions of the distal surface, are circular or subcircular in basal outline, have gently tapering sides and broadly rounded apices, a height of 2.5-9.5μ, and a basal diameter of 3-7.5μ. The largest elements are located in the polar region, and only 10 small elements project at the equator.

Dimensions (1 specimen only). Equatorial diameter of the exoexine 198.4 x 186.4μ, equatorial diameter of the intexine 119.5 x 109.8μ.

Type. Hypotype, GSC No. 15598. (GSC Loc. 7557)

Comparisons. Calyptosporites proteus (Naumova) Allen (1965, p. 735, Pl. 103, figs. 10, 11) described from the Givetian and probably upper Eifelian deposits of Vestspitsbergen, is smaller (100-170μ) and possesses slightly smaller elements, which appear from examination of the illustration (fig. 10) to be both uniformly distributed and of more or less constant size over the entire distal surface. *Calyptosporites velatus* (Eisenack) Richardson (1962, p. 192, *see* Richardson, 1960, p. 52, Pl. 14, fig. 4, text fig. 3) is similar in size and construction but possesses smaller sharply pointed cones.

Genus *GRANDISPORA* (Hoffmeister, Staplin and Malloy) Neves and Owens 1966

Type species: *Grandispora spinosa* Hoffmeister, Staplin and Malloy 1955

Grandispora mammillata n. sp.

Plate XIV, figures 1-4

Grandispora sp. *in* McGregor and Owens,1966, Pl. XIII, figs. 3-5; Pl. XIV, figs. 1, 2.

Description. Spores radial, trilete, camerate. Colour pale yellow to orange. Amb subcircular to broadly rounded triangular. Exine composed of two layers, the intexine which forms a subcircular to rounded triangular inner body and the exoexine which completely surrounds the inner body but is attached to it only in the region of the laesurae. Radius of the exoexine almost twice that of the intexine. Trilete mark distinct; laesurae straight, length equal to the radius of the inner body, sometimes simple, more frequently accompanied and obscured by elevated, flexuous folds of the exoexine which extend, decreasing in height and width, to the equator of the spore. Intexine laevigate, 1.5-5μ thick, secondary taper-pointed compression folds commonly present on the distal surface. Exoexine thinner, thickness at the equatorial margin 1.5-2μ, proximal surface smooth, laevigate, distal surface sparsely to moderately densely ornamented with discrete, mammoid, conate elements which are in part arranged in a

concentric manner. Elements 2-7μ high, 3-6.5μ wide at base; each consists of a bulbous or boss-like base with a more or less circular basal outline, surmounted by a sharply pointed conate or spinose projection. Distal surface of the exoexine also variably plicated with numerous long, narrow, irregularly orientated folds not exceeding 6μ in width. The mammoid conate elements may be borne as crests along the length of the folds.

Dimensions. (22 specimens measured). Maximum equatorial diameter of the spore 102.3-171.6μ (mean 141.9μ), maximum equatorial diameter of the inner body 72.6-105.6μ (mean 92.4μ).

Types. Holotype, GSC No. 15599; paratypes, GSC Nos. 15600, 15601, 15602.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7557.

Remarks. Although the specimens assigned to this species are constant in general construction, considerable variation has been observed in the distribution of the ornamentation and the secondary folds on the distal surface of the exoexine. The secondary folds which vary considerably in length, are in some specimens scattered over the entire distal surface whereas in others they are concentrated in the polar regions. The ornamentation elements are almost constant in shape and form but vary in size, the larger elements commonly being located in the polar regions and the smaller ones towards the equator. In some specimens the ornament is evenly distributed over the entire distal surface whereas in others it is concentrated on the exoexine underlying the distal surface of the inner body.

Comparisons. The distinctive mammoid, conate ornament and the long, narrow folds on the distal surface of the exoexine distinguish this species from all other species of *Grandispora*. *Hymenozonotriletes macrotuberculatus* Archangelskaya (1963, p. 26, Pl. 12, figs. 1-3), described from the Middle Devonian deposits of the Russian Platform, appears from Archangelskaya's description and from interpretation of the illustrations to be similar in general construction but is larger (180-250μ), possesses a coarser, mammoid conate ornament which is however similarly restricted to the distal surface and lacks the long, narrow folds on the distal surface of the exoexine.

Genus *RHABDOSPORITES* Richardson 1960

Type species: *Rhabdosporites langi* (Eisenack) Richardson 1960

Rhabdosporites micropaxillus n. sp.

Plate XV, figures 3-7

Description. Spores radial, trilete, camerate. Colour orange to brown. Amb rounded triangular to subcircular. Exine consists of two layers, the intexine which forms a rounded triangular to subcircular inner body and the exoexine which is attached to the intexine only over part of the proximal surface, probably in the region of the laesurae, being completely separated from it over the entire distal surface and most of the proximal surface. Trilete mark distinct; laesurae straight, simple or with low narrow lips which may be individually up to 3μ wide, length between 1/2 and the full radius of the inner body. Intexine laevigate, up to 2.5μ thick, may have long narrow subconcentrically arranged taper-pointed folds on its distal surface. Exoexine overlying the proximal surface of the inner body smooth or with a very fine infrastructure (? infrapunctation), remainder of the proximal surface and the entire distal

surface ornamented with densely distributed, small, cone-like or tubercular elements with subcircular basal outlines, up to 1μ in diameter (normally about 0.5μ) and 0.5-1μ high. Exoexine at the equator 3-4.5μ thick, resembling a limbus. Secondary folds may occur on the distal surface of the exoexine.

Dimensions (30 specimens measured). Maximum equatorial diameter 72.6-125.4μ (mean 89.1μ). Maximum equatorial diameter of the inner body 52.8-105.6μ (mean 64.4μ).

Types. Holotype, GSC No. 15608; paratypes, GSC Nos. 15607, 15609, 15610, 15611.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7579.

Comparisons. Rhabdosporites langi (Eisenack) Richardson (1960, p. 54, Pl. 14, figs. 8, 9) described from the Middle Old Red Sandstone of Scotland is larger (95-190μ) and possesses a slightly coarser ornament of small, parallel-sided, densely distributed, rod-like elements, and a slightly thicker exoexine which is more extensively folded. *Rhabdosporites firmus* Guennel (1963, pp. 256-257, fig. 12) is similar in size (100-124μ) but possesses a distinctly granular ornament on the exoexine. It does however appear probable from Guennel's description and from the illustration of the holotype that morphological intergradation may exist between the two species. *Rhabdosporites parvulus* Richardson (1965) from the upper Eifelian and Givetian deposits of Scotland is superficially similar but appears to possess a slightly coarser ornament of small, parallel-sided, rod-like elements. Several representatives of the Russian genus *Archaeozonotriletes* (sensu Naumova) described by Russian workers from the Devonian and Lower Carboniferous show broad similarities in general construction to this species, but in view of the inadequate description of the Russian species, particularly with respect to the exact nature of the exoexine-intexine relationships and the exoexine ornamentation, detailed comparison is difficult. *Archaeozonotriletes micromanifestus* Naumova var. *microtuberculatus* Chibrikova (1962, p. 414, Pl. 7, fig. 5) described from the lower Frasnian deposits of the Bashkirian SSR appears superficially similar in general construction but is smaller (55-70μ), possesses an exoexine which is thicker, producing a more prominent limbus-like wall thickness feature at the equator and an ornament which is described by Chibrikova as being composed of densely distributed, very small, rounded tubercles. *Archaeozonotriletes micromanifestus* Naumova var. *acanthinus* Chibrikova (1962, p. 415, Pl. 7, fig. 6) also described from the lower Frasnian deposits of western Bashkiria also is smaller (60-80μ) and may be distinguished from *R. micropaxillus* n. sp. by its densely distributed, short, straight spines.

Rhabdosporites langi (Eisenack) Richardson 1960

Plate XV, figures 1, 2

Type B Lang, 1925, p. 256, Pl. 1, figs. 3-6
Triletes langi Eisenack, 1944, p. 112, Pl. 2, fig. 4
Rhabdosporites langi (Eisenack) Richardson, 1960, p. 54, Pl. 14, figs. 8, 9.
Rhabdosporites langi (Eisenack) Richardson *in* Streel, 1964, p. 19, Pl. 2, fig. 4.
Rhabdosporites langi (Eisenack) Richardson *in* Piérart, 1964, p. 96, Pl. 3, fig. 14; Pl. 6, fig. 26.
Rhabdosporites langi (Eisenack) Richardson *in* Richardson, 1965, p. 589.
Rhabdosporites langi (Eisenack) Richardson *in* McGregor and Owens, 1966, Pl. VII, fig. 2; Pl. X, figs. 2, 5.

Description of specimens. Spores radial, trilete, camerate. Colour yellow to brown. Amb subcircular to rounded triangular. Exine consists of two layers, the intexine which forms a subcircular to rounded triangular inner body, and the exoexine which is attached to the intexine on its proximal surface, probably in the region of the laesurae but which is completely separated from the intexine over the entire distal surface and most of the proximal surface. Trilete mark distinct; sometimes obscured; laesurae straight, length between 3/4 and the full radius of the inner body, simple or accompanied by either low, narrow lips or variably developed, thick folds of the exoexine (individually up to 6μ wide) which may either extend to the ends of the laesurae or may continue some distance beyond the margin of the intexine towards the equator of the spore. Intexine laevigate, up to 2μ thick, commonly with subconcentrically arranged taper-pointed folds on its distal surface. Exoexine of the proximal surface overlying the inner body smooth, or with a very fine infrastructure; remainder of the proximal surface and the entire distal surface bears densely distributed, small, parallel-sided elements with truncated tips. Elements are normally discrete, but basal coalescence between adjacent elements may occur and produce very fine, short, irregular ridges. Elements are separated by narrow channels of thinner exine which simulate a negative reticulum. Individual elements are subcircular to irregular in basal outline, 0.5-1.5μ in diameter and up to 1.5μ high. Thickness of the exoexine at the equator 3-7μ, sometimes producing a faintly discernible limbus-like margin. Exoexine extensively folded.

Dimensions (34 specimens measured). Maximum equatorial diameter 102-231μ (mean 141.9μ), maximum equatorial diameter of the inner body 75.9-158.7μ (mean 108.9μ).

Types. Hypotypes, GSC Nos. 15605, 15606. (GSC Loc. 7557)

Remarks. The Canadian specimens described above are closely comparable with the Scottish specimens originally described by Richardson (1960). Two minor differences were observed which do not, however, alter the overall concept of the species. The size range of the Canadian specimens (102-231μ) is greater than that of the Scottish specimens (95-190μ) and the thick exoexine frequently produces in the Canadian specimens a feature at the equator of the spore which could be interpreted as a limbus. Richardson did not refer to such a feature in his description of the species, but it is apparent from examination of the specimens illustrated by him (Pl. 14, figs. 8, 9) that such a feature is present around much of the circumference of the spore.

Comparisons. *Hymenozonotriletes facetus* Archangelskaya (1963, p. 28, Pl. 15, figs. 1-6) described from the Middle Devonian deposits of the Russian Platform appears closely comparable to and may be synonymous with *Rhabdosporites langi*. *Hymenozonotriletes polymorphus* Naumova in litt., first formally described by Kedo (1955, p. 30, Pl. 3, fig. 8) from the Givetian deposits of the Bashkirian SSR, is superficially similar but it is difficult to determine from either the description or the illustration whether the spore is zonate or camerate. It also apparently possesses a thicker intexine and probably a thinner exoexine which does not produce a wall thickness feature at the equator of the spore. Both *Archaeozonotriletes macromanifestus* Naumova (1953, p. 31, Pl. 2, fig. 16) and *Archaeozonotriletes macromanifestus* Naumova (1953, p. 31, Pl. 2, fig. 18) are superficially similar to *R. langi* but possess a thicker exoexine which does not fold as readily as the exoexine of *R. langi*, and an ornament of small, densely distributed grana and cones as opposed to the rod-like ornament of *R. langi*.

Genus *CONTAGISPORITES* n. gen.

Type species: *Contagisporites optivus* (Chibrikova) n. comb.

Archaeozonotriletes optivus Chibrikova 1959, p. 60, Pl. 7, fig. 9

Diagnosis. Spores radial, trilete, camerate. Exine composed of two layers, the exoexine being attached to the intexine over only part of the proximal surface, being completely separated in the equatorial plane and over the entire distal surface. Amb subcircular to rounded triangular. Laesurae distinct, commonly accompanied by broad, thickened lips, and connected by prominent, broad, elevated, ridge-like curvaturae. Intexine forming the inner body wall thin, laevigate, commonly folded. Exoexine thick, contact areas smooth, remainder of the proximal surface and the entire distal surface bearing a granular, conate or spinose ornament.

Comparisons. The thick exoexine and the prominent curvaturae defining the limits of the contact areas render this genus readily distinguishable from all previously described camerate genera. *Spelaeotriletes* Neves and Owens (1966) possesses large contact areas, the extent of which is defined by a restriction in the distribution of the conate, verrucose or granular ornament rather than by distinct curvaturae as in *Contagisporites*. *Spelaeotriletes* may be further distinguished by its thinner exoexine and an inner body which is normally only visible in overoxidized specimens.

Contagisporites optivus (Chibrikova) n. comb. var. *optivus*

Plate XVI, figures 1-3

Archaeozonotriletes optivus Chibrikova 1959, p. 60, Pl. 7, fig. 9.
Retusotriletes sp. Taugourdeau-Lantz 1960, p. 145, Pl. 1, fig. 5.
Biharisporites spitsbergensis Vigran 1964, p. 12, Pl. 2, figs. 1-4.
Archaeozonotriletes optivus Chibrikova *in* McGregor and Owens, 1966, Pl. XVII, fig. 6.
Rhabdosporites cuvillieri Taugourdeau-Lantz 1967, pp. 54-56, Pl. 3, figs. 1-6.

Description of specimens. Spores radial, trilete, camerate. Colour orange brown. Amb broadly rounded triangular to subcircular. Exine composed of two layers, the intexine which forms the wall of the inner body, the outline of which is more or less concentric with the equatorial outline of the spore, and the exoexine which completely surrounds and extends a considerable distance beyond the equator of the intexine. Exoexine is attached to the intexine over the entire, or part of, the proximal surface but is separated in the equatorial plane and over the entire distal surface. Trilete mark distinct; laesurae straight, simple or accompanied by low narrow lips, extending the full radius of the inner body. Laesurae accompanied and partly obscured by thick, elevated folds of the exoexine (individually up to 12μ wide) which extend to the equator of the spore. Exoexine of the proximal surface overlying, or closely adjacent to, the equatorial margin of the intexine thickened to form elevated, ridge-like curvaturae 12-22.5μ wide. The thick folds of the exoexine accompanying the laesurae are swollen into thickened nodes (individually up to 17μ wide) where they intersect the curvaturae, and the two structures are fused. Intexine 1.5μ thick at the equator, laevigate. Exoexine thick, contact areas smooth, remainder of the proximal surface and the entire distal surface bearing densely distributed, fine coni or grana. Elements discrete, subcircular to polygonal in outline, 0.5-1.5μ in basal diameter and up to 1.5μ high. Those portions of the thickened, elevated folds of the exoexine accompanying the laesurae which occur outside the curvaturae bear the fine granular-conate ornament. whereas

those portions occurring inside the curvaturae are smooth. Inner proximal and distal surfaces of the exoexine very finely punctate. Exoexine at the equator up to 10μ thick and limbus-like.

Dimensions. (29 specimens measured). Maximum equatorial diameter of the spore 128-247.5μ (mean 181.5μ), maximum equatorial diameter of the inner body 75.9-148.5μ (mean 111.2μ).

Types. Hypotypes, GSC Nos. 15612, 15613, 15614. (GSC Loc. 7559)

Remarks. The specimens assigned by Allen (1965) to *Calyptosporites optivus* (Chibrikova) Allen (p. 736, Pl. 104, figs. 1-4) are superficially similar to *Archaeozonotriletes optivus* Chibrikova (1959) in general form and construction but possess a much coarser conate ornament on the exoexine of the equatorial portion of the proximal surface and over the entire distal surface. The specimens described and illustrated by Allen are here considered to be synonymous with *Contagisporites optivus* var. *vorobjevensis* (Chibrikova) n. comb. The assignment of this distinctive group of spores to the genus *Calyptosporites* by Allen is here rejected because the circumscription of that genus does not accommodate forms with prominently developed curvaturae. *Rhabdosporites cuvillieri* Taugourdeau-Lantz (1967, pp. 54-56, Pl. 3, figs. 1-6) described from the Frasnian of Boulonnais, France is considered synonymous with *Contagisporites optivus* (Chibrikova) n. comb. var. *optivus*. The assignment of this species to the genus *Rhabdosporites* is also rejected because the circumscription of that genus does not accommodate forms possessing well-developed curvaturae. Both groups of spores are therefore transferred to the new genus *Contagisporites* which is proposed for camerate spores with well-developed curvaturae.

Comparisons. *Contagisporites optivus* var. *vorobjevensis* (Chibrikova) n. comb. originally described from the Givetian deposits of western Bashkiria, is similar in size, but possesses a smaller inner body, wider curvaturae, and coarser, low verrucose or bluntly pointed conate elements on the exoexine. *Retusotriletes colliculosus* Chibrikova (1962, pp. 407-408, Pl. 6, fig. 2), described from the lower Frasnian deposits of western Bashkiria, is similar in size (180-240μ) but is acamerate, possesses less prominent curvaturae, and lacks the prominent folds of the exoexine accompanying the laesurae.

Contagisporites optivus var. *vorobjevensis* (Chibrikova) n. comb.

Plate XVI, figures 4-6

Archaeozonotriletes optivus var. *vorobjevensis* Chibrikova 1962, p. 430, Pl. 11, fig. 6.
Calyptosporites optivus (Chibrikova) Allen 1965, p. 736, Pl. 104, figs. 1-4.
Archaeozonotriletes cf. *A. optivus var. vorobjevensis* Chibrikova *in* McGregor and Owens 1966, Pl. XVI, figs. 3,4.
Archaeozonotriletes optivus var. *vorobjevensis* Chibrikova *in* McGregor and Owens 1966, Pl. XVI, figs. 5,6.

Description of specimens. Spores radial, trilete, camerate. Colour yellow to orange brown. Amb subcircular to broadly rounded triangular. Exine composed of two layers, the intexine forming a subcircular to rounded triangular inner body, and the exoexine, which completely surrounds the inner body and is extended some distance beyond its margin in the equatorial plane. Exoexine is attached to the intexine only on its proximal surface, being separated in the equatorial plane and over the entire distal surface. Trilete mark distinct; laesurae straight, simple, extending between three quarters and the entire radius of the inner body, accompanied by low, thick folds of the exoexine (individually 4-12μ wide) which may extend almost to the equator of the spore. Proximal surface of the exoexine overlying, or closely adjacent to, the equator of the inner

body, thickened to form ridge-like curvaturae up to 15μ wide. Intexine 1-2μ thick, laevigate. Exoexine of the contact areas and the polar side of the ridge-like curvaturae laevigate to finely granular. Remainder of the proximal surface and the entire distal surface of the exoexine ornamented with densely distributed, small verrucae and low, rounded coni. Elements are subcircular to polygonal in basal outline, 1-3μ high and up to 3μ in diameter, normally discrete, separated by narrow channels of thinner exoexine which may simulate a fine negative reticulum. Inner surface of the exoexine of both the proximal and the distal surfaces very finely to densely punctate. Exoexine at the equator of the spore up to 8μ thick. Distal surface of the exoexine commonly folded.

Dimensions (12 specimens measured). Maximum equatorial diameter of the spore 132-191.4μ (mean 168.3μ), maximum diameter of the inner body 92.4-138μ.

Types. Hypotypes, GSC Nos. 15615, 15616, 15617. (GSC Loc. 7559)

Comparisons. This variety is distinguished from var. *optivus* by the coarser and more densely distributed ornamentation of the exoexine, and the lower and wider thickened folds of the exoexine which accompany the laesurae. Since the two varieties appear to be readily distinguishable on the character of the exoexine ornamentation, it could be argued that there is sufficient justification to give full specific status to var. *vorobjevensis*. Such a step is however withheld until a complete assessment of the morphological intergradations (if any) between the two varieties can be made.

Contagisporites subnotatus (Chibrikova) n. comb. emend.

Plate XVII, figures 1-2

Archaeozonotriletes subnotatus Chibrikova 1959, p. 63, Pl. 8, fig. 7.
Archaeozonotriletes subnotatus Chibrikova *in* Andreyeva 1962, p. 198, Pl. 2, fig. 8.

Emended description. Spores radial, trilete, camerate. Colour orange. Amb rounded triangular to subpolygonal. Exine consists of two layers, the intexine which forms an inner body, the outline of which is concentric with that of the equatorial outline of the spore, and the exoexine which completely surrounds the inner body, being attached to it only on its proximal surface and being separated over the entire distal surface and at the equator. Trilete mark distinct; laesurae simple, straight, extending to the margin of the inner body, accompanied by wide, thickened, elevated lips of the exoexine (individually up to 6.1μ wide) which may extend some distance beyond the ends of the laesurae. Surface of the exoexine overlying, or closely adjacent to, the margin of the inner body is thickened to form low ridge-like curvaturae up to 7.6μ wide, with which the thickened folds that accompany the laesurae are fused. Intexine thin, laevigate. Exoexine thick, contact areas smooth or very finely granular, remainder of the proximal surface and the entire distal surface ornamented with small, densely distributed, discrete, blunt cones with subcircular or polygonal basal outlines. Individual elements up to 1.5μ high and up to 1.5μ in basal diameter. Exoexine up to 7μ thick at the equator, limbus-like. Distal surface of the exoexine commonly folded.

Dimensions (3 specimens measured). Maximum equatorial diameter of the spore 115-214.5μ.

Types. Hypotypes, GSC Nos. 15618, 15619. (GSC Loc. 7559)

Remarks. The specimens here assigned to *Contagisporites (Archaeozonotriletes) subnotatus* (Chibrikova) n. comb. are closely comparable to the specimens from the Kyn beds of the Upper Devonian of western Bashkiria

illustrated by Chibrikova (1959), although the structural interpretations placed on the present specimens differ considerably from those made by Chibrikova in the original description of the species. Although Chibrikova made no specific reference to curvaturae and the restriction in the distribution of the ornamentation on the proximal surface of the exoexine, it seems probable from interpretation of the illustrated specimen (Pl. 8, fig. 7) that such features are in fact present. Chibrikova also states that "The rays on the body do not coincide with those on the perispore and both have frills". From observations made on the present specimens it seems probable that Chibrikova misinterpreted the folding which commonly effects the distal surface of the exoexine as lips or folds associated with the laesurae. The laesurae in the specimen illustrated by Chibrikova are clearly accompanied by broad, thickened lips or folds of the exoexine, whilst the other Y-shaped thickening, which is interpreted by Chibrikova as "the rays of the persipore", is rotated 60 degrees from the position of the laesurae and is probably distal.

Comparisons. *Contagisporites optivus* (Chibrikova) n. comb. var. *optivus* possesses a smaller inner body, longer, higher folds of the exoexine accompanying the laesurae, more prominent curvaturae and a slightly finer granular-conate ornament. *Rhabdosporites scamnus* Allen (1965, pp. 737-738, Pl. 104, figs. 9-12) described from the Givetian deposits of Spitsbergen, is smaller (54-119μ), and although superficially similar, lacks either curvaturae or elevated, thickened folds of the exoexine accompanying the laesurae. The exoexine, which bears a dense granular ornament, is thinner and is commonly more extensively folded. *Archaeozonotriletes notatus* Naumova var. *asper* Chibrikova (1959, p. 63, Pl. 8, fig. 9) also appears superficially similar but is smaller (50-80μ), lacks a distinct granular ornamentation, and apparently lacks curvaturae or thickened folds of the exoexine associated with the laesurae.

Infraturma *PLANATI* Neves and Owens 1966

Genus *AURORASPORA* (Hoffmeister, Staplin and Malloy) Richardson 1960

Type species: *Auroraspora solisortus* Hoffmeister, Staplin and Malloy 1955

Auroraspora macromanifestus (Hacquebard) Richardson 1960

Plate XIV, figures 5-6

Dimensions (24 specimens measured). Maximum equatorial diameter 107-249μ (mean 186μ).

Types. Hypotypes, GSC Nos. 15603, 15604. (GSC Loc. 7560)

Subturma *MEMBRANATITRILETES* Neves and Owens 1966

Infraturma *CONTINUATI* Neves and Owens 1966

Genus *SPINOZONOTRILETES* (Hacquebard) Neves and Owens 1966

Type species: *Spinozonotriletes uncatus* Hacquebard 1957

Spinozonotriletes cassideus n. sp.

Plate XVII, figures 3-5; text figure 11

Spinozonotriletes sp. *in* McGregor and Owens 1966, Pl. XVIII, fig. 8

Description. Spores radial, trilete, camerate. Colour yellow to orange brown. Amb circular to subcircular, proximal surface flat, slightly concave or convex, distal surface hemispherical with a rounded or angular shoulder between the two surfaces. Exine composed of two layers, the intexine which forms a subcircular inner body that may possess numerous concentrically arranged taper-pointed folds on its distal surface, and the exoexine which completely surrounds the intexine and extends beyond its margin in the equatorial plane to form an undifferentiated flange of nearly constant width. The exoexine is separated from the intexine equatorially and, to varying degrees distally. Trilete mark distinct or indistinct; laesurae simple, straight, commonly obscured by thin elevated, contorted or sometimes flexuous folds of the exoexine that extend, decreasing in height, to the equator of the spore. Laesurae normally extend to the margin of the inner body. The folds of the exoexine accompanying the laesurae are up to 40μ high at the proximal pole and may form an apical prominence. Intexine thin, laevigate, commonly obscured by the thick, ornamented exoexine. Exoexine thick, roughened by very fine, densely distributed punctations. The entire distal surface and the equatorial portions of the proximal surface of the exoexine bear a densely distributed, subconcentrically arranged, conate and spinose ornament which is absent from the contact areas. The ornament is variable even on one specimen. It is composed of either broad-based conate or spinose elements with circular basal outlines, gently tapering sides and bluntly pointed terminations, or coarse biform elements consisting of a bulbous, boss-like base with a circular or subcircular basal outline surmounted by a small, cone-like projection. Elements 4-30μ high (commonly 10-20μ), 4-15μ in basal diameter; 22-50 elements project at the equatorial margin of the spore.

Dimensions (32 specimens measured). Maximum equatorial diameter of the spore, excluding the projecting ornament, 115.5-247.5μ (mean 148.5μ).

Types. Holotype, GSC No. 15622; paratypes, GSC Nos. 15620, 15621.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. *Spinozonotriletes uncatus* Hacquebard (1957, p. 316, Pl. 3, figs. 8-10) described originally from the Horton Group (Mississippian) of Nova Scotia and later recorded by Playford (1962, p. 657, Pl. 94, figs. 4-6) from the Lower Carboniferous of Spitsbergen is convexly subtriangular in equatorial outline, smaller (Playford, 1962, size 74-150μ, Playford, 1964, size 75-152μ) and has low lips accompanying the laesurae that do not form an apical prominence, and large, simple, broad-based cones and spines that are never mammoid. *Spinozonotriletes tenuispinosus* Hacquebard (1957, p. 316, Pl. 3, figs. 6,7) from the Horton Group of Nova Scotia is also smaller and bears more sparsely distributed, more slender, simple spines. *Acanthotriletes hacquebardii* Playford (1964, p. 20, Pl. 4, figs. 1-4) also described from the Horton Group of Nova Scotia is smaller (62-103μ) and, although superficially similar, is both azonate and acamerate and possesses a densely distributed ornament of simple, sharply pointed spines which is developed uniformly over both proximal and distal surfaces. *Archaeotriletes incompositus* (Chibrikova, 1959, p. 44, Pl. 3, fig. 1), described from the Givetian deposits of the Bashkirian SSR, bears some resemblance to *Spinozonotriletes cassideus* n. sp. but is smaller (65-85μ) and has simple laesurae which are only slightly more than half of the radius of the inner body in length. It also possesses broad-based, gently tapering spinae, with pointed or slightly expanded terminations, that are slightly longer than those of *S. cassideus* n. sp. Although Chibrikova does not specify whether the ornament is restricted to the distal surface or uniformly developed over both surfaces, there is a tendency for the shorter elements to occur in the

polar regions whereas the longer elements are more densely distributed in the equatorial region. *Archaeozonotriletes incognitus* Kedo (1955, p. 33, Pl. 4, fig. 9) described from the Middle Devonian deposits of the Byelorussian SSR appears closely comparable in general construction and in the nature of the ornament, but is smaller (80μ). ?*Spinozonotriletes* cf. *naumovii* (Kedo) Richardson (1965, p. 583, Pl. 92, figs. 3-5, text fig. 7) from the Eday beds (Givetian) of Scotland is comparable in size (85-231μ) and similar in general construction but possesses more sparsely distributed, simple, stout, broad-based, uniformly tapering, pointed spines which may be slightly longer than those of *S. cassideus* n. sp.

? *Spinozonotriletes rugosus* n. sp.

Plate XVII, figure 6; Plate XVIII, figure 1

Description. Spores radial, trilete. Colour yellow to brown. Amb subcircular; in lateral profile, proximal surface slightly convex or low pyramidal, distal surface hemispherical. Exine composed of two layers, the intexine which forms a subcircular inner body and the exoexine which completely surrounds it and is extended in the equatorial plane to form an undifferentiated flange of almost uniform width. Trilete mark distinct or obscured; laesurae simple, straight, extending approximately 3/4 of the radius of the inner body, commonly obscured by elevated, contorted folds of the exoexine which in some specimens extend to the equator of the spore. Intexine up to 4μ thick, laevigate, may possess indistinct concentric compression folds in the equatorial region. Exoexine thin, normally closely appressed to the intexine over the distal hemisphere but may be separated from it in the equatorial region and more particularly over the proximal surface, where the exoexine is extensively plicated by a series of subradially or irregularly orientated folds. Most of the folds of the exoexine overlie the inner body and may be completely absent from the equatorial region. Exoexine of the equatorial region of the proximal surface and the entire distal surface of the spore ornamented with slender, sharply pointed spines up to 3μ high (commonly 1-2μ) and 0.5-1μ in basal diameter.

Dimensions (31 specimens measured). Maximum equatorial diameter of the spore 82.5-135.3μ (mean 115.6μ), maximum diameter of the inner body 72.6-105.6μ.

Types. Holotype, GSC No. 15623; paratype, GSC No. 15624.

Type locality. Weatherall Formation, southern limb of the Robertson Point Anticline, 8 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7557.

Remarks. The assignment of this species to the genus *Spinozonotriletes* (Hacquebard) Neves and Owens (1966) is here regarded as tentative. Although the specimens attributed to this species possess some fundamental features in common with that genus, i.e. the zonate and partially camerate form and the spinose ornament, the apparent maximum separation of the exoexine from the intexine over its proximal surface, and the extensive folding of the exoexine over the proximal surface are features that are not normally associated with that genus.

Comparisons. *Hymenozonotriletes endemicus* Chibrikova (1959, p. 74, Pl. 12, figs. 1-3) described from the Takata Beds of the Devonian of western Bashkiria, possesses a wider flange-like extension of the exoexine which bears coarser, bluntly pointed cones and spines, and a smaller inner body which according to Chibrikova's description bears small, sharply pointed spines. There is no evidence from either Chibrikova's description or from the illustrated specimens to suggest that the exoexine is extensively folded over the proximal surface of the spore. *Hymenozonotriletes breviradius* Chibrikova (1962,

p. 431, Pl. 12, fig. 1) described from the Eifelian deposits of western Bashkiria, is larger (130-150μ) and although basically similar in construction, may be distinguished by its short, slender processes with bifurcate terminations, its shorter laesurae and its lack of an extensive series of folds on the proximal surface of the exoexine. *Hymenozonotriletes discors* (Chibrikova) Chibrikova (1962, pp. 431-432, Pl. 12, fig. 2) described from the Givetian deposits of western Bashkiria, is closely comparable in size (80-120μ) and general construction and possesses a similar exoexine ornament composed of minute cones and spines, but appears from the illustration to possess a much thicker inner body wall and to lack both extensive folding of the proximal surface of the exoexine and elevated, contorted folds accompanying the laesurae. *Hymenozonotriletes mirandus* Naumova (1953, p. 126, Pl. 18, fig. 34) appears to be superficially similar in general construction but possesses a fine tubercular (? granular) ornament and less densely distributed radially orientated plications on the exoexine. *Hymenozonotriletes acanthyrugosus* Chibrikova (1959, p. 73, Pl. 11, fig. 11) described from the Middle Devonian deposits of the Russian Platform, possesses a coarser ornament composed of stouter, bluntly pointed cones and spines, and lacks the extensive series of folds on the proximal surface of the exoexine. *Hymenozonotriletes meonacanthus* Naumova var. *rugosus* Kedo (1955, p. 28, Pl. 2, fig. 19) is to some extent similar in possessing a thin exoexine, bearing fine coni or spinae, which appears from Kedo's illustration to be extended in the equatorial plane in the form of a flange. The exoexine of the central portion of the spore is folded into a number of subradially orientated plications but it is not possible from either Kedo's description or illustration to determine whether the folds are proximal or distal. The Russian species may however be distinguished by its shorter laesurae that are not accompanied by elevated, contorted folds of the exoexine, and by the narrow "fringe" (? intexine wall thickness feature) at the equator of the inner body.

? *Spinozonotriletes* sp. A.

Plate XVIII, figure 2

Description. Spore radial, trilete. Colour orange. Amb broadly rounded triangular. Exine composed of two layers, the intexine which forms a subcircular to broadly rounded triangular inner body and the exoexine which completely surrounds it and is extended in the equatorial plane beyond its margin to form an undifferentiated flange of almost constant width. Trilete mark distinct; laesurae completely obscured by high, flexuous folds of the exoexine which extend to the equator of the spore. Intexine thin, laevigate. Exoexine of the proximal surface laevigate but the distal surface bears a distinctive ornament of concentrically arranged conate and spinose elements which are largest and most densely distributed in the distal polar region. Elements in the distal polar region, which are composed of a bulbous base, gently tapering sides and a sharply pointed termination, are 12.2-19.9μ high and 6.1-7.6μ in basal diameter. Towards the equator the elements are more sparsely distributed in a loosely concentric manner. Elements at the equatorial margin, which consist of a bulbous or boss-like base surmounted by a gently or sharply tapering termination, are 3-9μ high and 3-4.6μ in basal diameter.

Dimensions (1 specimen). Diameter of the spore, excluding the projecting ornament, 171.6 x 158.4 x 151.8μ, diameter of the inner body 118.8 x 92.4μ.

Type. Hypotype, GSC No. 15625. (GSC Loc. 7579)

Comparisons. This form is readily distinguished from all other species of *Spinozonotriletes* by the distinctive form and distribution of the ornamentation on the distal surface of the exoexine. *Zonotriletes latispinus* Luber *in* Luber and Waltz (1938, p. 27, Pl. 6, fig. 84) possesses a similar type of ornament on its distal surface but is smaller (50-80μ) and has more densely distributed ornamentation elements which appear from the illustration to exhibit considerable basal coalescence between adjacent elements.

Genus *GEMINOSPORA* Balme 1962 emend.

Type species: *Geminospora lemurata* Balme 1962

Emended diagnosis. Spores radial, trilete, camerate. Amb circular to rounded triangular; in lateral profile the proximal surface is flattened or low pyramidal, the distal surface hemispherical. Laesurae distinct, straight, commonly accompanied by thickened and/or elevated lips. Exine composed of two layers, the differentially thickened exoexine which is thickest over the distal surface, and the thin intexine which may be either closely appressed to or withdrawn to varying degrees from the exoexine, producing in extreme cases an inner body which is attached to the exoexine only in the region of the laesurae. Exoexine may be laevigate, punctate, or ornamented with a variety of elements including grana, coni, verrucae and spinae. Ornament normally reduced or absent on the contact areas.

Discussion. In the original description of the genus, Balme (1962, p. 4) emphasized three principal morphological features which could be utilized as criteria for distinguishing the spores of this genus, firstly the differentially thickened exoexine, secondly the frequent separation of the intexine from the exoexine to produce an inner body ("mesosporoid" of Balme), and finally the granular, conate or infrabaculose exoexine ornamentation. The combination of a thickened exoexine and variable separation of the thinner intexine from the exoexine to produce an inner body are features which occur commonly in Devonian spores. Indeed these features appear to be the principal criteria utilized by Naumova and other Russian palynologists for the assignment of spores to *Archaeozonotriletes* sensu Naumova. Allen (1965, p. 721), following the proposal of Potonié (1958, p. 28) that *Archaeozonotriletes variabilis* Naumova should be accepted as the type species for the genus *Archaeozonotriletes* Naumova (this being the first species described by Naumova who did not designate a type species), has restricted the circumscription of the genus to accommodate only patinate spores. Although the proposal by Potonié (1958) that *A. variabilis* Naumova should be accepted as the type species of the genus is completely justified according to the rules of the International Code of Botanical Nomenclature, that species is unfortunately grossly atypical of the large number of species that have been assigned to the genus. The original concept of the genus as proposed by Naumova appears to have been very close in structural organization to the present concept of *Geminospora*. The emended concept of the genus *Archaeozonotriletes* (Naumova) Allen necessitates that most of the species previously assigned to it must be reallocated. In order to avert the unnecessary establishment of numerous monospecific genera which share the same fundamental structural features as *Geminospora*, being distinguished only by difference in the exoexine ornamentation, the circumscription of *Geminospora* is expanded to accommodate a wider range of exine ornamentation. The expanded circumscription will accommodate many of the forms which have been rejected from the restricted concept of *Archaeozonotriletes*. A review of the species which have been assigned to the genus *Archaeozonotriletes* Naumova by Russian palynologists suggests that of the species which have been rejected following the restriction of the genus by Allen, the following appear suitable for transfer to *Geminospora* in it's emended form:-

Archaeozonotriletes comans Chibrikova 1959, Pl. 11, fig. 3.
A. comptus Naumova 1953, Pl. 5, fig. 9.
A. comptus Naumova var. *densispinosus* Chibrikova 1962, Pl. 8, figs. 1-3.
A. confusus Naumova 1953, Pl. 2, fig. 14.
A. confusus Naumova var. *interstatus* Chibrikova 1962, Pl. 7, fig. 11.
A. consimilis Kedo 1957, Pl. 4, fig. 1.
A. devonicus var. *minor* Kedo 1963, Pl. 7, figs. 173, 174.
A. exocus Chibrikova 1962, Pl. 11, fig. 4.
A. famenensis Naumova 1953, Pl. 17, figs. 31-34.

A. famenensis Naumova var. *gracilis* Kedo 1963, Pl. 7, figs. 171-172.
A. fragosus Chibrikova 1959, Pl. 10, fig. 6.
A. lasius var. *major* Naumova 1953, Pl. 2, fig. 17.
A. macromanifestus Naumova 1953, Pl. 12, fig. 1, Pl. 11, fig. 16.
A. macromanifestus Naumova var. *angulatus* Chibrikova 1962, Pl. 11, fig. 5.
A. meonacanthus Naumova 1953 *in* Chibrikova 1959, Pl. 7, fig. 4.
A. micromanifestus Naumova 1953, Pl. 2, fig. 18, Pl. 12, figs. 2-4.
A. micromanifestus Naumova var. *crispus* Chibrikova 1959, Pl. 11, fig. 1.
A. micromanifestus Naumova var. *limbatus* Chibrikova 1962, Pl. 7, figs. 7, 8.
A. micromanifestus Naumova var. *microsetosus* Kedo 1963, Pl. 7, fig. 164.
A. micromanifestus Naumova var. *minor* Naumova 1953, Pl. 4, fig. 11, Pl. 2, fig. 19.
A. mutabilis Kedo 1955, Pl. 5, fig. 3.
A. opiparus Naumova 1953, Pl. 12, fig. 5.
A. purus Naumova 1953, Pl. 2, fig. 15.
A. semilucensis Naumova 1953, Pl. 13, fig. 15.
A. aff. *semilucensis* Naumova *in* Kedo 1963, Pl. 7, fig. 157.
A. spinosellus Jush. *in* Kedo 1963, Pl. 8, fig. 182.
A. tuberculatus Kedo 1955, Pl. 5, figs. 6, 7.
A. venustus Naumova 1953, Pl. 2, fig. 21.
A. violabilis Chibrikova var. *major* Chibrikova 1962, Pl. 6, fig. 9.
A. visendus Chibrikova 1959, Pl. 9, fig. 7.
A. visendus Chibrikova var. *echinatus* Chibrikova 1959, Pl. 9, fig. 10.

The suggested assignment of all of these forms to the genus *Geminospora* is based principally on comparison of the illustrations and to a lesser extent on the specific descriptions. All of the species possess a relatively thick exoexine and a thinner intexine, the latter being variably separated from the exoexine, commonly forming a clearly defined inner body. Before any of the above species are formally transferred to *Geminospora* it is desirable that cotype specimens should be examined.

Geminospora antaxios (Chibrikova) n. comb.

Plate XVIII, figures 3-6

Archaeozonotriletes antaxios Chibrikova 1962, p. 412, Pl. 6, fig. 10.
Archaeozonotriletes antaxios Chibrikova *in* McGregor and Owens 1966, Pl. XVII, figs. 4, 5.

Description of specimens. Spores radial, trilete, commonly camerate. Colour yellow to orange. Amb subcircular to rounded triangular; proximal surface flattened, distal surface hemispherical. Exine composed of two layers, intexine thin, exoexine differentially thickened with the maximum thickness (3-15.3μ) at the equator and over the distal surface. The two layers sometimes closely appressed, more commonly variably separated with the intexine withdrawn from the exoexine in the equatorial plane and over at least part of the distal surface, producing a well-defined inner body. Trilete mark distinct; laesurae straight, extending between 3/4 and the full radius of the intexine, accompanied by elevated, thickened lips that are individually up to 6μ wide in the polar region but which decrease in height and width towards the equator. Contact areas may be clearly defined, delimited equatorially by arcuate curvaturae which result from a marked change in exine thickness. Curvaturae most apparent in the radial positions, being coincident with the equator of the spore in the interradial positions. Exoexine of the contact areas thin, surface punctate or ornamented with minute grana. Exoexine of the remainder of the proximal surface and the entire distal surface ornamented with densely distributed, small grana, coni and microverrucae. Elements normally discrete, circular to angular in basal outline, up to 1.5μ in basal diameter and up to 1μ high. Ornament is restricted to the distal surface in forms lacking curvaturae but if the latter feature is developed the ornament may transgress onto the proximal surface in the radial positions.

Dimensions (108 specimens measured). Maximum equatorial diameter 59.4-128.7μ (mean 89.1μ).

Types. Hypotypes, GSC Nos. 15626, 15627, 15628. (GSC Loc. 7559)

Remarks. The distinctive form of the differentially thickened exoexine and the tendency for the intexine to separate from it and produce an inner body (mesosporoid of Balme, 1962) are the principal criteria utilized to justify the transfer of this species to *Geminospora* (Balme) emend. The inconsistent development of curvaturae is a feature which can be accommodated within the genus because incipient curvaturae were recorded in some of the specimens of the type species *G. lemurata* by Balme.

Comparisons. The specimens of *Archaeozonotriletes antaxios* described by Chibrikova (1962) from the Eifelian deposits of the western slopes of the southern Urals in the Bashkirian SSR appear identical to the Canadian specimens. Chibrikova's description of this species was based on only nine specimens, none of which showed either curvaturae or separation of the two layers of the exine. The greater number of specimens examined during the current investigation has allowed a more detailed study of the morphological variation within the species, and apparently the Russian specimens may be accommodated within the expanded concept of the species. *Geminospora lemurata* Balme (1962, p. 5, Pl. 1, figs. 1-5), described from the Upper Devonian deposits of the Carnarvon Basin, Western Australia, may be distinguished from *G. antaxios* Chibrikova n. comb. by its smaller size (38-67μ), its thinner exoexine and the lack of elevated lips accompanying the laesurae. *Archaeozonotriletes nalivkini* Naumova (1953, p. 85, Pl. 13, fig. 18) described from the Frasnian deposits of the Russian Platform, appears superficially similar to the present species, but detailed comparison is difficult due to the inadequate description of the Russian species. It is however interesting to note that the thickened lips which accompany the laesurae in *A. nalivkini* are slightly expanded at their extremities in a similar manner to the thickened lips of those specimens of *G. antaxios* which possess well-developed curvaturae. *Stenozonotriletes carnosus* Ishchenko (1958, p. 81, Pl. 10, fig. 123) described from the Lower Carboniferous deposits of the Dnieper-Donetz Basin also appears superficially similar to *G. antaxios* but lacks lips accompanying the laesurae and does not exhibit any separation of the two layers of the exine. *Stenozonotriletes bellus* Guennel (1963, p. 253, fig. 8) described from Devonian deposits filling a cavity in a Middle Silurian reef in southern Illinois, is apparently similar in general construction but has a thinner exoexine and lacks lips accompanying the laesurae. Guennel refers to the thickened exoexine in the equatorial plane as forming a cingulum but examination of the specimen illustrated by Guennel suggests that it may equally well be interpreted as a wall thickness feature of the exoexine. Guennel makes no specific reference to separation between the two layers of the exine, but there is a suggestion of minor separation occurring in the illustrated specimen. *Geminospora svalbardiae* (Vigran) Allen (1965, pp. 696-697, Pl. 94, figs. 12-16) from the Emsian to Givetian deposits of Spitsbergen, is very similar and may be in part synonymous with *G. antaxios*. It appears to differ only in its thinner exoexine (3-7μ), narrower lips, consistently granular ornament and frequent possession of tangential and arcuate compression folds on the surface of the exoexine.

Geminospora punctata n. sp.

Plate XIX, figures 1-9

Geminospora sp. *in* McGregor and Owens 1966, Pl. XV, figs. 7-10.
Unidentified spore types *in* Kerr, McGregor and McLaren 1965, Pl. 4, figs. 15, 16.

Description. Spores radial, trilete, camerate. Colour yellow to orange brown. Amb subcircular to rounded triangular. Trilete mark distinct; laesurae straight, 2/3 to slightly more than 3/4 of the spore radius in length, accompanied by low, narrow lips which in some specimens are elevated and slightly flexuous. Overall width of the lips rarely exceeds 4μ. Ends of the

laesurae may show minor bifurcation. Exine composed of two layers, intexine thin and smooth, exoexine differentially thickened, 6-16.2μ thick over the distal surface, 3-7μ thick over the proximal surface (measurements made on laterally and obliquely compressed specimens). The two layers may be closely appressed but are more commonly variably separated, particularly in the equatorial region and over the distal surface, resulting in a clearly defined inner body. Wall of the inner body may possess peripheral compression folds. Surface of the exoexine of both proximal and distal surface possesses fine, densely distributed punctations. Equator of the spore appears finely striated because of the punctations which pass completely through the thick exoexine.

Dimensions (152 specimens measured). Maximum equatorial diameter 39.6-99μ (mean 56.1μ).

Types. Holotype, GSC No. 15633; paratypes, GSC Nos. 15629, 15630, 15631, 15632, 15634, 15635, 15636, 15637.

Type locality. Griper Bay Formation, west side of Mould Bay, Prince Patrick Island, Northwest Territories, GSC Loc. 7558.

Remarks. Although considerable variation was observed in the degree of separation between the intexine and the exoexine, no positive relationship could be proven between the degree of separation and the overall size of the spore.

Comparisons. Foveosporites pertusus Vigran (1964, pp. 18-19, Pl. IV, figs. 3-4, Pl. V, figs. 1-2a-d) described from the Frasnian deposits of Mimerdalen, Spitsbergen, appears superficially very closely comparable to *G. punctata* n. sp., particularly with respect to the exine ornamentation and the differentially thickened nature of the exine, but may be distinguished by its apparent acamerate form. Vigran in her description of the species makes no reference to any separation of the exine layers to form an inner body. *Geminospora lemurata* Balme (1962, p. 5, Pl. 1, figs. 5-10) from the Frasnian deposits of the Carnarvon Basin, Western Australia, is closely comparable in general construction but has a smaller size range (38-67μ) and a granular, conate or infrabaculose ornament on the exoexine. *Geminospora spinosa* Allen (1965, p. 697, Pl. 94, figs. 17-19) described from sediments of probable upper Givetian age from Spitsbergen is also superficially similar in general construction but possesses longer laesurae which are accompanied by higher lips, and an infragranulate exoexine which bears small spinae. *Geminospora tuberculata* (Kedo) Allen (1965, p. 696, Pl. 94, figs. 10, 11) from the Givetian of Spitsbergen possesses a thinner, infragranulate exoexine (2-3μ thick) which over the equatorial portions of the proximal surface and the entire distal surface bears fine granules and cones. Several species described by Russian workers and assigned to the genus *Archaeozonotriletes* Naumova bear a strong resemblance to *G. punctata* n. sp. *Archaeozonotriletes incrustatus* Archangelskaya (1963, p. 22, Pl. 5, figs. 1, 2 and Pl. 6, figs. 1, 2) from the Upper Devonian of the Russian Platform appears from the illustrations to possess a similar thick, punctate exoexine and a thinner intexine which is in part separated from the exoexine, but differs by being larger (210-360μ). *Archaeozonotriletes lasius* Naumova which was first formally described by Tuzova (1959, p. 124, Pl. 4, fig. 20) from the Givetian and Frasnian deposits of Eastern Tataria, USSR, *A. lasius* var. *major* Naumova (1953, p. 31, Pl. 2, fig. 17) described from the Givetian of the Russian Platform, and *A. confusus* Naumova (1953, p. 30, Pl. 2, fig. 14) originally described from the uppermost Givetian deposits of the Russian Platform and later recorded by Kedo (1955, p. 34, Pl. 4, fig. 10) from the uppermost Givetian of the Byelorussian SSR all appear from their descriptions and illustrations to possess a similar thickened exoexine and a thinner intexine which is separated to varying degrees from the exoexine. They differ from *G. punctata* n. sp. by possessing a shagreen instead of punctate exoexine. The other species, assigned by the Russian workers to *Archaeozonotriletes*, which

could be transferred to the genus *Geminospora* are distinguished from *G. punctata* by possessing a strongly developed positive ornamentation of the exoexine.

Geminospora verrucosa n. sp.

Plate XIX, figures 10-12

Unidentified spore types *in* Kerr, McGregor and McLaren 1965, Pl. 4, figs. 9, 11.

Foveosporites pertusus Vigran *in* McGregor 1967, Pl. 1, figs. 18, 19.

Description. Spores radial, trilete, camerate. Colour yellow to orange brown. Amb circular to rounded triangular; proximal surface flattened, distal surface hemispherical. Exine composed of two layers, intexine thin, exoexine differentially thickened with the greatest thickness over the distal surface. Two layers may be closely appressed, but more commonly are variably separated with the separation starting in the equatorial plane but progressively affecting the entire distal surface and the equatorial portions of the proximal surface, resulting in a clearly defined inner body. Trilete mark distinct or partially obscured by exine ornamentation; laesurae straight, usually as long as the radius of the inner body, accompanied by narrow, low or slightly elevated lips. Ends of the laesurae may exhibit minor bifurcation. Intexine thin, apparently laevigate. Exoexine distinctly punctate proximally and distally. Punctations are small, densely distributed and from examination of the equatorial margin appear to pass completely through the exoexine, thereby imparting a characteristic striated appearance to the equatorial margin of the spore. In addition to the dense punctation, the distal surface of the exoexine bears a scattered ornament of coarse, broad based, bluntly pointed and rounded cones and flat-topped verrucae. Diameter of the elements 4-7μ, height up to 4μ. Basal coalesence between adjacent elements producing rudimentary cristae occurs commonly. Ornament absent from the proximal surface of the exoexine.

Dimensions (49 specimens measured). Maximum equatorial diameter 46.2-69.3μ (mean 56.1μ).

Types. Holotype, GSC No. 15638; paratypes, GSC Nos. 15639, 15640.

Type locality. Griper Bay Formation, west side of Mould Bay, Prince Patrick Island, Northwest Territories, GSC Loc. 7558.

Comparisons. Densosporites striatiferus Hughes and Playford (1961, p. 35, Pl. 2, figs. 16-18) described from the Lower Carboniferous deposits of Spitsbergen, bears a strong resemblance to this species but possesses a clearly defined cingulum with a characteristic striated surface and an irregularly lobed equatorial margin as opposed to the variably thickened, punctate exoexine of *G. verrucosa* n. sp. *D. striatiferus* also lacks coni or verrucae on the distal surface of the exoexine. *Lophozonotriletes dentatus* Hughes and Playford (1961, pp. 36, 38, Pl. 3, figs. 8-10), also illustrated by Playford (1963, Pl. 91, fig. 5), also described from the Lower Carboniferous of Spitsbergen, differs by possessing a cingulate equatorial margin and a considerably coarser distal ornament of bacula and verrucae. *Lophozonotriletes scurrus* Naumova (1953, p. 38, Pl. 3, figs. 22-23) originally described from the uppermost Givetian deposits of the Russian Platform and subsequently recorded by numerous other Russian palynologists from deposits of the same age from various parts of the USSR, appears to accommodate a variable group of spores which in part resembles *G. verrucosa* n. sp. It is difficult to determine from either the descriptions or the illustrations the precise nature of the thickened outer layer of the exine (perispore of the Russian workers). In the equatorial plane this layer could be interpreted as either a true equatorial structure or a thickened exoexine similar to that of *Geminospora*. The ornament, which is described as tubercular by the Russian workers, appears to include verrucae, coarse coni and bacula, and is in general terms comparable with that of *G. verrucosa* n. sp.

Archaeozonotriletes accitus Chibrikova (1959) var. *angulatus* Chibrikova (1962, p. 427, Pl. 10, fig. 4) described from the Givetian deposits of western Bashkiria, appears superficially similar to *G. verrucosa* n. sp. but detailed comparison is not possible due to the lack of information in Chibrikova's description concerning the component layers of the exine.

Geminospora plicata n. sp.

Plate XX, figures 1, 2

Archaeozonotriletes sp. *in* McGregor and Owens 1966, Pl. XVII, fig. 2.
Archaeozonotriletes sp. *in* McGregor and Owens 1966, Pl. XVII, fig. 3.

Description. Spores radial, trilete, camerate. Colour yellow to orange. Amb rounded triangular, subcircular or circular. Trilete mark distinct; laesurae straight, length 3/4 to almost the full radius of the spore, commonly accompanied by low thickened lips (individually up to 4.5μ wide) and by thin elevated, flexuous folds of the exoexine which extend, decreasing in height, to the equator of the spore. Exine composed of two layers, the intexine which is thin and laevigate and the differentially thickened exoexine which is thickest (2.5-8μ) in the equatorial region and over the distal surface. The two layers are normally closely appressed to each other, but may be separated to varying degrees, particularly in the equatorial region of the proximal surface and over the entire distal surface, resulting in a clearly defined inner body. Exoexine of the proximal surface smooth but that of the distal surface bears densely distributed, minute, discrete grana and coni which are up to 1μ high and approximately 0.5μ in diameter. Distal surface of the exoexine bears major secondary folds that are characteristically arranged to form a coarse, triangular structure, the apices of which occur in the radial positions.

Dimensions. (19 specimens measured). Maximum equatorial diameter 59.4-86μ (mean 66μ).

Types. Holotype, GSC No. 15641; paratype, GSC No. 15642.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. The distinctive triangular-subtriangular secondary fold structure on the distal surface of the exoexine readily distinguishes spores of this species from all other species of *Geminospora* and also from all spores of basically similar construction which have been assigned to the genus *Archaeozonotriletes* Naumova by Russian palynologists. *Archaeozonotriletes notatus* Naumova (1953, p. 84, Pl. 13, fig. 12 and p. 116, Pl. 17, fig. 25) originally described from the Frasnian and Famennian deposits of the Russian Platform, appears similar in overall construction but possesses a fine, densely distributed tubercular ornament, long, simple laesurae and a simple triradiate fold on the distal surface of the exoexine. *A. notatus* Naumova var. *microspinosus* Chibrikova (1962, pp. 420-421, Pl. 9, fig. 2) and *A. notatus* Naumova var. *asper* Chibrikova (1959, p. 63, Pl. 8, fig. 9) also possess a simple triradiate fold on the distal surface of the exoexine. *A. rugosus* Naumova (1953, p. 85, Pl. 13, fig. 17) may be distinguished by possessing a number of irregularly orientated, taper-pointed folds on its distal surface.

Geminospora sp. A.

Plate XX, figure 3

Description (one specimen, preserved in slightly oblique compression). Spore radial, trilete, camerate. Colour orange. Exine composed of two

layers, the intexine is thin, very finely punctate and withdrawn from the exoexine over the entire distal surface and in the equatorial region of the proximal surface, resulting in a distinct inner body with a subcircular equatorial outline and concentric peripheral compression folds on its distal surface. Exoexine 3-4.6μ thick in the equatorial region. Trilete mark distinct; laesurae simple, straight, 4/5 to the full radius of the inner body in length. Curvaturae absent but the contact areas, which extend a short distance beyond the equator of the intexine, possess very fine, densely distributed grana. Exoexine of the remainder of the proximal surface and the entire distal surface bears densely distributed small, commonly bent, echinate spines, up to 3μ high and 0.5-1μ in basal diameter.

Dimensions. Maximum equatorial diameter 66-59.4μ, maximum diameter of the inner body 47.4-45.9μ.

Type. Hypotype, GSC No. 15643. (GSC Loc. 7580)

Remarks. The minute, echinate ornament of the exoexine renders this form distinguishable from all other species of *Geminospora*.

Suprasubturma *PERINOTRILITES* Erdtman 1947

Genus *PEROTRILITES* (Erdtman) Couper 1953

Type species: *Perotrilites granulatus* Couper 1953

Perotrilites aculeatus n. sp.

Plate XX, figures 4-7

Perotrilites sp. McGregor 1960, p. 35, Pl. 12, fig. 8.

Description. Spores radial, trilete. Colour yellow. Amb circular or subcircular. Spore consists of a thick walled body surrounded by a loosely fitting thin "perispore". Trilete mark normally distinct; laesurae straight, extending 1/2 to 2/3 of the radius of the spore body in length, sometimes simple, more commonly accompanied by elevated, flexuous folds of the "perispore" which may obscure the laesurae. Exine smooth or very finely granular, up to 2.5μ thick. "Perispore" attached to the exine only in the region of the trilete mark. In some specimens it appears closely appressed to the exine whereas in others it may extend up to 10μ beyond the equator of the exine. "Perispore" bears a scattered ornament of small, sharply pointed coni and rare grana, and possesses numerous randomly orientated compression folds of variable length, width and concentration. Elements up to 2μ high (commonly 1-1.5μ) and less than 1μ in basal diameter.

Dimensions (23 specimens measured). Maximum equatorial diameter 64.5-102.3μ (mean 85.8μ).

Types. Holotype, GSC No. 15645; paratypes, GSC Nos. 15644, 15646, 15647.

Type locality. Griper Bay Formation, 1 mile north of Stevens Head, west coast of Melville Island, Northwest Territories, GSC Loc. 5116.

Comparisons. *Perotrilites ergatus* Allen (1965, pp. 731-732, Pl. 102, figs. 16-20) from the Givetian of Vestspitsbergen appears superficially closely comparable to *Perotrilites aculeatus* n. sp. but possesses a thicker exine (4-10μ) and longer, wider folds of the "perispore" accompanying the laesurae. It does however possess a similar sparsely distributed conate ornament on the

"perispore". *Diaphanospora riciniata* Balme and Hassell (1962, p. 22, Pl. 4, figs. 1-4, text fig. 5) and *Diaphanospora perplexa* Balme and Hassell (1962, p. 22, Pl. 4, figs. 5-7) described from the Upper Devonian of the Canning Basin, Western Australia, are both smaller (50-76μ and 54-64μ respectively) and possess a spore body with a thickened equator, longer laesurae and a thin unornamented outer "perispore". *Diaphanospora apiculata* Guennel (1963, pp. 257-258, figs. 14, 15) described from deposits dated as Middle or early Late Devonian from southern Illinois is also smaller (38-56μ) and possesses an equatorially thickened body margin and distinct coni that are restricted to the distal surface. *Diaphanospora reticulata* Guennel (1963, pp. 258-259, figs. 17-19) also from the Middle or early Late Devonian of Illinois differs by possessing a wide equatorial flange surrounding the spore body and a thin, distal "perispore". *Perotrilites perinatus* Hughes and Playford (1961, p. 33, Pl. 2, figs. 7-10) described from the Lower Carboniferous of Spitsbergen possesses longer laesurae and an unornamented "perispore". The specimens recorded by Vigran (1964) as *Perotrilites* cf. *perinatus* (p. 19, Pl. 3, figs. 7, 8) from the Upper Devonian of Spitsbergen possess short laesurae and a conate ornament on the "perispore" and may be synonymous with *P. aculeatus* n. sp.

Perotrilites minor n. sp.

Plate XX, figures 8-10

Description. Spores radial, trilete. Colour yellow. Amb circular to broadly rounded triangular. Trilete mark distinct; laesurae straight, simple or accompanied by low, narrow lips, individually up to 1.5μ wide, extending between 1/2 and the full radius of the spore body. Exine of the spore body smooth, up to 1.5μ thick. Spore body completely surrounded by a thin, almost transparent, smooth to very finely granular "perispore" that is normally closely appressed to the spore body but may extend up to 6μ beyond its equator. "Perispore" characteristically folded, with numerous randomly orientated, short, irregular plications.

Dimensions (24 specimens measured). Maximum equatorial diameter 42.3-74μ (mean 56.1μ).

Types. Holotype, GSC No. 15649; paratypes, GSC Nos. 15648, 15650.

Type locality. Griper Bay Formation, west side of Mould Bay, Prince Patrick Island, Northwest Territories, GSC Loc. 7558.

Comparisons. Perotrilites perinatus Hughes and Playford (1961, p. 33, Pl. 2, figs. 7-10) has a broader size range (44-90μ), a thicker exine (2.5-4μ), and a more loosely fitting "perispore" which projects up to 10μ beyond the equator of the spore body. *Diaphanospora apiculata* Guennel (1963, pp. 257-258, figs. 14-15) is distinguished by its fine conate ornament on the distal surface of the "perispore". *D. riciniata* Balme and Hassell (1962, p. 22, Pl. 4, figs. 1-4, text fig. 5) and *D. perplexa* Balme and Hassell (1962, p. 22, Pl. 4, figs. 5-7) both have a much thicker exine which imparts a limbate appearance to the equator of the spore body, more prominent thickened lips accompanying the laesurae, and a more loosely fitting "perispore".

Perotrilites sp. A.

Plate XX, figure 11

Description (one specimen). Spore radial, trilete, consisting of a spore body completely surrounded by a thin, almost transparent, plicated "perispore". Colour brown. Amb circular. Trilete mark distinct; laesurae simple, straight, 1/3 to 1/2 of the spore body radius in length. Exine of the spore body smooth, up to 4.5μ thick. "Perispore" thin, extends up to 9μ beyond the

margin of the spore body, ornamented on its distal surface and at the equator by small sharply pointed conate elements up to 2μ high, ornament absent from most of the proximal surface. "Perispore" characteristically plicated with long narrow folds which are normally irregularly orientated but over part of the proximal surface possess a subradial orientation. "Perispore" attached to the exine in the region of the trilete mark, where it forms elevated, slightly flexuous folds which accompany the laesurae.

Dimensions (one specimen). Overall diameter 85.8 x 82.6μ, diameter of the spore body 77 x 75.9μ.

Type. Hypotype, GSC No. 15651. (GSC Loc. 7559)

Comparisons. The large size and distinctive conate ornament developed only on the distal surface of the "perispore" renders this spore type distinguishable from other members of the genus. *Perotrilites aculeatus* n. sp. possesses a thinner exine and more sparsely distributed coni on both the proximal and distal surfaces of the "perispore". *Perotrilites perinatus* Hughes and Playford (1961, p. 33, Pl. 2, figs. 7-10) may be distinguished by its laevigate to finely granular "perispore". *Diaphanospora apiculata* Guennel (1963, pp. 257-258, figs. 14-15) is smaller (38-56μ) and has a thicker exine, but it possesses a similar conate ornament which is also restricted to the distal surface.

Turma *MONOLETES* Ibrahim

Subturma *AZONOMONOLETES* Luber

Infraturma *PSILAMONOLETI* Van der Hammen

Genus *LATOSPORITES* Potonié and Kremp 1954

Type species: *Latosporites latus* (Kosanke) Potonié and Kremp 1954

Latosporites sp. A.

Plate XX, figure 13

Description (one specimen). Spore bilateral, monolete. Colour brown. Amb subcircular. Monolete mark distinct, simple, straight, extending approximately 2/3 of the spore diameter. Ends of the monolete mark show minor bifurcation. Exine up to 7.5μ thick at the equator, producing a pseudocingulate appearance. Surface of the exine very finely punctate. Diameter 85.8 x 75.9μ.

Type. Hypotype, GSC No. 15653. (GSC Loc. 5116)

Comparisons. The only previously recorded representatives of this genus from the Devonian are the two specimens from talus fragments of coal collected from Stevens Head on the west coast of Melville Island, which were tentatively assigned to the genus by McGregor (1960, pp. 38-39, Pl. 13, figs. 11, 12). They possess a thinner exine and are smaller (50-66μ). Representatives of this genus are more commonly encountered in the Upper Carboniferous, but no species described possesses a comparably thick exine. Winslow (1962, p. 66, Pl. 15, figs. 1, 8, 8a, 9, 10) has described several specimens of monolete spores from the Bedford Shale and the Berea Sandstone (lowermost Mississippian) of Ohio, and assigned them to *Laevigatosporites* (Ibrahim) Schopf, Wilson and Bentall. They all possess a much thinner exine than *Latosporites* sp. A.

Latosporites sp. B.

Plate XX, figure 12

(?) *Latosporites* sp. McGregor, 1960, pp. 38-39, Pl. 13, figs. 11, 12

Description (one specimen). Spore bilateral, monolete. Amb subovoid. Monolete mark moderately distinct, slightly bent, extending at least half of the diameter of the spore. Exine 1.5-4.5μ thick in the equatorial plane. Surface of the exine very finely granular. There is some evidence of minor separation between the two component layers of the exine. Diameter 59.4 x 42.9μ.

Type. Hypotype, GSC No. 15652. (GSC Loc. 7557)

Remarks. This specimen appears closely comparable to (?) *Latosporites* sp. McGregor (1960), but differs slightly by exhibiting evidence of minor separation of the two component layers of the exine in the equatorial plane. The specimen referred to as *Archaeoperisaccus* sp. illustrated in McGregor and Owens 1966 (Pl. XXV, fig. 7) also appears superficially similar but would appear to differ by possessing a thin outer "perispore" that is clearly separated over the majority of the surface of the exine.

Subturma *ZONOMONOLETES* Luber

Genus *ARCHAEOPERISACCUS* (Naumova) Potonié 1958

Type species: *Archaeoperisaccus menneri* Naumova 1953

Archaeoperisaccus oblongus n. sp.

Plate XXI, figures 1-6

Archaeoperisaccus cf. *A. timanicus* Pashkevich 1964, *in* McGregor and Owens 1966, Pl. XVIII, figs. 4, 5.

Description. Spores bilateral, monolete, ? camerate. Colour yellow. Amb ovoid with rounded or bluntly pointed apices. Amb of the inner body subcircular. In lateral profile subspherical, proximal surface slightly less convex than the distal surface. Exine composed of two layers, the intexine which forms the inner body and the exoexine which is normally closely appressed to it but extends a considerable distance beyond its margin in the longitudinal plane and to a lesser extent in the transverse plane to form a thin flange or bladder-like extension. The two layers of the exine may be slightly separated, particularly in the equatorial plane and over at least the more equatorial portion of the distal surface. Monolete mark distinct; laesura straight, extending the entire diameter of the inner body, simple or with low, narrow lips, commonly obscured by elevated folds of the exoexine, up to 15μ high, which extend, decreasing in height particularly over the equatorial extension of the exoexine, to the equator of the spore. Intexine up to 1.5μ thick, laevigate. Exoexine thin except distally beneath the equator of the intexine, where it may be slightly thickened, producing a narrow darker band. Surface of the exoexine minutely roughened by very fine, dense infrapunctation; distal surface bears coni that are most densely distributed in the region underlying the intexine and are scattered over the equatorial portions. Over the central portions of the distal surface the coni which are up to 4.5μ high and up to 3.5μ in basal diameter, are commonly fused at their bases with adjacent elements to form short rudimentary cristae or irregular, convolute ridges up to 14μ long. The ornament may be

concentrated on that portion of the exoexine which immediately underlies the equator of the intexine, thus accentuating the slight equatorial thickening of the exoexine. Over the equatorial extension of the exoexine the elements are similar in form and size but are normally discrete and are much less densely distributed. Elements are rare on the equatorial portions of the proximal surface.

Dimensions (52 specimens measured). Maximum equatorial diameter of the spore 62.7-102.3μ (mean 82.5μ), minimum equatorial diameter of the spore 36.3-59.4μ (mean 49.5μ). Maximum equatorial diameter of the inner body 33-62.1μ (mean 56.1μ), minimum equatorial diameter of the inner body 29.6-49.5μ (mean 42.9μ).

Types. Holotype, GSC No. 15656; paratypes, GSC Nos. 15654, 15655, 15657, 15658.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. *Archaeoperisaccus timanicus* Pashkevich (1964, p. 126, Pl. 14, figs. 1-4) described from the Frasnian deposits of North Timan is superficially similar to this species but is smaller (46.5-62.7μ), possesses an intexine which has a "marbly-verrucose (sinuate) or reticulate-cellular sculpture" on its distal surface and an exoexine that is extensively folded, and lacks thin, elevated folds accompanying the laesura. *A. verrucosus* Pashkevich (1964, p. 127, Pl. 14, figs. 5-8) also described from the Frasnian deposits of North Timan, possesses an intexine which bears a verrucose ornament on its distal surface and an exoexine which is ornamented with sparsely distributed tubercules.

Archaeoperisaccus scabratus n. sp.

Plate XXI, figures 7-13

? *Archaeoperisaccus* sp. *in* McGregor and Owens 1966, Pl. XVIII, figs. 6, 7.

Description. Spores bilateral, monolete, ? camerate. Colour orange. Amb ovoid; in lateral profile surface flat or slightly convex, distal surface hemispherical. Exine composed of two layers, the intexine which forms an inner body that is more roundly ovoid than the amb of the spore, and the exoexine which completely surrounds the intexine and is extended equatorially beyond its margin to form a wide, undifferentiated flange that is rounded in profile. Exoexine normally closely appressed to the intexine although minor separation of the two layers may occur in the equatorial plane and over the more equatorial portion of the distal surface. Monolete mark distinct; laesura straight to slightly sinuous, equal to 1/2-3/4 of the diameter of the inner body in length, accompanied and partly obscured by thin, elevated, flexuous folds of the exoexine which are up to 15μ high at the proximal pole and extend decreasing in height, to the equator of the spore. Intexine thin, laevigate. Exoexine thin proximally but much thicker equatorially and distally. Exoexine 4-5μ thick in the distal polar region (measured on laterally compressed specimens). Exoexine minutely roughened by very fine, dense infrapunctation. Minute echinate projections, approximately 0.5μ high, are present on the equatorial flange.

Dimensions (21 specimens measured). Maximum equatorial diameter of the spore 62.7-92.4μ (mean 79.2μ), minimum equatorial diameter of the spore 36.3-85.8μ (mean 46.2μ). Maximum equatorial diameter of the inner body 42.9-52.8μ (mean 47.9μ), minimum equatorial diameter of the inner body 23.1-33μ (mean 26.4μ).

Types. Holotype, GSC No. 15664; paratypes, GSC Nos. 15659, 15660, 15661, 15662, 15663, 15665.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. *Archaeoperisaccus mirus* Naumova (1953, p. 91, Pl. 14, figs. 14, 15) appears to be the most closely comparable species of *Archaeoperisaccus* described by the Russian workers. However it is smaller (maximum diameter of the spore 50-55μ) and possesses an equatorial flange-like extension of the exoexine which appears from Naumova's illustrations to be thinner than that of *A. scabratus* n. sp. *A mirandus* Naumova (1953, p. 90, Pl. 14, fig. 11) described from the upper Frasnian sediments of the Russian Platform, possesses a similar thick, wide equatorial flange but is smaller (maximum diameter of the spore (50-55μ), possesses densely distributed small coni and verrucae over the entire surface of the exoexine, and lacks elevated folds of the exoexine accompanying the laesura. *A. elongatus* Naumova (1953, p. 91, Pl. 14, fig. 16) and *A. ovalis* Naumova (1953, p. 91, Pl. 14, fig. 13) both are smaller and possess a thinner exoexine. Detailed comparison with any of the Russian species mentioned above is diffucult because their descriptions do not contain any details concerning the structural relationships between the exoexine and the intexine or of the precise nature of the equatorial extension of the exoexine.

Archaeoperisaccus opiparus n. sp.

Plate XXII, figures 1-6

Archaeoperisaccus sp. *in* McGregor and Owens 1966, Pl. XVIII, figs. 1-3.

Description. Spores bilateral, monolete, ? camerate. Colour yellow to orange. Amb elongate, ovoid. Exine composed of two layers, the intexine which forms a roundly ovoid inner body and the exoexine which completely surrounds it and is extended in the equatorial plane to form an undifferentiated flange, the maximum diameter of which coincides with the longest diameter of the spore. The two layers of the exine are normally closely appressed, although there is evidence of minor separation in the equatorial plane and over the more equatorial portion of the distal surface. Monolete mark distinct; laesura which equals the longest diameter of the inner body in length and may be accompanied by low narrow lips, is commonly obscured by strong elevated folds of the exoexine. The folds are up to 20μ high at the proximal pole, and extend, decreasing in height, to the equator of the spore. Intexine 1-1.5μ thick, laevigate. Exoexine slightly thicker, minutely roughened by very fine infrastructure (? infrapunctation) and distally ornamented by broad-based tubercular elements surmounted by small mammoid, conate or spinose terminations. The elements which are up to 10μ high and up to 9μ in basal diameter are normally discrete, although basal coalescence between the bases of adjacent elements may occur, resulting in the formation of rudimentary cristae. Surface of the exoexine between the larger elements densely ornamented with small coni and spinae.

Dimensions (21 specimens measured). Maximum equatorial diameter of the spore 108.9-151.8μ (mean 125.4μ), minimum equatorial diameter of the spore 72.6-99μ (mean 90.75μ). Maximum equatorial diameter of the inner body 59.4-79.2μ (mean 66μ), minimum equatorial diameter of the inner body 36.3-56.1μ (mean 49.5μ).

Types. Holotype, GSC No. 15667; paratypes, GSC Nos. 15666, 15668, 15669, 15670, 15671.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. The specimen of *Archaeoperisaccus* sp. figured by McGregor *in* Kerr, McGregor and McLaren (1965, Pl. 4, fig. 18) from a coal seam assemblage from the Griper Bay Formation of northern Helena Island appears identical to the specimens here assigned to *A. opiparus* n. sp.

Comparisons. The large size and distinctive mammoid, tubercular ornament distinguishes this species from all other species of *Archaeoperisaccus*. *A. timanicus* Pashkevich (1964, p. 126, Pl. 14, figs. 1-4) is smaller (46.5-62.7μ), lacks the elevated folds of the exoexine accompanying the laesurae, and also lacks the prominent ornamentation on the distal surface of the exoexine, which is instead extensively folded. *A. verrucosus* Pashkevich (1964, p. 127, Pl. 14, figs. 5-8) also is smaller, and possesses a verrucose ornament on the distal surface of the intexine and a sparsely distributed tubercular ornament on the exoexine.

INCERTAE SEDIS

Genus *ANCYROSPORA* (Richardson 1960) Richardson 1962

Type species: *Ancyrospora grandispinosa* (Richardson 1960) Richardson 1962

Ancyrospora furcula n. sp.

Plate XXIII, figures 1-4; text figure 12

Ancyrospora spp. *in* McGregor and Owens 1966, Pl. XIX, figs. 1, 2

Description. Spores radial, trilete. Colour yellow to orange brown. Amb excluding the projecting ornament, rounded triangular to subcircular. Exine composed of two layers, the intexine which forms a rounded triangular inner body and the exoexine which is closely appressed to it and extends equatorially to form a narrow flange or pseudoflange. Trilete mark distinct; laesurae straight, extending to the margin of the inner body, commonly obscured by thin, elevated folds of the exoexine which extend to the equator of the spore. Folds commonly form an apical prominence up to 30μ high. The intexine is thin and smooth. Exoexine of the proximal surface finely roughened or minutely wrinkled, and bears a scattered ornament of coni and grana up to 3μ in height. Exoexine may be thickened distally under and adjacent to the inner body, simulating a weakly bizonate flange. Distal surface of the exoexine bears broad-based processes with bi-, tri-, or multifurcate terminations. The processes are arranged in a loosely concentric manner with the longer elements occurring in the equatorial region and the shorter ones at the distal pole. Each process consists of a broad-based cone or spine with moderate to sharply tapering sides, terminated by a narrow, slightly expanded, solid, bi-, tri-, or multifurcate termination. Surface of the conate part of the process very finely striated. Elements occurring in the polar region are commonly discrete, rarely fused at their bases. In the equatorial regions fusion between the bases of adjacent elements is common, and in many cases fusion may affect the entire length of the process except the multifurcate termination. Up to 35 processes project at the equator. Height of the processes 10-38.2μ, basal diameter 4.6-15μ, width of termination 2-5μ.

Dimensions (30 specimens measured). Maximum equatorial diameter, excluding the projecting ornament, 72.6-105μ (mean 89.1μ).

Types. Holotype, GSC No. 15672; paratypes, GSC Nos. 15673, 15674, 15675.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. *Ancyrospora (Archaeotriletes) langi* (Taugourdeau-Lantz) Allen (1965, p. 743, Pl. 106, figs. 5-7) from the Givetian of Vestspitsbergen possesses a wider equatorial flange and a more densely distributed ornament of processes which lack tri or multifurcate terminations and have instead small fragile bifurcate tips. The elements are comparable in size. Allen (1965) records their length as 8-38μ and Taugourdeau-Lantz (1960) quoted them as being about 18μ. Allen recorded elevated, membranous lips associated with the laesurae in *A. langi*, but that species appears to lack the apical prominence which is a characteristic feature of *A. furcula* n. sp. *A. pulchra* n. sp. is larger (141-181μ) and bears longer, stouter processes which possess a different type of termination. There is a marked similarity in construction between the two species and although readily distinguishable, they are obviously closely related. Both possess scattered coni on the exoexine between the major processes. *A. ancyrea* var. *ancyrea* Richardson (1962, pp. 178-179, Pl. 25, figs. 6, 7, text figs. 5, 6, 10b) from the Middle Old Red Sandstone of Scotland is in part larger (82-169μ) and possesses a wider equatorial flange, shorter laesurae (extending 1/3 to 1/2 of the radius of the inner body), and more slender processes with wide, laterally extended and reflexed bifurcate terminations. Fewer of the processes project at the equator. Some of the specimens of *A. (Spinozonotriletes) carnarvonensis* Balme (1962, pp. 7-8, Pl. 2, figs. 17-19, text fig. 2) from the Upper Devonian of Western Australia show some general similarity to *A. furcula* n. sp. but they are larger (95-196μ), and have a variable ornamentation which includes squat cones, mammoid protuberances and long spinose elements, all ending with a solid, laterally extended and reflexed bifurcate termination. *Hymenozonotriletes incisus* Naumova (1953, p. 68, Pl. 9, fig. 11) is comparable in size but possesses a wider equatorial flange and shorter, stouter coni at the equator, between which there is considerable basal fusion. The elements also lack bifurcate terminations.

Ancyrospora melvillensis n. sp.

Plate XXIII, figures 5, 6

Description. Spores radial, trilete. Colour yellow. Amb rounded triangular to triangular. Exine composed of two layers, the intexine which forms the wall of the inner body and the exoexine which is closely appressed to it and extends equatorially to form a wide, thin, undifferentiated flange of inconsistent width around the body. Trilete mark distinct; laesurae straight, simple, extending to the margin of the inner body, commonly obscured by thin, elevated folds of the exoexine. Intexine thin and smooth. Exoexine also thin, minutely roughened by very fine punctation that frequently imparts a finely striated appearance to the surface of the spore and the ornament. Exoexine ornamented distally and equatorially with coarse coni and bacula with minute, bifurcate terminations. At the equator the elements are coarse, broad-based cones or spines with gently tapering sides and blunt or truncated tips which bear very small, bifurcate terminations. Over the polar portion of the distal surface the elements are mainly parallel-sided bacula with slightly expanded bases and small reflexed or laterally extended bifurcate terminations. Elements occurring in the polar region are frequently smaller than those at the equator and are always more slender. Surface of the elements finely striated. Up to 25 elements project at the equator. Height of the processes 9-30μ, basal diameter 3-15μ.

Dimensions (10 specimens measured). Maximum equatorial diameter, excluding the projecting ornament, 92.4-115.5μ (mean 99μ). Maximum diameter of the inner body 56-85.8μ (mean 69.3μ).

Types. Holotype, GSC No. 15676; paratype, GSC No. 15677.

Type locality. Griper Bay Formation, 1 mile north of Stevens Head, west coast of Melville Island, Northwest Territories, GSC Loc. 5116.

Comparisons. *Ancyrospora simplex* Guennel (1963, p. 257, fig. 13) described from Middle and early Upper Devonian deposits of Illinois, appears closely comparable to this species in size and general organization, but it lacks bifurcate terminations to the processes. In addition, *A. simplex* does not exhibit any differentiation of the ornamentation elements on the distal surface. *A.* cf. *simplex* described by Vigran (1964, p. 26, Pl. 6, figs. 1-3) from the Middle Devonian deposits of Spitsbergen may be distinguished by similar criteria. *Hymenozonotriletes argutus* Naumova (1953, pp. 67-68. Pl. 9, fig. 9) described from the Lower Frasnian of the USSR and later recorded by Kedo (1955, p. 32, Pl. 4, fig. 40) from the upper Givetian and lower Frasnian deposits of the Byelorussian SSR and by Tuzova (1959, p. 146, Pl. 12, fig. 3) from the Upper Devonian of Tataria, shows some similarity to *Ancyrospora melvillensis* n. sp. Although it is comparable in size, it may be distinguished by its markedly bizonate flange and by the character of the ornament of the exoexine. Whereas the elements at the equator are like those of *A. melvillensis* n. sp., being stout, broad-based cones with either blunt or narrow bifurcate terminations, they differ in both size and density of distribution. The remainder of the distal surface bears an ornament of small, broad-based, blunt coni as opposed to the larger, slender baculose processes of *A. melvillensis* n. sp. The specimen illustrated by Tuzova, although apparently smaller, possesses elements at the equator which are closely comparable in profile to those of *A. melvillensis* n. sp., but the remainder of the distal surface is ornamented with very small, sparsely distributed cones. *H.* cf. *argutus* Naumova described by Taugourdeau-Lantz (1960, p. 147, Pl. 3, fig. 36) from the lower Frasnian of Beaulieu, France possesses more densely distributed coni at the equator, and none of the elements have bifurcate terminations. Additional specimens illustrated by Taugourdeau-Lantz (1962, Pl. 1, figs. 1, 2, 5) shows closer similarity to, and may be partly synonymous with, *A. melvillensis* n. sp. They differ however by possessing a greater density of ornament at the equator although the overall form of the elements is closely comparable. *H. incisus* Naumova (1953, p. 68, Pl. 9, fig. 11) described from the lower Frasnian deposits of the USSR is also closely comparable to *A. melvillensis* n. sp. It possesses a similar ornament of coarse, broad-based, conate elements at the equator but none of the elements possess bifurcate terminations. There is an apparent complete lack of major elements in the distal polar region. *H.* cf. *incisus* Naumova described by Taugourdeau-Lantz (1960, p. 147, Pl. 3, figs. 35, 37) from the lower Frasnian of Beaulieu, France possesses an ornament at the equator and over the distal surface composed of long, pointed spines with minute bifurcate terminations. It lacks bacula in the distal polar region.

Ancyrospora ampulla n. sp.

Plate XXIV, figures 1-4; text figure 13

Description. Spores radial, trilete. Colour yellow to orange. Amb rounded triangular to subcircular. Exine composed of two layers, the intexine which forms the inner body and the exoexine which is closely appressed to it and is extended in the equatorial plane to form a wide flange. Trilete mark distinct; laesurae commonly obscured by thin, flexuous folds of the exoexine, up to 15μ high, which extend to the equator. Intexine smooth, up to 2.5μ thick.

Exoexine thin proximally, shagreen with scattered punctations. In the equatorial plane the exoexine is extended to form a flange 15-41μ wide. The width of the flange is variable on each specimen and the maximum width does not consistently occur in either the radial or the interradial positions. Exoexine of the distal surface underlying and closely adjacent to the inner body slightly thickened, producing a weakly bizonate flange. Distally the exoexine is shagreen and bears distinctive broad-based processes with narrow bifurcate or multifurcate terminations which are arranged in a loosely concentric manner. Form of the processes variable, either broad-based, steeply tapering coni or spinae or shorter, almost parallel-sided or gently tapering, stout bacula, all with a narrow bi- or multifurcate termination. Processes compressed on the surface of the spore appear to possess bulbous bases. Small spines, up to 4μ high, occur between the larger processes. Up to 30 bifurcate processes project at the equatorial margin. Height of the processes 7.6-15μ, basal diameter 3-7.6μ, width of bifurcate terminations 2.5-3μ.

Dimensions (44 specimens measured). Maximum equatorial diameter, excluding projecting ornament, 90-132μ (mean 114μ), maximum equatorial diameter of the inner body 39.6-66μ (mean 52μ).

Types. Holotype, GSC No. 15678; paratypes, GSC Nos. 15679, 15680.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. *Ancyrospora grandispinosa* Richardson (1960, p. 55, Pl. 14, fig. 7, text figs. 5, 6c) from the Middle Old Red Sandstone (lower Givetian) of Scotland is much larger (overall size (174-276μ, diameter of inner body 90-210μ) and possesses a wider flange and longer (24-54μ) processes with bulbous bases, more slender shafts and wider, laterally extended and reflexed, bifurcate terminations. *A. ancyrea* var. *ancyrea* Richardson (1962, pp. 177-178, Pl. 25, figs. 6, 7, text figs. 5, 6, 10b) also from the Middle Old Red Sandstone of Scotland, has a broader size range (82-169μ), a larger inner body (51-116μ) and a correspondingly narrower flange, and considerably longer processes. *Hymenozonotriletes argutus* Naumova (1953, pp. 67-68, Pl. 9, fig. 9) described from the lower Frasnian deposits of the Russian Platform and also recorded by Kedo (1955, p. 32, Pl. 4, fig. 4) from the upper Givetian and lower Frasnian of the Byelorussian SSR is broadly comparable in size and general construction but possesses a more prominent bizonate flange and lacks long elevated flexuous folds accompanying the laesurae. Due to the lack of adequate description it is impossible to make detailed comparisons between the ornaments of the two species. The specimen illustrated by Naumova possesses a superficially similar ornament of broad based conate processes with either narrow bifurcate terminations or bluntly pointed apices projecting at the equator. Many of the elements do, however, appear to be larger than those of *A. ampulla* n. sp. It is impossible from Naumova's illustration to interpret the nature of the ornament on the polar portions of the distal surface. *Hymenozonotriletes melanidus* Naumova (1953) *in* Kedo (1955, p. 28, Pl. 2, fig. 20) is similar in general construction but possesses a densely distributed, small, conate ornament.

Ancyrospora involucra n. sp.

Plate XXIV, figures 5, 6; Plate XXV, figures 1, 2; text figure 14

Ancyrospora sp. *in* McGregor and Owens 1966, Pl. XX, figs. 2, 3

Description. Spores radial, trilete. Colour yellow to orange brown. Amb, excluding the projecting ornament, rounded triangular to subcircular.

Exine composed of three layers, the intexine forming the inner body, the thick exoexine which is closely appressed to the intexine and extended in the equatorial plane to form a thick, narrow flange or pseudoflange, and an outermost thin "perispore". Trilete mark distinct; laesurae straight, extending to the margin of the inner body, accompanied by elevated, moderately thick folds of the exoexine which extend to the equator of the spore and commonly obscure the laesurae. Inner body rounded triangular, intexine smooth, up to 3μ thick, commonly obscured by the thickness and the ornament of the exoexine. Exoexine thick, surface minutely roughened due to dense, fine punctuation, extended equatorially to form a thick pseudoflange 7-21μ wide. Entire distal surface and the equator of the exoexine possesses a distinctive ornament of coarse conate or spinose processes which bear minute bi- or multifurcate terminations. Each element consists of a stout, broad-based conate or spinose process with gently to moderately tapering sides, terminated by either a solid, slightly expanded, flat topped pad which may bear 2, 3, 4, or more minute spinules, or a simple, laterally extended bifurcate termination. Surface of the processes, excluding the solid terminal portion, is finely striated. 18-40 elements project at the equatorial margin. Length of the processes 18-46μ, basal diameter 9-20μ, width of solid terminal portion of the process 3-9μ. The elements are arranged in a loosely concentric manner with the greatest concentration occurring in the equatorial region. The longest elements occur in the equatorial region whereas the shortest are located in the distal polar region. A very thin, third exine layer is clearly visible in most of the specimens examined, occurring outside the exoexine. It is observed over the surface of the spore as a thin minutely wrinkled perispore-like layer and appears to almost completely surround the projecting ornament at the equator.

Dimensions (23 specimens measured). Maximum equatorial diameter, excluding the projecting ornament, 82.5-118.8μ (mean 105.6μ).

Types. Holotype, GSC No. 15681; paratypes, GSC Nos. 15682, 15683, 15684.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Remarks. The presence of three readily discernible exine layers in the spores of this species is a feature that has not been recorded previously in the spores assigned to the genus *Ancyrospora*. The presence of the additional thin outer layer is not at the present time considered sufficient justification for the erection of a new genus to accommodate this group of spores. A similar thin outer layer has been observed by the author on specimens of *Ibrahimispores magnificus* Neves (1961) from the Namurian deposits of northern England. The holotype of that species (Neves, 1961, Pl. 31, fig. 3) shows a thin exine layer between the processes that project at the equatorial margin which appears to be superficially similar to that described here. The term "perispore" is here applied tentatively to this layer which completely envelopes the spore.

Comparisons. This species may be readily distinguished from other species assigned to the genus by its distinctive ornament and its thin outer "perispore-like" layer.

Ancyrospora pulchra n. sp.

Plate XXV, figures 3-5; Plate XXVI, figures 1, 2; text figure 15

Description. Spores radial, trilete. Colour orange to brown. Amb irregular due to projecting ornament, amb excluding projecting ornament rounded triangular to subcircular. Exine composed of two layers, the intexine which forms the wall of an inner body, and the thicker exoexine which

appears to be closely appressed to the intexine and is extended in the equatorial plane to form a narrow, solid flange. Trilete mark distinct; laesurae straight, extending to the margin of the inner body, accompanied by either low, thickened lips up to 4.5μ wide or thin, elevated, flexuous folds which may form an apical prominence up to 33μ high. Intexine up to 2μ thick, laevigate. Exoexine thick, surface minutely roughened due to very fine, dense infrapunctation and bears a variably distributed ornament of grana and coni, individual elements 1.5-3μ high and about 1.5μ in basal diameter. In addition, the equator and the entire distal surface possesses stout processes with bi-, tri- or multifurcate terminations. Each element consists of a broad-based shaft with gently tapering sides and a solid, slightly expanded bi-, tri- or multifurcate termination. Surface of the processes finely punctate or very finely striated, and the small granular and conate elements which ornament the exoexine between the processes may extend some way up the basal part of the shaft. Elements compressed over the body of the spore commonly show bulbous bases. The processes are arranged in a subconcentric manner. Those elements distributed over the polar portions of the distal surface are more or less discrete although basal coalescence between adjacent elements may occur, whereas those at the equator show extensive basal coalescence which may result in the formation of a low, thickened ridge joining the bases of groups of up to 5 elements. In general the longest elements are located at the equator and the shorter ones at the distal pole; 26-47 elements project at the equator. Maximum height of the elements 15-70μ, basal diameter 7-30μ.

Dimensions (25 specimens measured). Maximum equatorial diameter, excluding the projecting ornament, 141-181μ (mean 165μ).

Types. Holotype, GSC No. 15687; paratypes, GSC Nos. 15685, 15686, 15688, 15689.

Type locality. Griper Bay Formation, southern limb of the Robertson Point Anticline, 6 miles northeast of Beverley Inlet, Melville Island, Northwest Territories, GSC Loc. 7559.

Comparisons. *Ancyrospora ancyrea* var. *ancyrea* Richardson (1962, pp. 178-179, Pl. 25, figs. 6-7, text figures 5, 6, and 10b) described from the Middle Old Red Sandstone of Scotland, is smaller (82-169μ), possesses a wider pseudoflange but shorter laesurae which extend only 1/3 to 1/2 the radius of the inner body. It is distinguishable by the character and distribution of the ornamentation on the distal surface and at the equatorial margin. The processes, which are shorter (8-51μ long), have stout, sharply tapering conical bases, slender shafts and considerably wider, laterally extended and often reflexed bifurcate terminations. *A. ancyrea* var. *ancyrea* also lacks small cones and spines on the surface of the exoexine between the processes. *A. longispinosa* Richardson (1962, pp. 181-182, Pl. 26, figs. 1-3, text fig. 8) also from the Middle Old Red Sandstone of Scotland, is larger (180-236μ) and bears longer processes (70-120μ) composed of a stout, steeply tapering conical basal portion, a slender, almost parallel-sided shaft and a wide, laterally extended and reflexed bifurcate termination. *Archaeotriletes langi* Taugourdeau-Lantz (1960, p. 145, Pl. 3, figs. 33, 34 and 39) from the lower Frasnian of Beaulieu (Boulonnais) France is smaller (105-130μ) and possesses shorter (about 18μ long) conical processes with small fragile bifurcate terminations. *A. furcula* n. sp. is also smaller (72.6-105μ) and ornamented with processes which although similar in general construction to those of *A. pulchra* n. sp., are shorter, more slender and have small. solid, slightly expanded bi-, tri- or multifurcate terminations. *A. (Spinozonotriletes) carnarvonensis* Balme (1962, pp. 7-8, Pl. 2, figs. 17-19, text fig. 2) from the Upper Devonian of the Carnarvon Basin, Western Australia, appears in part similar to *A. pulchra* n. sp., but possesses shorter, bifurcate-tipped processes which are variable both in size, shape and type of bifurcate termination. the unnamed and undescribed specimens figured by Kosanke (1964, p. 77, figs. 4-6) are comparable in size (133.6 and 147μ)

but appear to possess a wider pseudoflange. It is impossible to draw more detailed comparisons.

? *Ancyrospora magnifica* n. sp.

Plate XXVI, figure 3; Plate XXVII, figures 1, 2.

Description. Spores radial, trilete, camerate. Colour yellow to orange. Amb broadly rounded triangular to subcircular; in lateral profile the proximal surface is flattened, the distal surface hemispherical. Exine composed of two layers, the intexine which forms a subcircular to circular inner body and the exoexine which completely surrounds the inner body and is extended in the equatorial plane to form a thick equatorial flange. Exoexine closely appressed to the intexine over the proximal surface but the two layers are variably separated in the equatorial plane and over part of or the entire distal surface. Trilete mark distinct; laesurae simple, straight, extending to the margin of the inner body, accompanied and commonly obscured by thick, elevated flexuous folds of the exoexine which are up to 42μ high in the polar region and which extend, decreasing in height, to the equator of the spore. Intexine thin, commonly obscured by the thicker exoexine, laevigate, commonly possessing numerous concentrically or randomly orientated compression folds on its distal surface. Exoexine thick, in some specimens of almost uniform thickness over both the proximal and the distal surfaces whereas in others, the region underlying and closely adjacent to the distal surface of the intexine may be thicker than that of the remainder of the spore, resulting in a bizonate flange. Surface of the exoexine minutely roughened as a result of the dense, fine infrapunctation. Proximal surface of the exoexine laevigate; distal surface bears solid, discrete coni, spinae and bacula, many of which support minute bifurcate terminations. The elements, which are distributed in a subconcentric manner, are extremely variable in form even on one specimen. Individual elements have broad bases, and gently or sharply tapering, or parallel sides, sharply pointed, rounded or truncated apices and small, slightly expanded, laterally extended and partly reflexed bifurcate terminations. Height of elements 7.5-53.2μ (commonly 12-30μ), basal diameter 5.7-14μ. The elements, which are uniformly distributed over the distal surface, are of almost constant size on any one specimen; 11-38 elements project at the equator.

Dimensions (39 specimens measured). Maximum equatorial diameter of the spore 210-330μ (mean 270μ). The inner body is difficult to measure because it is commonly obscured by the thicker exoexine.

Types. Holotype, GSC No. 15690; paratypes, GSC Nos. 15691, 15692.

Type locality. Griper Bay Formation, east side of graben (5 miles southwest of Mould Bay Weather Station), west coast of Mould Bay, Prince Patrick Island, Northwest Territories, GSC Loc. 7576.

Remarks. The possession of coni, spinae and bacula with distinct bifurcate terminations is the principal criterion utilized in the tentative assignment of this species to *Ancyrospora*. It must however be pointed out that the general construction of the specimens i.e. the possession of a wide uniform or bizonate flange, the camerate relationship between the exoexine and the intexine in the equatorial plane and to varying degrees over the distal surface, and the possession of an in part spinose ornament, are features normally associated with the closely related genus *Spinozonotriletes* (Hacquebard) Neves and Owens (1966). All species previously assigned to *Spinozonotriletes* possess simple spinose ornament. This species appears to differ from all others previously assigned to *Ancyrospora* by possessing an exoexine which is clearly separated from the intexine in the equatorial plane and over at least part of the distal surface. Until the precise relationships between the two genera are clearly established, the tentative assignment of this species to *Ancyrospora* seems justifiable.

Comparisons. *Ancyrospora grandispinosa* Richardson (1960, p. 55, Pl. 14, fig. 7; text figs. 5, 6c) (also illustrated in Richardson, 1962, Pl. 27, figs. 3-5) described from the Middle Old Red Sandstone (lower Givetian) of Scotland, is superficially similar in appearance but is slightly smaller (174-276μ) and possesses "long spines with hollow, wide, conical bases which taper sharply to a more slender stem, the stem tapers nore gently to the apex where it swells slightly and bifurcates" and shorter folds ("lips") of the exoexine accompanying the laesurae. *Ancyrospora (Spinozonotriletes) carnarvonensis* Balme (1962, pp. 7-8, Pl. 2, figs. 17-19; text fig. 2) described from the Upper Devonian (Frasnian) deposits of the Carnarvon Basin, Western Australia, is smaller (95-196μ) and possesses a narrower equatorial flange and a more variable conate or spinose ornament of hollow elements with solid bifurcate terminations that are extremely variable in form. *Hymenozonotriletes breviradiatus* Chibrikova (1962, p. 431, Pl. 12, fig. 1) described from the Eifelian deposits of western Bashkiria, is also smaller (130-150μ) and possesses a shorter laesurae, and smaller, very fine, slender spines with minor bifurcate terminations.

Spore Type A.

Plate XXVIII, figures 1, 3, 5

Description. Complete or imcomplete tetrads of large, circular or subcircular, trilete spores. Exine up to 2.5μ thick, surface very finely punctate, extensively folded. Trilete mark distinct; laesurae straight, exceeding 2/3 of the spore radius in length, accompanied by low, narrow, thickened lips. Tetrads appear to be covered by a thin, highly folded surrounding layer. Commonly observed in groups of three or four but rarely observed singly.

Dimensions (34 specimens measured). Maximum diameter of individual spores in tetrads 125.4-165μ.

Types. Hypotypes, GSC Nos. 15693, 15694, 15695. (GSC Loc. 7559)

Spore Type B.

Plate XXVIII, figures 2, 4

Description. Spores radial, trilete, camerate. Colour pale yellow to orange. Amb rounded triangular with broadly rounded apices. Exine composed of two layers, the intexine, which forms a rounded triangular to subcircular inner body, and the exoexine which completely surrounds the inner body but which is attached to it only on the proximal surface and possibly over the polar portion of the distal surface, being separated in the equatorial plane and over at least part of the distal surface. The exoexine is extended some distance beyond the inner body in the equatorial plane but it is not possible to determine whether this extension is camerate or zonate. Laesurae indistinct or obscured by elevated, flexuous folds of the exoexine which extend, decreasing in height, to the equator of the spore. Intexine thin, laevigate or finely infragranulate, commonly with concentrically arranged compression folds on its distal surface. Exoexine thin, of almost uniform thickness over the entire surface of the spore, proximal surface smooth or finely infrapunctate, distal surface verrucose. On the portion of the distal surface of the exoexine underlying the inner body, the verrucae which are subcircular, polygonal or irregular in outline and 4-15μ (commonly 5-9μ) in diameter, are densely distributed but normally discrete, being separated by narrow channels of thinner exine. Over the equatorial portions of the distal surface the verrucae are less densely distributed and more variable in size. There is a sharply defined boundary

between the central area with its densely distributed ornament and the equatorial region on which the elements are more widely scattered. Numerous short, irregular, radially orientated plications up to 5μ wide are developed in the region of the boundary and may extend almost to the equator of the spore. Numerous elements project at the equatorial margin of the spore but in general they are smaller (up to 3μ high and 3-5μ in diameter) than those over the remainder of the distal surface, and they commonly have rounded conate profiles.

Dimensions (4 specimens measured). Maximum equatorial diameter of the spore 181-239μ, maximum equatorial diameter of the inner body 89-122μ.

Types. Hypotypes, GSC Nos. 15696, 15697. (GSC Loc. 7560)

Remarks. Generic assignment of this distinctive group of spores is withheld until more specimens become available for examination in order that additional information on the structure and range of morphological variation within the group may be obtained. It is of interest to note that in some specimens the elements located at the margin of the central densely ornamented region appear to possess at their bases a small cavity which may be enlarged and impart an "arch-like" appearance to the element.

STRATIGRAPHIC SIGNIFICANCE OF THE MIOSPORES

Composition of the assemblages

The stratigraphic distribution of the 73 species and types of miospores recorded and described in this report is summarized in Table 1. Although it may be apparent from that table that the assemblages from the lower part of the Weatherall Formation may be readily distinguished from those of the upper part of the Weatherall Formation and likewise the assemblages from the Weatherall Formation as a whole from those of the Griper Bay Formation, it is necessary to point out that the results were obtained from the examination of only 14 samples (including two from the Hecla Bay Formation which yielded no microfloral assemblages) all of which were randomly collected from the succession. The results obtained probably outline many of the general trends in the progressive change in the composition of the microfloral assemblages occurring in the Middle and early Upper Devonian rocks of the western Queen Elizabeth Islands. It is however equally probable that the recorded distribution may reflect the influence of two fundamental criteria, the large stratigraphic interval between many of the samples and the inadequate representation of samples from a wide range of sedimentary environments at any one time.

Before any firm conclusions regarding the stratigraphic distribution of miospores in the Givetian, Frasnian and early Famennian sediments of the region can be proposed, it is essential that additional samples taken at regular intervals throughout the succession, involving as many synchronous sedimentary facies as possible, be examined. Because of the limited number of samples examined, it is proposed at the present time to draw only general conclusions.

Microfloral Assemblages from the Weatherall Formation

The assemblages obtained from both the lower and the upper parts of the Weatherall Formation are normally diverse in composition and lack any overwhelmingly dominant element. Particularly in the lower member of the formation, there are many large, camerate miospores, i.e. *Rhabdosporites langi* (Eisenack) Richardson, *Calyptosporites velatus* (Eisenack) Richardson, *Calyptosporites* sp. A, *Auroraspora macromanifestus* (Hacquebard) Richardson, *Grandispora mammillata*

Table 1

STRATIGRAPHIC DISTRIBUTION OF MIOSPORES

Species \ Locality	Weatherall Formation				Hecla Bay Formation					Griper Bay Formation				
	7557	7560	7578	7579	-	-	7559	7580	7581	5116	5116	7577	7576	7558
Punctatisporites glabrimarginatus								X						
Retusotriletes distinctus							X							
Retusotriletes dubius		X		X										
Retusotriletes politus		X												
Cyclogranisporites amplus			X							X				
Apiculatisporis microconus	X	X		X										
Apiculatisporis microechinatus	X	X												
Apiculatasporites cf. *dilucidus*										X				
Apiculiretusispora granulata							X							
Apiculiretusispora apsoga							X							
Apiculiretusispora nitida							X							
Apiculiretusispora sp. A.							X							
Apiculiretusispora sp. B.							X							
Verrucosisporites confertus											X		X	
Verrucosisporites variabilis										X				
Verruciretusispora robusta	X	X												
Verruciretusispora magnifica							X			X				
Verruciretusispora magnifica forma endoformis										X				
Verruciretusispora pallida				X						X	X			
Verruciretusispora grandis										X				
Hystricosporites delectabilis										X				
Hystricosporites furcatus							X	X						
Hystricosporites reflexus							X							
Hystricosporites grandis	X	X		X										
Hystricosporites gravis	X	X		X										
Hystricosporites harpagonis	X	X		X										

Species \ Locality	Weatherall Formation				Hecla Bay Formation					Griper Bay Formation				
	7557	7560	7578	7579	-	-	7559	7580	7581	5116	5116	7577	7576	7558
Hystricosporites sp. A.		X												
Hystricosporites sp. B.		X												
Hystricosporites sp. C.							X							
Convolutispora subtilis								X						
Acinosporites acanthomammillatus	X													
Stenozonotriletes notatus				X			X							
Stenozonotriletes inspissatus							X							
Archaeozonotriletes variabilis							X	X		X				
Camarozonotriletes parvus	X	X	X	X							X			
Samarisporites tozeri							X							
Samarisporites praetervisus							X							
Samarisporites inaequus	X			X						X	X			
Samarisporites galeatus														X
Samarisporites concinnus				X										
Calyptosporites velatus	X	X	X	X										
Calyptosporites sp. A.	X													
Grandispora mammillata	X	X	X	X										
Auroraspora macromanifestus	X	X		X										
Rhabdosporites micropaxillus				X				X						
Rhabdosporites langi	X	X	X	X										
Contagisporites optivus							X							
Contagisporites optivus var. *vorobjevensis*							X							
Contagisporites subnotatus							X							
Spinozonotriletes cassideus							X							
? *Spinozonotriletes rugosus*	X			X										
Spinozonotriletes sp. A.				X										
Geminospora antaxios				X										
Geminospora punctata												X		X
Geminospora plicata							X							
Geminospora verrucosa												X		X
Geminsopora sp. A.								X						

Species \ Locality	Weatherall Formation				Hecla Bay Formation					Griper Bay Formation				
	7557	7560	7578	7579	-	-	7559	7580	7581	5116	5116	7577	7576	7558
Perotrilites aculeatus										X				
Perotrilites minor														X
Perotrilites sp. A.							X							
Latosporites sp. A.										X				
Latosporites sp. B.		X												
Archaeoperisaccus oblongus							X				X			
Archaeoperisaccus opiparus							X							
Archaeoperisaccus scabratus							X							
Ancyrospora furcula							X							
Ancyrospora melvillensis										X				
Ancyrospora ampulla							X							
Ancyrospora involucra							X							
Ancyrospora pulchra							X							
?*Ancyrospora magnifica*													X	
Spore Type A.							X							
Spore Type B.			X											

n. sp., *Spinozonotriletes* sp. A, ?*Spinozonotriletes rugosus* n. sp. together with numerous representatives of the genus *Samarisporites* Richardson (many of which still await description). The common occurrence of the large camerate spores is in general agreement with their expected occurrence in an offshore or marine environment (a view in part supported by the lithological evidence provided by the sample from GSC Loc. 7557). The presence of representatives of the genus *Hystricosporites* McGregor in appreciable numbers in some of the assemblages is, however, more difficult to explain because the representatives of that genus possess an ornament of heavy processes with bifurcate terminations which would not be suited morphologically for widespread distribution into a marine environment. Of the genera which are absent from the assemblages of the Weatherall Formation, *Ancyrospora* Richardson is perhaps the most significant, because spores of that genus were common in the Middle Old Red Sandstone (Givetian) deposits of Scotland (Richardson, 1960, 1962, 1965). The genus has however been found to occur commonly in the Griper Bay Formation, particularly in assemblages from coals, and its absence from the assemblages of the Weatherall Formation may in part be due to the local absence of an environment suitable for its accumulation.

Microfloral Assemblages from the Hecla Bay Formation

No microfloral remains were extracted from either of the two samples of the Hecla Bay Formation that were examined during the course of the present investigation. Because much of the Hecla Bay Formation appears to have been

deposited in an environment which was suitable for the preservation of microfloral remains, it is essential that additional material be examined before any final conclusions concerning the stratigraphic distribution of miospores of the Middle and early Upper Devonian rocks of the region are proposed. It is of interest to note that McGregor (1967, p. 180) has recently briefly described one miospore assemblage from this formation from Helena Island (GSC Loc. 7024). This assemblage obtained from a limy sandstone lens containing late Givetian invertebrates, contained only a few large camerate spores such as *Calyptosporites proteus* (Naumova) Allen, but was characterized by the occurrence in large numbers of small, coarsely sculptured spores of the *Acanthotriletes* (Naumova) Potonié and Kremp, *Apiculatasporites* Ibrahim, *Lophozonotriletes* (Naumova) Potonié, *Raistrickia* (Schopf, Wilson and Bentall) Potonié and Kremp and *Verrucosisporites* (Ibrahim) Smith and Butterworth types. McGregor also recorded three species of *Camarozonotriletes* (Naumova) Potonié from this assemblage. In the present investigation this genus was recorded in all the assemblages examined from the Weatherall Formation.

Microfloral Assemblages from the Griper Bay Formation

Unlike those of the Weatherall Formation, five of the eight samples of the Griper Bay Formation, all from either coal seam or carbonaceous shale horizons, yielded assemblages which possess one or two overwhelmingly dominant components. The assemblage obtained from the coal seam exposed at GSC Loc. 5116 was dominated by the *Verruciretusispora pallida* (McGregor) n. comb. - *V. grandis* (McGregor) n. comb. complex of spores and the coal seam exposed at GSC Loc. 7558 by *Geminospora* Balme emend. The assemblage obtained from the carbonaceous shale horizon at GSC Loc. 7559 was more diverse in composition, comprising several species of *Archaeoperisaccus* (Naumova) Potonié, *Apiculiretusispora* Streel, *Hystricosporites* McGregor and *Ancyrospora* Richardson.

Camerate spores belonging to the genera *Calyptosporites* Richardson, *Auroraspora* Hoffmeister, Staplin and Malloy, *Rhabdosporites* Richardson, *Contagisporites* n. gen. and *Spinozonotriletes* (Hacquebard) Neves and Owens occurred rarely in the coal seam assemblages from the Griper Bay Formation but were common in the carbonaceous shale assemblage from GSC Loc. 7559. The occurrence of spores of the genus *Archaeoperisaccus* in the assemblage from GSC Loc. 7559 is of particular interest. McGregor, *in* Kerr, McGregor and McLaren (1965), has recorded this genus from the Griper Bay Formation of northern Helena Island and in McGregor and Owens (1966) illustrated representatives of the genus from the Escarpment Member of the Hay River Formation (GSC Loc. 30425) of the Northwest Territories. Both of the records from the Griper Bay Formation were from coaly shale horizons whilst that from the Hay River Formation was from a limestone. It would therefore appear that this distinctive group of spores which has previously been recorded only from the middle and upper Frasnian deposits of the USSR is likely to occur in a wide range of sedimentary environment.

COMPARISONS WITH OTHER REGIONS

The inter-regional correlation of Devonian microfloral assemblages is, at the present time, greatly hindered by the lack of a unified morphological classification scheme for dispersed spores, the lack of adequate stratigraphic control, and commonly by the description of microfloral assemblages which are representative of only one environment of deposition and which therefore do not give a complete record of the microflora at any one time.

Because only the more distinctive elements of the microfloral assemblages from the Weatherall Formation and the Griper Bay Formation are described in this report, it is only possible to draw generalized comparisons with the assemblages described from other regions.

The assemblages described from the Middle Old Red Sandstone of Scotland by Richardson (1960, 1962 and 1965) are the most closely comparable in composition to the Canadian material described here. The assemblages described by Richardson from the Eday and Thurso Flagstone Groups and the upper part of the *Achanarras* Fish Bed, all of which are Givetian in age, are similar to those described from the Weatherall Formation of eastern Melville Island. The following species occur in both regions: - *Retusotriletes dubius* (Eisenack) Richardson, *Apiculatisporis microconus* Richardson, *Acinosporites acanthomammillatus* Richardson, *Rhabdosporites langi* (Eisenack) Richardson, *Calyptosporites velatus* (Eisenack) Richardson and *Auroraspora macromanifestus* (Hacquebard) Richardson. *Retusotriletes distinctus* Richardson and representatives of the genus *Ancyrospora* Richardson which were recorded from the upper Eifelian and Givetian deposits of Scotland by Richardson, were absent from the assemblages obtained from the Weatherall Formation, but were commonly recorded in certain of the assemblages from the Griper Bay Formation. It is impossible at present to assess fully whether the differences in occurrence of these two groups of spores is a reflection of true differences in stratigraphic distribution between the two regions or whether their presence in Scotland is the result of their occurrence in a restricted sedimentary environment which was not sampled from the Weatherall Formation during the present investigation.

At the generic level, a broad similarity exists between the assemblages from Scotland and the western Queen Elizabeth Islands. In addition to the genera mentioned above, the following also occur in the assemblages from the two areas: - *Hystricosporites* McGregor, *Samarisporites* Richardson, *Stenozonotriletes* (Naumova) Potonié and *Spinozonotriletes* (Hacquebard) Neves and Owens. The only genera of significance which occur in the Canadian material described here, but which are absent from the Middle Old Red Sandstone assemblages from Scotland, are *Verruciretusispora* n. gen., *Camarozonotriletes* (Naumova) Potonié and *Grandispora* (Hoffmeister, Staplin and Malloy) Neves and Owens. All three were recorded from the Weatherall Formation, although *Verruciretusispora* n. gen. was recorded most frequently from the Griper Bay Formation.

The Givetian assemblage described by Piérart (1964) from Roncquières, Belgium, is closely comparable in composition to the Givetian assemblages described by Richardson from the Middle Old Red Sandstone of Scotland but contains only two species which occur in the assemblages from the Weatherall Formation of eastern Melville Island, i.e. *Calyptosporites velatus* (Eisenack) Richardson and *Rhabdosporites langi* (Eisenack) Richardson. The assemblage from the lower Givetian of La Vesdre à Goé, Belgium described by Streel (1964) is broadly similar in composition to that described by Piérart, but contains only one species in common with the assemblages from the Weatherall Formation, namely *Rhabdosporites* cf. *langi* (Eisenack) Richardson. The genus *Apiculiretusispora* was described by Streel from this material but the Canadian representatives of that genus recorded here were restricted to the younger Griper Bay Formation.

The lower Frasnian assemblage described by Taugourdeau-Lantz (1960) from Beaulieu, France, is more diverse in composition than the Givetian assemblages from Belgium described by Piérart and Streel, but possesses only one species in common with the Canadian assemblages. The specimens referred to by Taugourdeau-Lantz as *Retusotriletes* sp. appears identical to *Contagisporites optivus* (Chibrikova) n. comb. which was recorded from the Griper Bay Formation. Recently Taugourdeau-Lantz (1967, pp. 54-55, Pl. 3, figs. 1-6) has described a similar group of spores as *Rhabdosporites cuvillieri* from deposits of middle and upper Frasnian age from Bas Boulonnais, France. (The latter form is here considered synonymous with *Contagisporites optivus* (Chibrikova) n. comb.) The Beaulieu assemblage also contains numerous spores with stout spines with small bifurcate terminations, which Taugourdeau-Lantz has assigned to the genus *Archaeotriletes* Naumova, but which resemble many of the species of *Ancyrospora* Richardson recorded from the Griper Bay Formation. Zonate spores possessing strong spinose ornamentation, which were assigned by Taugourdeau-Lantz to *Hymenozonotriletes* Naumova, may be similar to some of the species of

Samarisporites Richardson recorded from the Griper Bay Formation. The upper Givetian and Frasnian assemblages from Mimerdalen, Spitsbergen, described by Vigran (1964), have only one species in common with the assemblages obtained from the Weatherall and Griper Bay Formations. The assemblage recorded by Vigran from the cannel coal deposit of late Givetian age contains specimens referred to by Vigran as *Densosporites devonicus* Richardson which appear closely comparable with the Canadian specimens of *Samarisporites tozeri* n. sp. which were recorded from the Griper Bay Formation. Comparisons at the generic level are however more extensive. The cannel coal assemblage contains *Hystricosporites* McGregor and *Calyptosporites* Richardson, both of which occur in the Weatherall Formation. It is of interest to note that *Ancyrospora* Richardson which is a common component of the Scottish Givetian assemblages, was absent from both the Weatherall Formation and the Spitsbergen Givetian samples.

The Frasnian assemblage described by Vigran from the Upper *Svalbardia* Sandstone contains many forms comparable to those from the Griper Bay Formation. The spores described by Vigran as *Biharisporites spitsbergensis* appear identical with the Canadian species *Contagisporites optivus* (Chibrikova) n. comb. *Hystricosporites* McGregor, *Ancyrospora* Richardson and *Perotrilites* (Erdtman) Couper are common to the assemblages of both regions whilst the spores described by Vigran as *Lycospora svalbardiae* and *Foveosporites pertusus* appear to be closely comparable in structural organization to the *Verruciretusispora pallida* (McGregor) n. comb. - *V. grandis* (McGregor) n. comb. and *Geminospora punctata* n. sp. groups of spores which are numerically important components of the Griper Bay Formation assemblages.

The Givetian assemblages described by Allen (1965) from north and central Vestspitsbergen bear only superficial resemblance to the assemblages from the Weatherall Formation. *Auroraspora macromanifestus* (Hacquebard) Richardson is the only species, and *Hystricosporites* McGregor, *Samarisporites* Richardson, *Calyptosporites* Richardson, *Grandispora* (Hoffmeister, Staplin and Malloy) Neves and Owens and *Rhabdosporites* Richardson the only genera occurring in both regions. Many of the Givetian genera recorded by Allen, including *Geminospora* Balme, *Hystricosporites* McGregor, *Convolutispora* Hoffmeister, Staplin and Malloy, *Samarisporites* Richardson, *Perotrilites* (Erdtman) Couper, *Archaeozonotriletes* (Naumova) Allen, *Calyptosporites* Richardson and *Ancyrospora* Richardson do however occur in the Griper Bay Formation, and three species, *Samarisporites praetervisus* (Naumova) Allen, *Archaeozonotriletes variabilis* (Naumova) Allen and *Contagisporites (Calyptosporites) optivus* var. *vorobjevensis* (Chibrikova) n. comb. occur in both areas.

Detailed comparisons with the miospore assemblages described from the various parts of the USSR is made difficult by the different morphological classification system employed for the description of the assemblages and by the commonly inadequate nature of the species descriptions and illustrations. The assemblages described from the Givetian deposits of the Russian Platform by Naumova (1953) contain only two species which are broadly comparable to those described from the assemblages of the Weatherall Formation. *Camarozonotriletes pusillus* Naumova is similar in organization to *C. parvus* n. sp and *Hymenozonotriletes polymorphus* Naumova closely resembles the Canadian specimens of *Rhabdosporites langi* (Eisenack) Richardson. It is of interest to note that in the assemblages from the Givetian deposits of the Russian Platform there is a marked absence of spores possessing processes with bifurcate terminations whereas in many of the assemblages of the Weatherall Formation spores of the genus *Hystricosporites* McGregor are common. Of the spores described by Naumova from the middle and upper Frasnian deposits of the Russian Platform, the most significant are the several species of the genus *Archaeoperisaccus* (Naumova) Potonié. This genus, which has also been recorded by Pashkevich (1964) from the lower and middle Frasnian deposits of North Timan and by Sennova (1965) from the upper Frasnian deposits of the Timan-Pechora province and the Bol'shezemel'skaya tundra region, is common at certain horizons in the Griper Bay Formation and may therefore be of considerable significance for establishing a Frasnian (probably middle or upper Frasnian) age for part of that formation.

Spore assemblages of upper Eifelian to lower Frasnian age from the eastern part of the Russian Platform have been examined by Archangelskaya (1963) but her paper contains only the descriptions and stratigraphical records of new species thereby making detailed comparisons of the complete assemblages impossible. Of the species described from the upper Eifelian deposits by Archangelskaya, *Hymenozonotriletes macrotuberculatus*, *H. longus*, *H. facetus* and *Archaeozonotriletes arduus* appear to be respectively closely comparable with *Grandispora mammillata* n. sp., Spore Type B., *Rhabdosporites langi* (Eisenack) Richardson and *Acinosporites acanthomammillatus* Richardson all of which were recorded from the Weatherall Formation (Givetian).

Farther to the east in the Bashkirian SSR, Chibrikova (1959, 1962) has described spore assemblages from the Middle and lower part of the Upper Devonian succession in the region of the southern Urals. Whereas in general there is little similarity in the composition of the assemblages with those of the Canadian succession, five species recorded by Chibrikova from the Eifelian, Givetian and lower Frasnian deposits of the Bashkirian SSR were recorded from the Griper Bay Formation.

Retusotriletes apsogus Chibrikova [Eifelian]
= *Apiculiretusispora apsoga* (Chibrikova) n. comb.

Retusotriletes antaxios Chibrikova [Eifelian]
= *Geminospora antaxios* (Chibrikova) n. comb.

Archaeozonotriletes optivus Chibrikova [Lower Frasnian]
= *Contagisporites optivus* var. *optivus* (Chibrikova) n. comb.

Archaeozonotriletes optivus var. *vorobjevensis* Chibrikova [Givetian]
= *Contagisporites optivus* var. *vorobjevensis* (Chibrikova) n. comb.

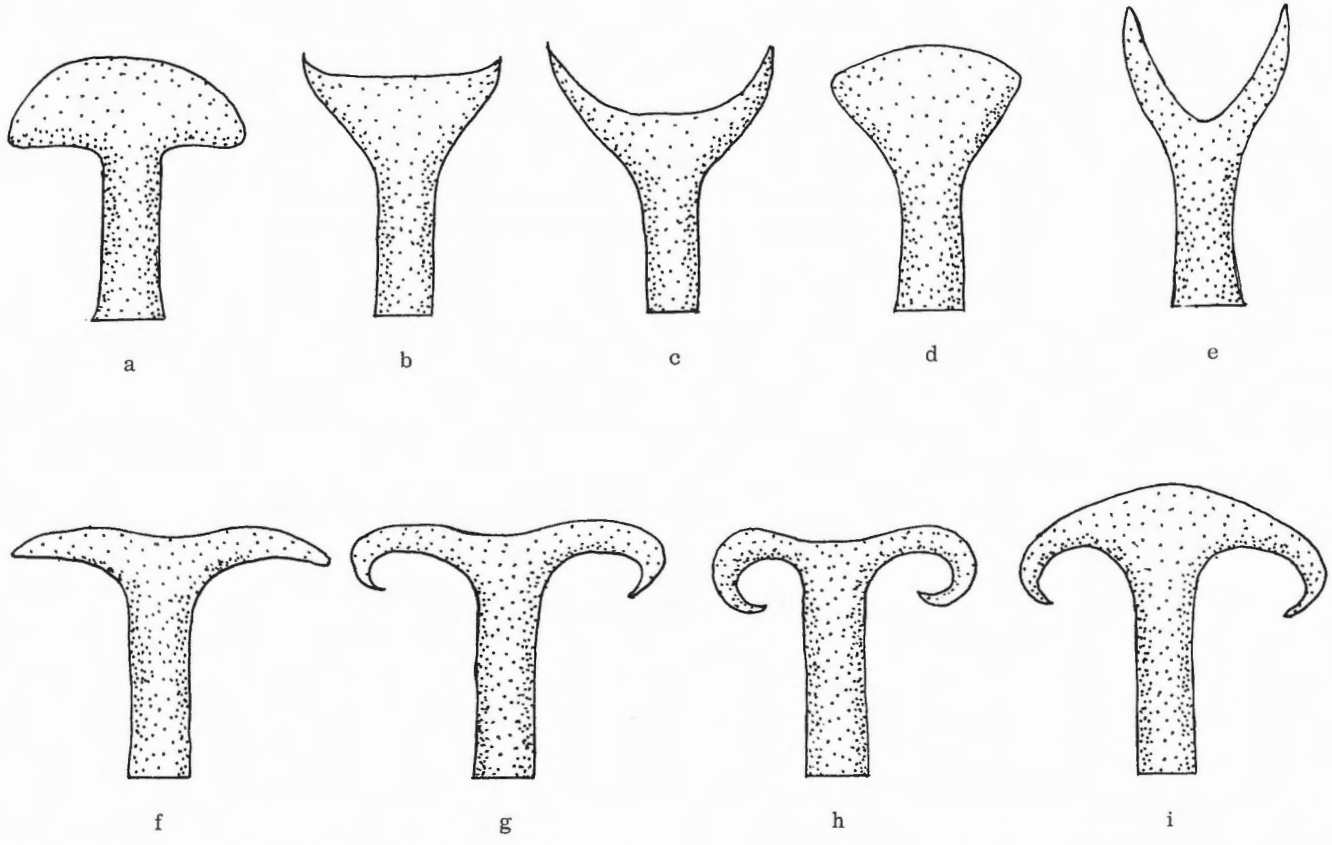
Archaeozonotriletes subnotatus Chibrikova [Lower Frasnian]
= *Contagisporites subnotatus* (Chibrikova) n. comb.

Spores possessing processes with bifurcate terminations occur very rarely in the assemblages from the Bashkirian SSR.

The Middle Devonian assemblages described by Kedo (1955) from the northeastern part of the Byelorussian SSR bear only a superficial resemblance to the Canadian assemblages, although some of the forms that are quantitatively important in the Russian assemblages are also important in some of the assemblages from the Weatherall Formation, i.e. *Hymenozonotriletes proteus* Naumova and *H. echiniformis* Naumova which are closely comparable to *Calyptosporites velatus* (Eisenack) Richardson; *Hymenozonotriletes polymorphus* Naumova which resembles *Rhabdosporites langi* (Eisenack) Richardson and *Camarozonotriletes* spp. The Byelorussian assemblages contain many representatives of the genus *Archaeozonotriletes* Naumova, several of which appear closely comparable to forms from the Griper Bay Formation that are assigned to the genus *Geminospora* Balme emend.

In North America, the assemblage of late Middle or early Upper Devonian age described by Guennel (1963) from deposits infilling cavities in the Silurian Tilden Reef of southern Illinois bears some general similarity to the assemblages from the western Queen Elizabeth Islands. *Stenozonotriletes bellus* Guennel appears to be similar in structural organization to some of the forms of *Geminospora* Balme emend. that were recorded from the Griper Bay Formation. Of the remaining types present in the Tilden Reef, representatives of the genus *Rhabdosporites* Richardson were also recorded from the Weatherall Formation and representatives of *Ancyrospora* Richardson and *Perotrilites* (Erdtman) Couper were recorded from the Griper Bay Formation.

Of the species recorded by McGregor (1964) in the assemblage from the Yahatinda (Ghost River) Formation of late Givetian or possibly early Frasnian age from Alberta, none are directly comparable with forms recorded in the western Queen Elizabeth Islands assemblages, but the dominant form in the assemblage, *Retusotriletes greggsii* McGregor, is closely comparable in structural organization to representatives of the *Verruciretusispora pallida* (McGregor) n. comb. - *V. grandis* (McGregor) n. comb. complex of spores which are common in some of the assemblages from the Griper Bay Formation.



a, expanded; b, triangular; c, extended triangular; d, expanded triangular; e, extended; f, laterally extended; g, laterally extended and reflexed; h, reflexed; i, laterally extended, expanded and reflexed

Figure 4. Diagrammatic representation of the terminology used in the description of the terminal bifurcate portion of the processes in the genus Hystricosporites McGregor.

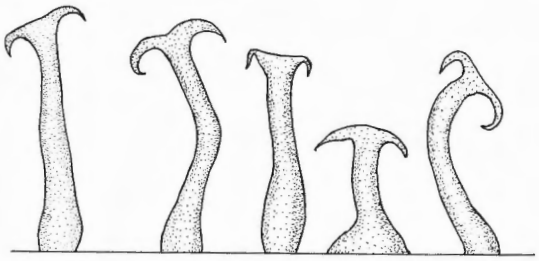


Figure 5. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Hystricosporites delectabilis* McGregor 1960. Approximate magnification x 500.

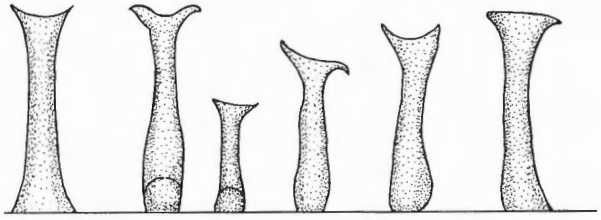


Figure 6. Illustrating the diversity of the sculptural elements (as seen in lateral view) of *Hystricosporites furcatus* n. sp. Approximate magnification x 500.

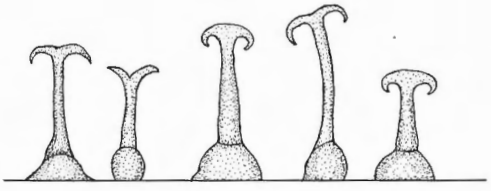


Figure 7. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Hystricosporites reflexus* n. sp. Approximate magnification x 500.

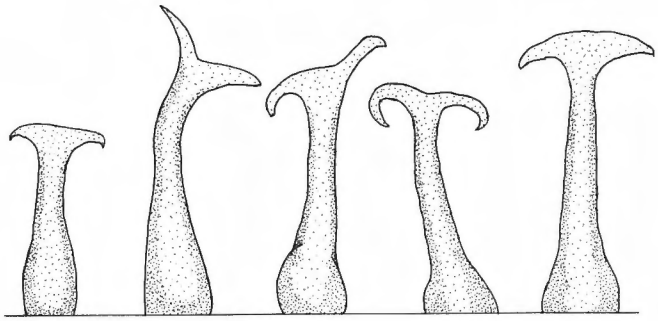


Figure 8. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Hystricosporites grandis* n. sp. Approximate magnification x 500.

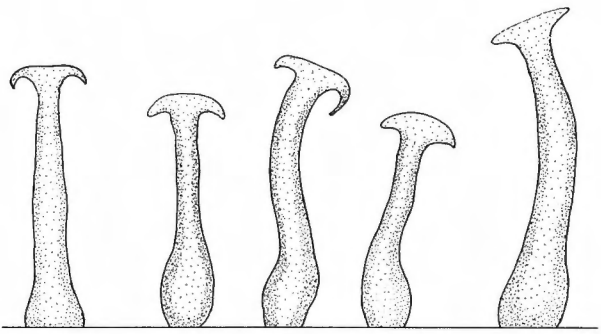


Figure 9. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Hystricosporites gravis* n. sp. Approximate magnification x 375.

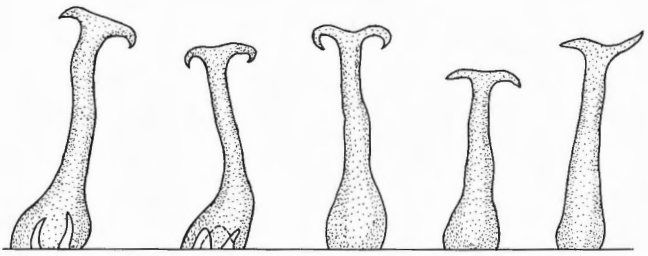


Figure 10. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Hystricosporites harpagonis* n. sp. Approximate magnification x 375.

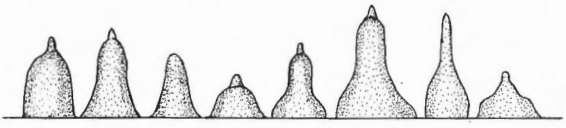


Figure 11. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Spinozonotriletes cassideus* n. sp. Approximate magnification x 500.

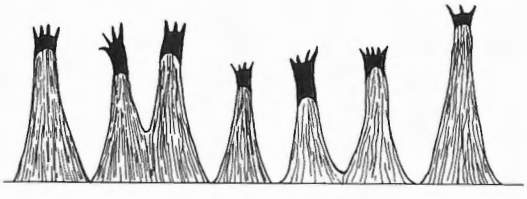


Figure 12. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Ancyrospora furcula* n. sp. Approximate magnification x 500.

Figure 13. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Ancyrospora ampulla* n. sp. Approximate magnification x 500.

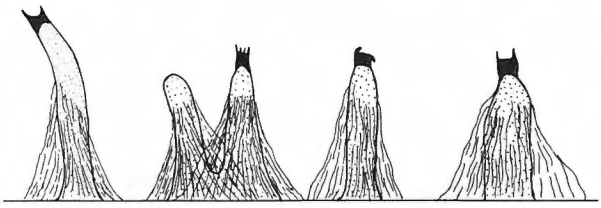


Figure 14. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Ancyrospora involucra* n. sp. Approximate magnification x 500.

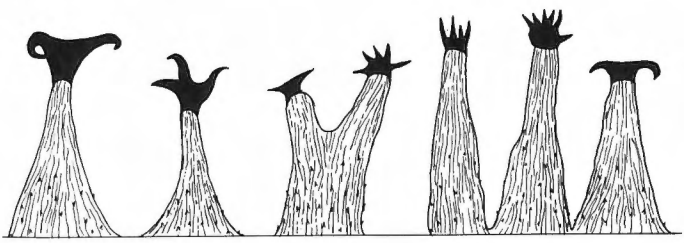


Figure 15. Illustrating the diversity of sculptural elements (as seen in lateral view) of *Ancyrospora pulchra* n. sp. Approximate magnification x 375.

REFERENCES

Allen, K.C.
1965: Lower and Middle Devonian spores of north and central Vestspitsbergen; *Palaeontol.*, vol. 8, Pt. 4, pp. 687-748.

Andreyeva, E.M.
1962: Most important Middle Devonian spores of the Kuznetsk Basin; *Contr. Phytostratig. Dev. Sed. Altae - Sayan Mountain Region, Tr. VSEGEI, N.S.*, vol. 70, pp. 191-213.

Archangelskaya, A.D.
1963: New spore finds from Devonian deposits of the Russian Platform; *Ministerstvo Geol. i Okhrani Nedr. SSSR, Tr. Vses. Nauchno - Issled. Geologorazved. Neft. Inst.*, vol. 37, pp. 18-30.

Artuz, S.
1957: Die Sporae dispersae der turkischen Steinkhole von Zonguldak - Gebiet; *Istanbul Univ. fen Fakultesi Mecmuasi*, ser. B, vol. 22, No. 4, pp. 239-263.

1959: Zonguldak Bolgesindeki Alimolla, Sulu ve Buyuk Komur Damarlarinin Sporolojik Etudu; *Istanbul Univ. fen Fakultesi Monografileri*, No. 15, 73 pp.

Balme, B.E.
1962: Upper Devonian (Frasnian) spores from the Carnarvon Basin, Western Australia; *The Palaeobotanist*, vol. 9 (1960), Nos. 1 and 2, pp. 1-10.

1964: The palynological record of Australian Pre-Tertiary floras; *Ancient Pacific Floras*, pp. 49-80.

Balme, B.E. and Hassell, C.W.
1962: Upper Devonian spores from the Canning Basin, Western Australia; *Micropaleontology*, vol. 8, No. 1, pp. 1-28.

Bhardwaj, D.C.
1957: The palynological investigations of the Saar coals (Part 1 - Morphology of Sporae dispersae); *Palaeontographica*, B, vol. 101, pp. 73-125.

Birkenmajer, K. and Turnau, E.
1962: Lower Carboniferous age of the so-called Wijde Bay Series in Hornsund, Vestspitsbergen; *Norsk Polarinstitutt*, Arbok 1961, pp. 41-61.

Butterworth, M.A. and Williams, R.W.
1958: The small spore floras of coals in the Limestone Coal Group and Upper Limestone Group of the Lower Carboniferous of Scotland; *Trans. Roy. Soc. Edinburgh*, vol. 63, Pt. 2, No. 17, pp. 353-392.

Chaloner, W.G.
1959: Devonian megaspores from Arctic Canada; *Palaeontol.*, vol. 1, Pt. 4, pp. 321-332.

1963: Early Devonian spores from a borehole in southern England; *Grana Palynologica*, vol. 4, Pt. 1, pp. 100-110.

Chibrikova, E.V.
1959: Spores from the Devonian and older rocks of Bashkiria; *Akad. Nauk SSSR, Bashkir. Filial Data on Palaeontol. and Stratig. of Devonian and Older Depos. Bashkiria*, pp. 3-116.

1962: Spores from Devonian terrigenous deposits of the Bashkir region and the southern slopes of the Urals; *Akad. Nauk SSSR, Bashkir. Filial, Gorno - Geol. Inst.*, pp. 353-476.

Copeland, M.J.
1962: Devonian Conchostraca from Melville Island, Canadian Arctic; *Geol. Surv. Can.*, Bull. 91, pp. 12-17.

Couper, R.A.
1953: Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand; *New Zealand Geol. Surv.*, Paleontol. Bull., No. 22, 77 pp.

Dettmann, M.E.
1963: Upper Mesozoic microfloras from southeastern Australia; *Roy. Soc. Victoria*, vol. 77, pp. 1-148.

Dybová, S. and Jachowicz, A.
1957: Microspores from the Upper Silesian coal measures; *Inst. Geol. Prace*, vol. 23, 307 pp.

Eisenack, A.
1944: Über einige pflanzliche Funde in Geschieben, nebst Bemerkungen zum Hystrichosphaerideen - Problem; *Zeitschrift f. Geschiebef. u. Flachlandsgeol.*, vol. 19, pp. 103-124, 182-186.

Greggs, R.G., McGregor, D.C., and Rouse, G.E.
1962: Devonian plants from the type section of the Ghost River Formation of western Alberta; *Science*, vol. 135, pp. 930-931.

Guennel, G.K.
1963: Devonian Spores in a Middle Silurian Reef; *Grana Palynologica*, vol. 4, No. 2, pp. 245-261.

Hacquebard, P.A.
1957: Plant spores from the Horton Group (Mississippian) of Nova Scotia; *Micropaleontol.*, vol. 3, No. 4, pp. 301-324.

Hacquebard, P.A. and Barss, M.S.
1957: A carboniferous spore assemblage in coal from the South Nahanni River area, Northwest Territories; *Geol. Surv. Can.*, Bull. 40, 63 pp.

Hoeg, O.A.
1942: The Downtonian and Devonian Flora of Spitsbergen; *Skr. Norges Svalb.-og Ishavs-Unders.*, No. 83, 228 pp.

Hoeg, O.A., Bose, M.N., and Manum, S.
1955: On double walls in fossil megaspores, with description of *Duosporites congoensis* n. gen., n. sp.; *Nytt. Magasin for Botanikk*, vol. 4, pp. 101-107.

Hoffmeister, W.S., Staplin, F.L., and Malloy, R.E.
1955a: Mississippian plant spores from the Hardinsburg Formation of Illinois and Kentucky; *J. Paleontol.*, vol. 29, No. 3, pp. 372-399.

Hoffmeister, W.S., Staplin, F.L., and Malloy, R.E. (cont'd)
1955b: Geological range of Paleozoic plant spores in North America; *Micropaleontol.*, vol. 1, No. 1, pp. 9-27.

Horst, U.
1955: Die Sporae dispersae des Namurs von Westoberschlesein und Mahrisch - Ostrau; *Palaeontographica*, B, vol. 98, Nos. 4-6, pp. 137-236.

Hughes, N.F. and Playford, G.
1961: Palynological reconnaissance of the Lower Carboniferous of Spitsbergen; *Micropaleontol.*, vol. 7, No. 1, pp. 27-44.

Imgrund, R.
1960: Sporae dispersae des Kaipingbeckens, ihre paläontologische und stratigraphische Bearbeitung im Hinblick auf eine Parallelisierung mit Ruhrkarbon und dem Pennsylvanian von Illinois; *Geol. Jahrb.*, vol. 77, pp. 143-204.

Ishchenko, A.M.
1952: Atlas of microspores and pollen of the Middle Carboniferous of the western part of the Donets Basin; *Akad. Nauk Ukr. SSR, Inst. Geol. Nauk*, 83 pp.

1958: Spore - pollen Analysis of the Lower Carboniferous sediments of the Dnieper - Donets Basin; *Akad. Nauk Ukr. SSR, Tr. Inst. Geol. Nauk*, ser. Stratigraphy and Palaeontology, No. 17, 188 pp.

Kedo, G.I.
1955: Spores of the Middle Devonian of the northeastern Byelorussian SSR; *Akad. Nauk BSSR, Inst. Geol. Nauk*, Palaeontol. and Stratigraphy BSSR, Sb. 1, pp. 5-59.

1957: Spores from the supra-salt Devonian deposits of Pripyat depression and their stratigraphic significance; *Akad. Nauk BSSR, Inst. Geol. Nauk*, Palaeontology and Stratigraphy BSSR, Sb. 2, pp. 3-43.

1963: Spores of the Tournaisian Stage of the Pripyat depression and their stratigraphic significance; *Akad. Nauk BSSR, Inst. Geol. Nauk*, ser. Palaeontology and Stratigraphy BSSR, Sb. 4, pp. 3-121.

Kerr, J.W., McGregor, D.C., and McLaren, D.J.
1965: An unconformity between the Middle and Upper Devonian rocks of Bathurst Island, with comments on Upper Devonian faunas and microfloras of the Parry Islands; *Bull. Can. Petrol. Geol.*, vol. 13, No. 3, pp. 409-431.

Kosanke, R.M.
1950: Pennsylvanian spores of Illinois and their use in correlation; *Bull. Illinois State Geol. Surv.*, No. 74, 128 pp.

1964: Applied Paleozoic Palynology; *in* Palynology in Oil Exploration; *Soc. Econ. Paleontol. Mineralogists, Spec. Publ.*, No. 11, pp. 75-89.

Lambe, L.M.
1910: The palaeontological results of the Dominion government "Arctic" Expedition of 1908-1909; *in* Bernier, J.E., Rept. on Dominion Govt. Exped. to Arctic Is. and Hudson Strait on Board D.G.S. Arctic (1908-1909), pp. 479-489.

Lang, W.H.
1925: Contributions to the study of the Old Red Sandstone flora of Scotland, I. On plant remains from the Fish Beds of Cromarty; *Trans. Roy. Soc. Edinburgh*, B, vol. 54, Pt. 2, No. 2, pp. 253-272.

Leclercq, S.
1960: Sporomorphes du Dévonien de Belgique, Contribution I; *Acad. Roy. Belge*, Bull. Classe Sci., ser. 5, vol. 46, No. 4, pp. 250-256.

Love, L.G.
1960: Assemblages of small spores from the Lower Oil-shale Group of Scotland; *Proc. Roy. Soc. Edinburgh*, B, vol. 67, Pt. 2, No. 7, pp. 99-126.

Luber, A.A.
1955: Atlas of spores and pollen grains of the Palaeozoic deposits of Kazakhstan; *Akad. Nauk Kazakh. SSR*, 128 pp.

Luber, A.A. and Waltz, I.E.
1938: Classification and stratigraphic value of spores of some Carboniferous coal deposits in the U.S.S.R.; *Trans. Cent. Geol. Prospecting Inst.*, fasc. 105, 45 pp.

1941: Atlas of microspores and pollen of the Palaeozoic of the U.S.S.R.; *Trans. VSEGEI*, Bull. 139, 107 pp.

McGregor, D.C.
1960: Devonian spores from Melville Island, Canadian Arctic Archipelago; *Palaeontol.*, vol. 3, Pt. 1, pp. 26-44.

1961: Spores with proximal radial pattern from the Devonian of Canada; *Geol. Surv. Can.*, Bull. 76, 11 pp.

1963: Palaeobotanical evidence for the age of the basal Devonian strata at Ghost River, Alberta; *Bull. Can. Petrol. Geol.*, vol. 11, No. 3, pp. 299-303.

1964: Devonian miospores from the Ghost River Formation, Alberta; *Geol. Surv. Can.*, Bull. 109, 31 pp.

1967: Composition and range of some Devonian spore assemblages of Canada; *Rev. Palaeobot. Palynology*, vol. 1, pp. 173-183.

McGregor, D.C. and Owens, B.
1966: Illustrations of Canadian Fossils. Devonian Spores of Eastern and Northern Canada; *Geol. Surv. Can.*, Paper 66-30, 66 pp.

Naumova, S.N.
1953: Spore-pollen complexes of the Upper Devonian of the Russian Platform and their stratigraphic significance; *Tr. Inst. Geol. Nauk, Akad. Nauk SSSR*, vol. 143 (Geol. ser. 60), 204 pp.

Neves, R.
1961: Namurian plant spores from the southern Pennines, England; *Palaeontol.*, vol. 4, Pt. 2, pp. 247-279.

Neves, R. and Owens, B.
1966: Some Namurian camerate miospores from the English Pennines; *Pollen et Spores*, vol. 5, No. 2, pp. 337-360.

Ozolin'a, V.
1960: Spora Vidusdevona Zivetas Stava Nogulumos Latvijas PSR; *Geol. un Derigo Izraktenu Inst. Raksti*, vol. 5, pp. 189-203.

Pashkevich, N.G.
1964: New Devonian species of *Archaeoperisaccus* (Gymnosperms) from North Timan; *Palaeontol. J.*, No. 4, pp. 126-129.

Piérart, P.
1964: Découverte de mégaspores et miospores dans le Givétien de Roncquières (Brabant, Belgique); *Bull. de la Soc. belge de Géol., de Paleontol. et d'Hydrol.*, t. 73, Pt. 1, pp. 81-100.

Playford, G.
1962: Lower Carboniferous microfloras of Spitsbergen - Part One; *Palaeontol.*, vol. 5, Pt. 3, pp. 550-618.

1963: Lower Carboniferous microfloras of Spitsbergen - Part Two; *Palaeontol.*, vol. 5, Pt. 4, pp. 619-678.

1964: Miospores from the Mississippian Horton Group of eastern Canada; *Geol. Surv. Can.*, Bull. 107, 47 pp.

Potonié, R.
1956: Synopsis der Gattungen der Sporae dispersae. I. Teil: Sporites; *Beih. Geol. Jahrb.*, vol. 23, 103 pp.

1958: Synopsis der Gattungen der Sporae dispersae. II. Teil: Sporites (Nachtrage), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates; *Beih. Geol. Jahrb.*, vol. 31, 114 pp.

1960: Synopsis der Gattungen der Sporae dispersae. III. Teil: Nachtrage Sporites, Fortsetzung Pollenites. Mit Generalregister zu Teil I-III; *Beih. Geol. Jahrb.*, vol. 39, 189 pp.

Potonié, R. and Kremp, G.
1954: Die Gattungen der paläozoischen Sporae dispersae und ihre Stratigraphie; *Geol. Jahrb.*, vol. 69, pp. 111-194.

1955: Die Sporae dispersae des Ruhrkarbons, ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. Teil. I; *Palaeontographica*, B, vol. 98, Nos. 1-3, pp. 1-136.

Richardson, J.B.
1960: Spores from the Middle Old Red Sandstone of Cromarty, Scotland; *Palaeontol.*, vol. 3, Pt. 1, pp. 45-63.

1962: Spores with bifurcate processes from the Middle Old Red Sandstone of Scotland; *Palaeontol.*, vol. 5, Pt. 2, pp. 171-194.

Richardson, J.B. (cont'd)
1965: Middle Old Red Sandstone spore assemblages from the Orcadian Basin, northeast Scotland; *Palaeontol.*, vol. 7, Pt. 4, pp. 559-605.

Schemel, M.P.
1950: Carboniferous plant spores from Daggett County, Utah; *J. Paleontol.*, vol. 24, pp. 232-244.

Schopf, J.M., Wilson, L.R., and Bentall, R.
1944: An annotated synopsis of Paleozoic fossil spores and the definition of generic groups; *Illinois State Geol. Surv.*, Rept. Invest. 91, 72 pp.

Sennova, V.F.
1965: Guide spore assemblages of Upper Devonian deposits of the Timan - Pechora province and the Bol'shezemel'skaya tundra region; *Dokl. Akad. Nauk SSSR*, vol. 163, No. 1, pp. 175-178.

Smith, A.H.V.
1964: Report of C.I.M.P. Working Group No. 6, *Verrucosisporites* (Ibrahim) emend.; *Compte Rendu de 5ème Cong. Int. de Stratig. et de Géol. Carb.*, vol. 3, pp. 1071-1077.

Smith, A.H.V. and Butterworth, M.A.
1967: Miospores in the coal seams of the Carboniferous of Great Britain; *Special Papers in Palaeontol.*, No. 1, 324 pp.

Sommer, F.W.
1963: Devonian microspores from Aragarças, Goiás. I. *Archaeotriletes; Anais da Academia Brasileira de Ciencias*, vol. 35, No. 4, pp. 565-569.

Staplin, F.L.
1960: Upper Mississippian plant spores from the Golata Formation, Alberta, Canada; *Palaeontographica*, B, vol. 107, Nos. 1-3, pp. 1-40.

1961: New plant spores similar to *Torispora* Balme; *J. Paleontol.*, vol. 35, No. 6, pp. 1227-1231.

Staplin, F.L. and Jansonius, J.
1964: Elucidation of some Paleozoic densospores; *Palaeontographica*, B, vol. 114, Nos. 4-6, pp. 95-117.

Streel, M.
1964: Une association de spores du Givétian Inférieur de la Vesdre à Goé (Belgique); *Ann. Soc. Géol. Belgique*, vol. 87, No. 7, pp. 1-30.

Sullivan, H.J.
1964: Miospores from the Lower Limestone Shales (Tournaisian) of the Forest of Dean, Gloucestershire; *Compte Rendu 5ème Cong. Int. Stratig. et Géol. Carb.*, vol. 3, pp. 1249-1259.

Taugourdeau-Lantz, J.
1960: Sur la microflore du Frasnien Inférieur de Beaulieu (Boulonnais); *Rev. Micropaléontol.*, vol. 3, No. 3, pp. 144-154.

1962: Remarque sur la structure du genre *Hymenozonotriletes* (Naumova 1937?, 1939) ex Naumova, 1953; *Rev. Micropaléontol.*, vol. 5, No. 1, pp. 51-53.

Tangourdeau-Lantz, J. (cont'd)

1967: Spores nouvelles du Frasnien du Bas Boulonnais (France); *Rev. Micropaléontol.*, vol. 10, No. 1, pp. 48-60.

Thorsteinsson, R. and Tozer, E.T.

1959: Western Queen Elizabeth Islands, District of Franklin, Northwest Territories; *Geol. Surv. Can.*, Paper 59-1, 7 pp.

Tozer, E.T.

1956: Geological reconnaissance, Prince Patrick, Eglinton and western Melville Islands, Arctic Archipelago, Northwest Territories; *Geol. Surv. Can.*, Paper 55-5, 32 pp.

Tozer, E.T. and Thorsteinsson, R.

1964: Western Queen Elizabeth Islands, Arctic Archipelago; *Geol. Surv. Can.*, Mem. 332, 242 pp.

Tuzova, L.S.

1959: Stratigraphic significance of spores and pollen of the Devonian of Eastern Tartaria; *Izv. Akad. Nauk SSSR, Kazansk, fil.*, ser. Geol. Nauk, No. 7, pp. 97-181.

Vigran, J.O.

1964: Spores from Devonian deposits, Mimerdalen, Spitsbergen; *Norsk Polarinstitutt*, Skrifter, Nr. 132, 32 pp.

Winslow, M.R.

1962: Plant spores and other microfossils from Devonian and Lower Mississippian rocks of Ohio; *U.S. Geol. Surv.*, Prof. Paper 364, 93 pp.

PLATES I to XXVIII

PLATE I

(All figures x500, and from unretouched negatives)

Figures 1-3 *Punctatisporites glabrimarginatus* n. sp. (Page 9)
1, holotype, distal surface, GSC No. 15489; 2, distal surface, GSC No. 15490; 3, proximal surface, GSC No. 15491.

Figures 4-7 *Retusotriletes distinctus* Richardson, 1965 (Page 11)
4, proximal surface, GSC No. 15492; 5, distal surface, GSC No. 15493; 6, distal surface, GSC No. 15494; 7, proximal surface, GSC No. 15495.

Figures 8-10 *Retusotriletes dubius* (Eisenack) Richardson, 1965 (Page 12)
8, distal surface, GSC No. 15496; 9, distal surface, GSC No. 15497; 10, proximal surface, GSC No. 15498.

Plate I

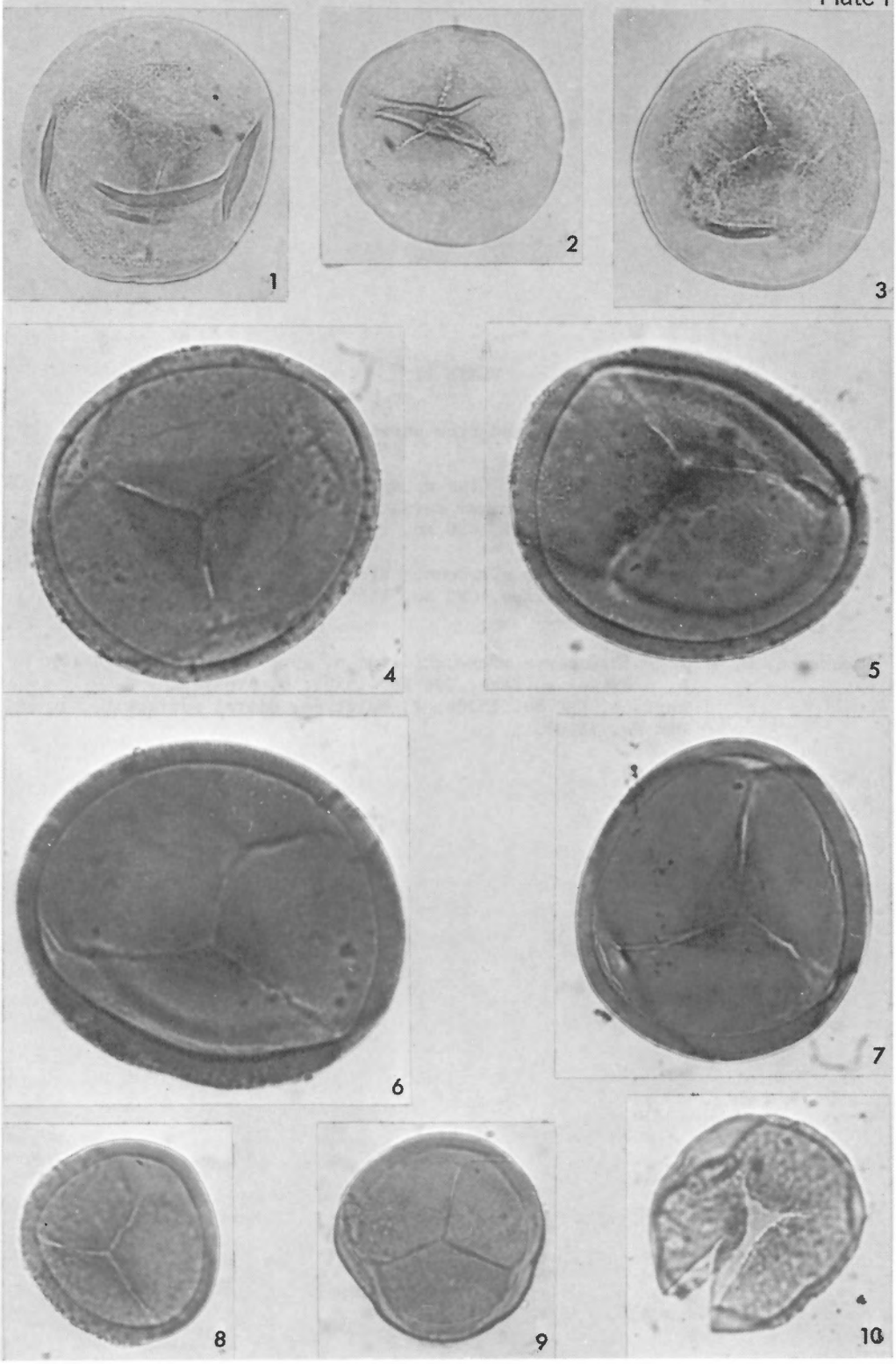


PLATE II

(All figures x500, and from unretouched negatives)

Figures 1, 2 — *Retusotriletes politus* n. sp. (Page 12)
1, holotype, proximal surface, GSC No. 15499;
2, distal surface, GSC No. 15500.

Figures 3, 5 — *Apiculatisporis microconus* Richardson, 1965 (Page 13)
3, distal surface, GSC No. 15501; 5, distal surface, GSC No. 15502.

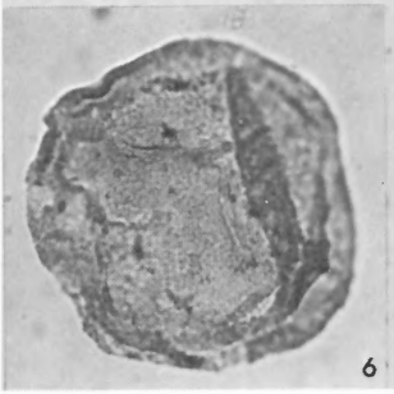
Figures 4, 6, 7 — *Apiculatisporis microechinatus* n. sp. (Page 14)
4, proximal surface, GSC No. 15503; 6, proximal surface, GSC No. 15504; 7, holotype, distal surface, GSC No. 15505.

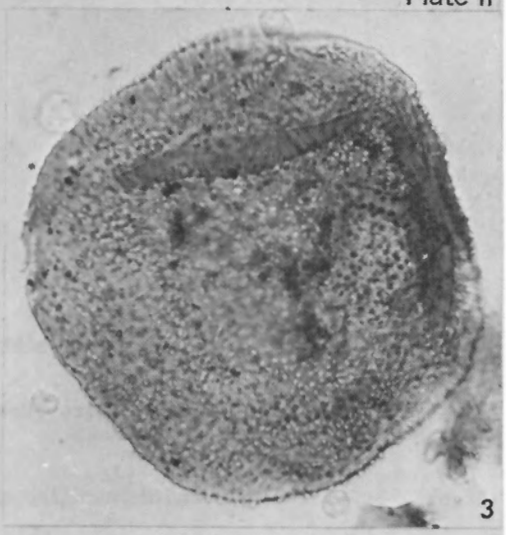
Plate II

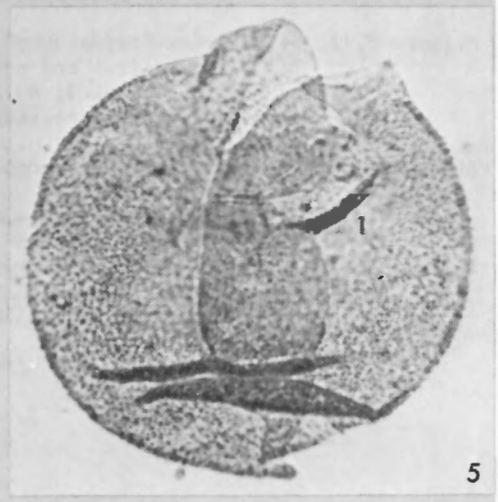

1


2


4


6


3


1
5


7

PLATE III

(All figures x500 except where otherwise stated, and from unretouched negatives)

Figures 1, 4, 5 — *Apiculatasporites* cf. *dilucidus* McGregor, 1960 (Page 14)
1, distal surface, GSC No. 15506; 4, subpolar view, GSC No. 15507; 5, proximal surface, GSC No. 15508.

Figures 2, 3, 6, 8 — *Apiculiretusispora granulata* n. sp. (Page 15)
2, 3, distal and proximal surfaces respectively, GSC No. 15509; 6, 8, holotype, distal and proximal surfaces respectively, GSC No. 15510.

Figure 7 — *Apiculiretusispora apsoga* (Chibrikova) n. comb. (Page 16)
Distal surface, x330, GSC No. 15511.

Figures 9-11 — *Apiculiretusispora nitida* n. sp. (Page 17)
9, holotype, distal surface, GSC No. 15512; 10, subpolar view, GSC No. 15513; 11, distal surface, GSC No. 15514.

Plate III

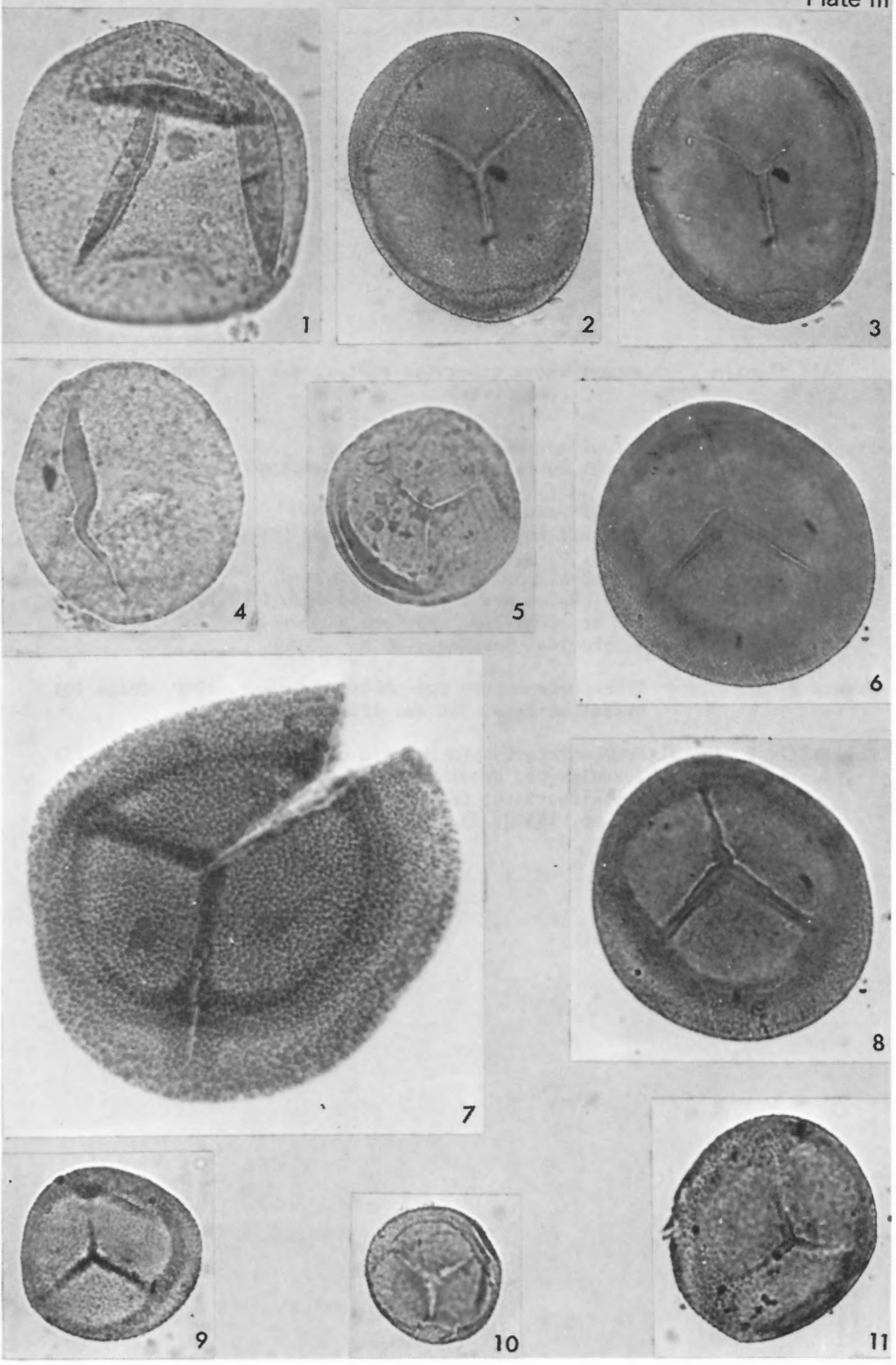


PLATE IV

(All figures x500 except where otherwise stated, and from unretouched negatives)

Figure 1 — *Apiculiretusispora* sp. A. (Page 18)
Distal surface, x330, GSC No. 15515.

Figure 2 — *Apiculiretusispora* sp. B. (Page 19)
Proximal surface, x330, GSC No. 15516.

Figures 3-6 — *Verrucosisporites confertus* n. sp. (Page 19)
3, 4, holotype, proximal and distal surfaces respectively, GSC No. 15517; 5, proximal surface, GSC No. 15518; 6, proximal surface, GSC No. 15519.

Figure 9 — *Verrucosisporites variabilis* McGregor, 1960 (Page 20)
Distal surface, GSC No. 15520.

Figures 7, 8, 10, 11 — *Verruciretusispora robusta* n. sp. (Page 21)
7, holotype, proximal surface, GSC No. 15521; 8, distal surface, GSC No. 15522; 10, distal surface, GSC No. 15523; 11, distal surface, GSC No. 15524.

Plate IV

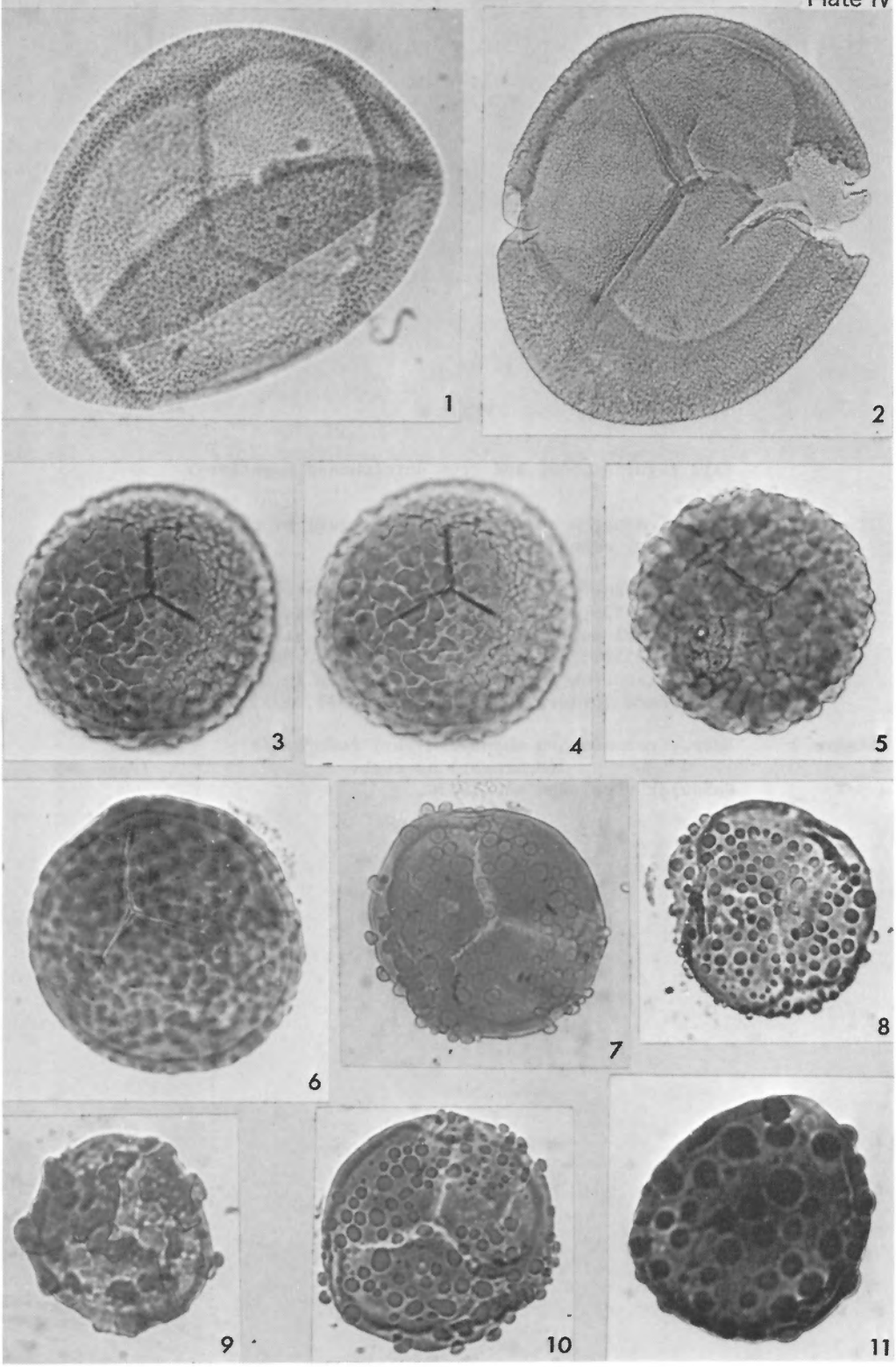


PLATE V

(All figures x500, and from unretouched negatives)

Figures 1-6 *Verruciretusispora magnifica* (McGregor) n. comb. var. *magnifica*, emend.

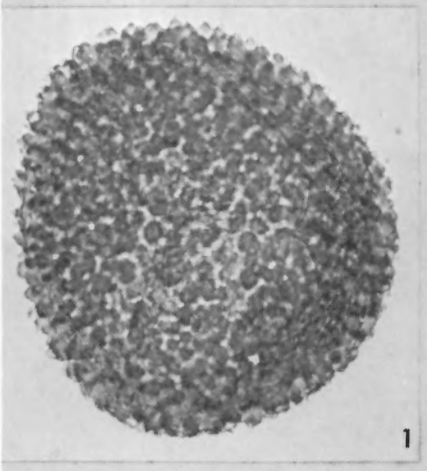
(Page 22)

1, distal surface, GSC No. 15525; 2, lateral view, GSC No. 15526; 3, distal surface, GSC No. 15527; 4, proximal surface, GSC No. 15528; 5, distal surface, GSC No. 15529; 6, tetrad of spores, GSC Nos. (clockwise from and including specimen in bottom right-hand corner) 15530, 15531, 15532, 15533.

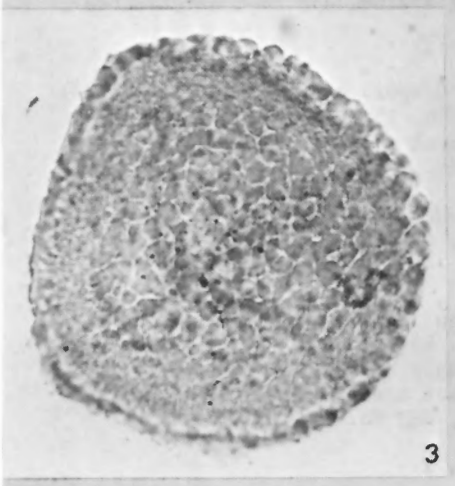
Figure 7 *Verruciretusispora magnifica* var. *endoformis* (McGregor) n. comb. (Page 24)

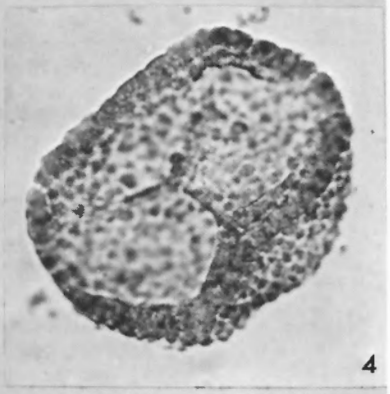
Subpolar view, GSC No. 15534.

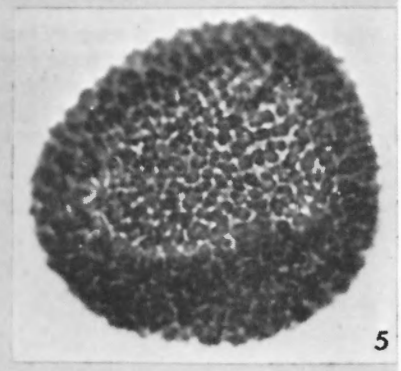
Plate V


1


2


3


4


5


6


7

PLATE VI

(All figures x500 except where otherwise stated, and from unretouched negatives)

Figures 1-4 *Verruciretusispora pallida* (McGregor) n. comb. emend. 1, distal surface, GSC No. 15535; 2, proximal surface, GSC No. 15536; 3, distal surface, GSC No. 15537; 4, subpolar view, GSC No. 15538. (Page 24)

Figures 5, 6 *Hystricosporites delectabilis* McGregor, 1960 5, lateral view, x330, GSC No. 15539; 6, proximal surface, x330, GSC No. 15540. (Page 27)

Figures 7-9 *Hystricosporites furcatus* n. sp. 7, holotype, proximal surface, x330, GSC No. 15541; 8, proximal surface showing strongly developed, radially orientated ridges on the contact areas, x330, GSC No. 15542; 9, subpolar view, x330, GSC No. 15543. (Page 28)

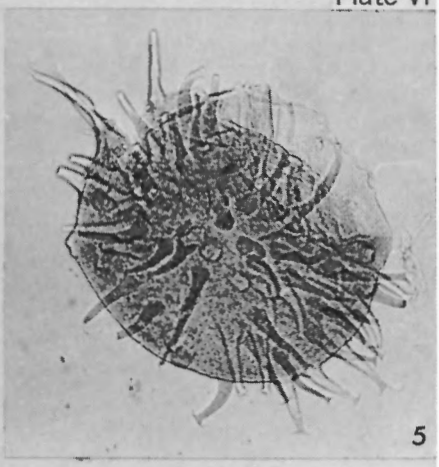
Plate VI

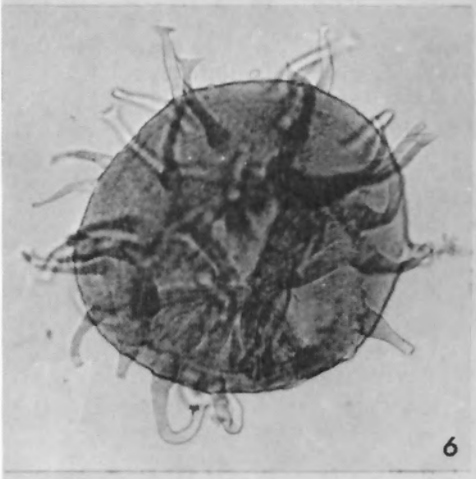

1

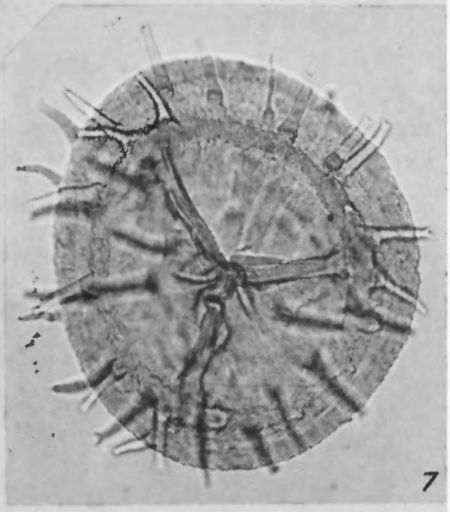

2

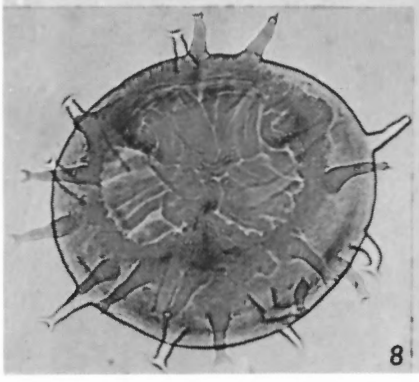

3


4


5


6


7


8

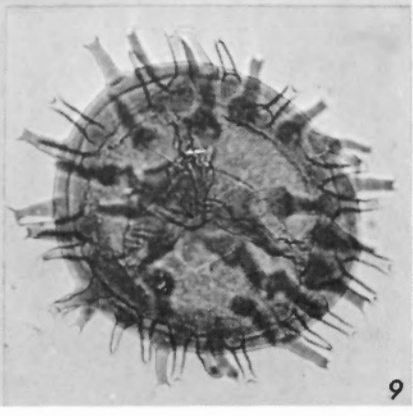

9

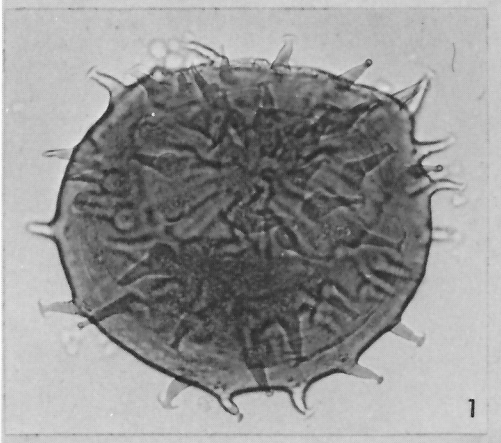
PLATE VII

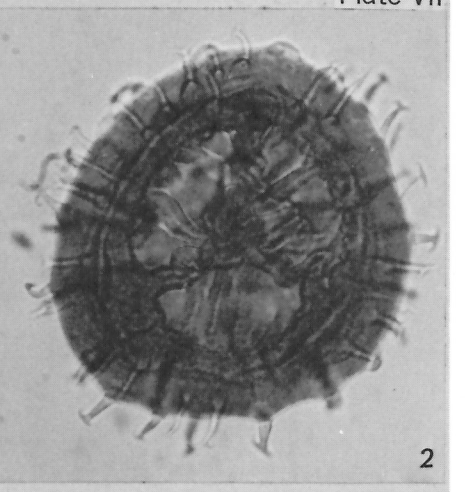
(All figures x330, and from unretouched negatives)

Figures 1-4 *Hystricosporites reflexus* n. sp. (Page 29)
1, distal surface, GSC No. 15544; 2, proximal surface, GSC No. 15545; 3, holotype, proximo-lateral view, GSC No. 15546; 4, lateral view, GSC No. 15547.

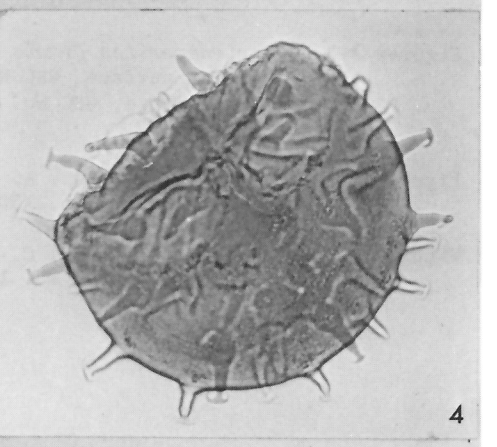
Figures 5, 6 *Hystricosporites grandis* n. sp. (Page 30)
5, distal surface, GSC No. 15548; 6, holotype, proximo-lateral view, GSC No. 15549.

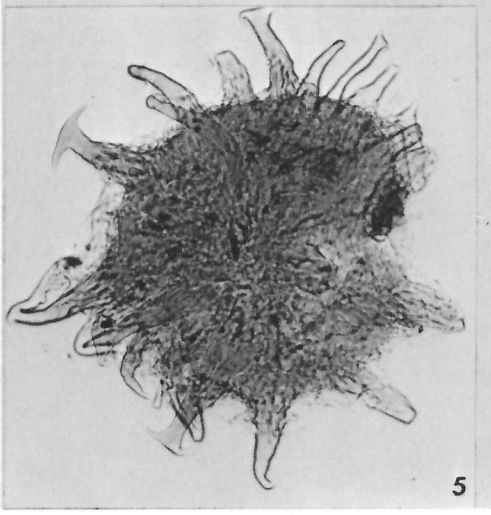
Plate VII


1


2


3


4


5

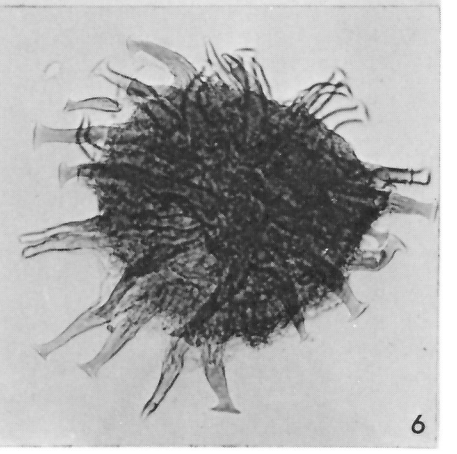

6

PLATE VIII

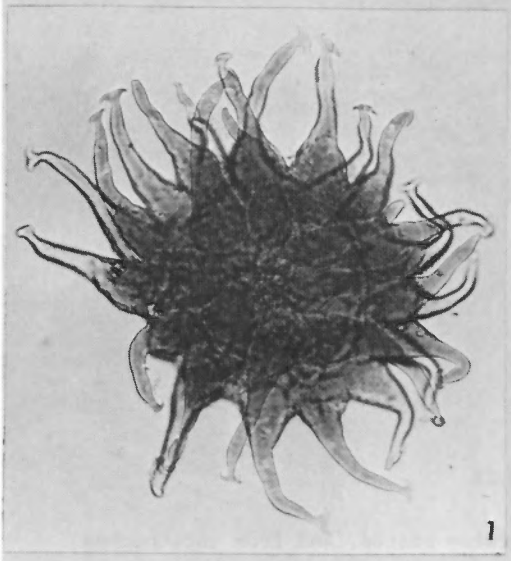
(All figures x330 except where otherwise stated, and from unretouched negatives)

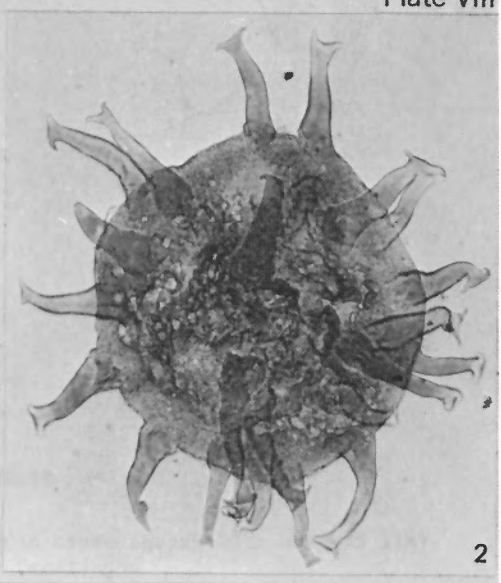
Figures 1-3 *Hystricosporites gravis* n. sp. (Page 31)
1, distal surface, GSC No. 15550; 2, holotype, distal surface, GSC No. 15551; 3, distal surface, GSC No. 15552.

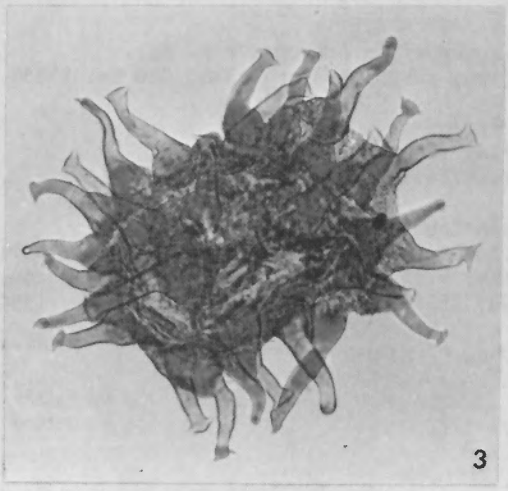
Figure 4 *Hystricosporites* sp. A. (Page 33)
Lateral compression, x500, GSC No. 15553.

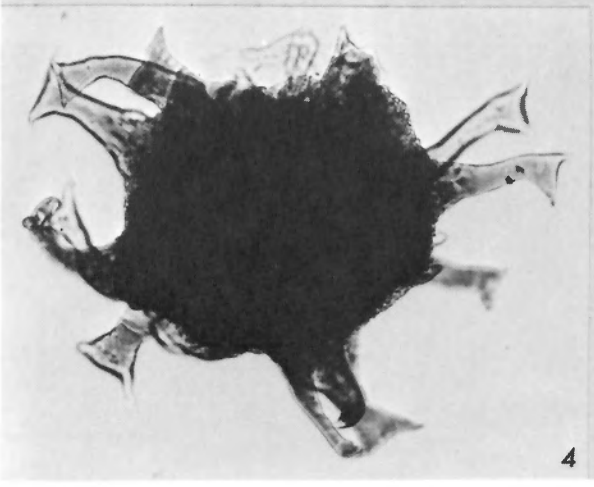
Figure 5 *Hystricosporites* sp. C. (Page 34)
Subpolar view, GSC No. 15554.

Plate VIII


1


2


3


4

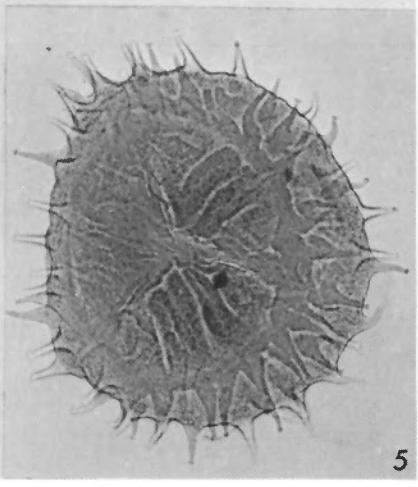

5

PLATE IX

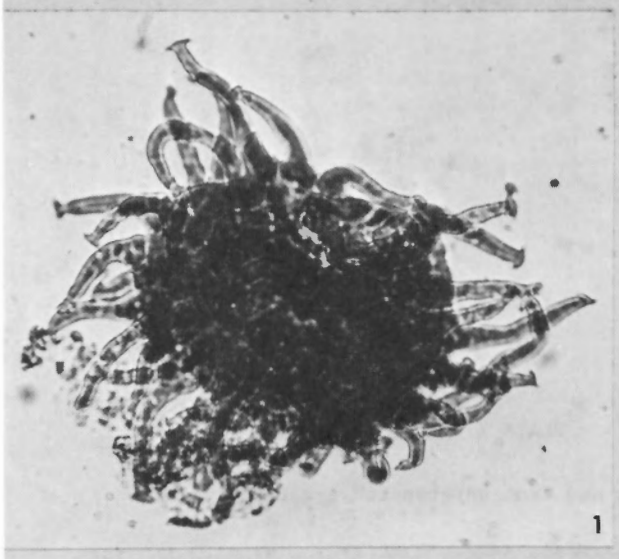
(All figures x500 except where otherwise stated, and from unretouched negatives)

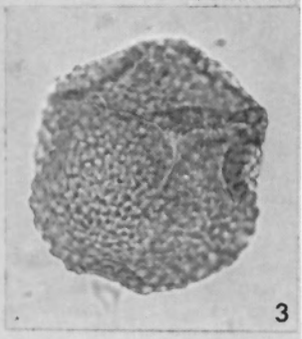
Figure 1 *Hystricosporites harpagonis* n. sp. (Page 32)
Holotype, subpolar view, x330, GSC No. 15555.

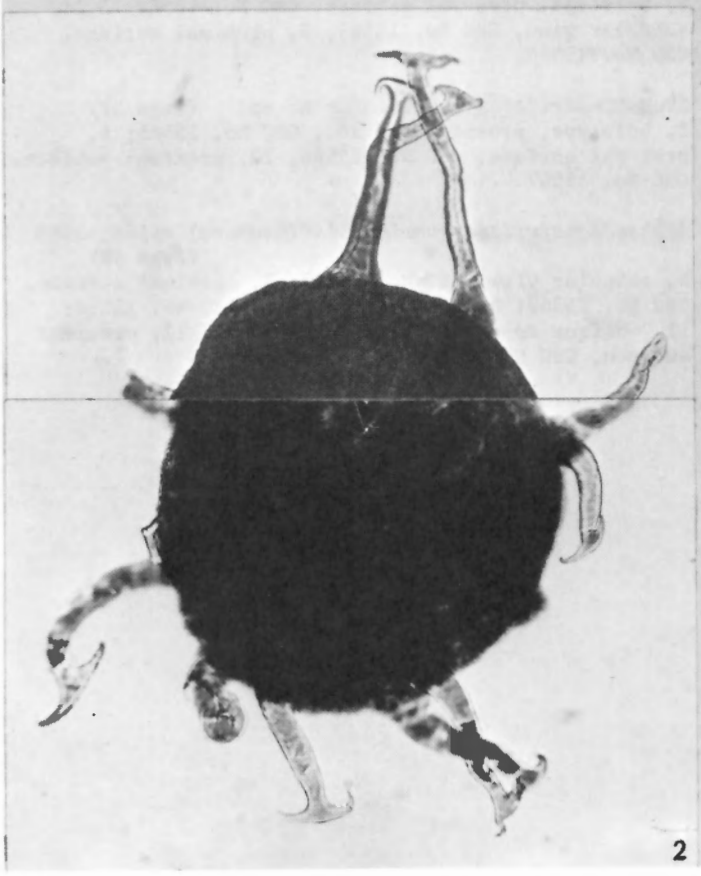
Figure 2 *Hystricosporites* sp. B. (Page 33)
Subpolar view, x330,
GSC No. 15556.

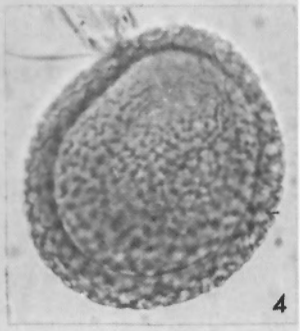
Figures 3-6 *Convolutispora subtilis* n. sp. (Page 35)
3, holotype, proximal surface, GSC No. 15557; 4, subpolar view, GSC No. 15558; 5, oblique compression, GSC No. 15559; 6, subpolar view, GSC No. 15560.

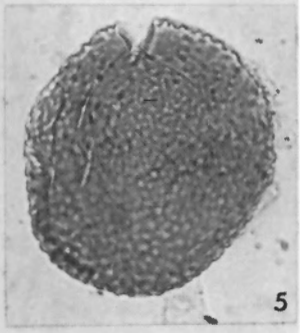
Plate IX


1


3


2


4


5

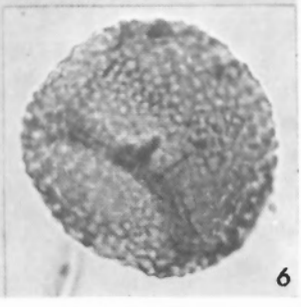

6

PLATE X

(All figures x500, and from unretouched negatives)

Figure 1 — *Acinosporites acanthomammillatus* Richardson, 1965 (Page 35)
Subpolar view, GSC No. 15561.

Figures 2, 5, 9 — *Stenozonotriletes notatus* n. sp. (Page 36)
2, holotype, proximal surface, GSC No. 15562; 5, subpolar view, GSC No. 15563; 9, proximal surface, GSC No. 15564.

Figures 3, 6, 10 — *Stenozonotriletes inspissatus* n. sp. (Page 37)
3, holotype, proximal surface, GSC No. 15565; 6, proximal surface, GSC No. 15566; 10, proximal surface, GSC No. 15567.

Figures 4, 7, 8, 11, 12 — *Archaeozonotriletes variabilis* (Naumova) Allen, 1965 (Page 38)
4, subpolar view, GSC No. 15568; 7, proximal surface, GSC No. 15569; 8, proximal surface, GSC No. 15570; 11, oblique compression, GSC No. 15571; 12, proximal surface, GSC No. 15572.

Plate X

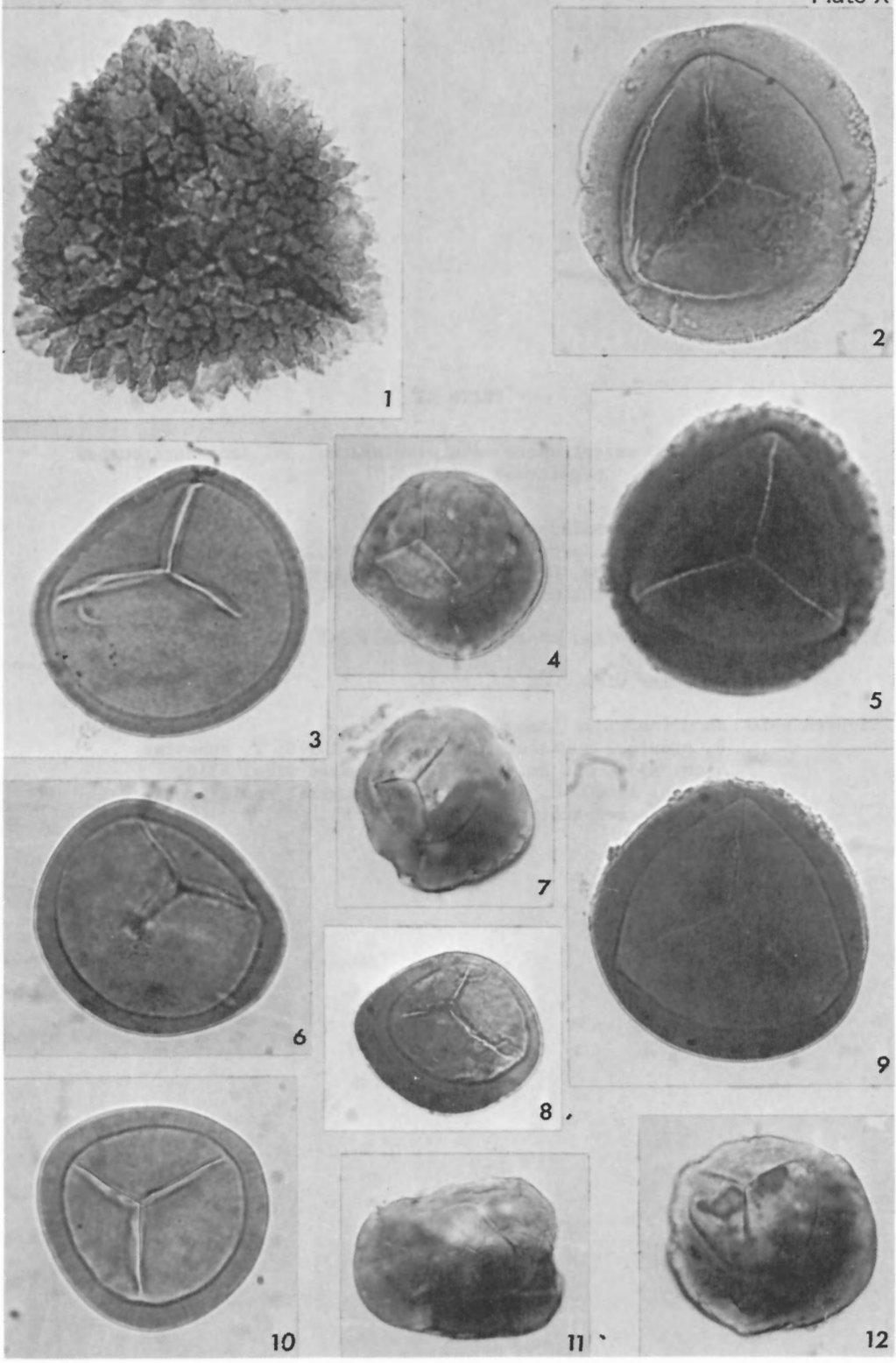


PLATE XI

(All figures x500 except where otherwise stated, and from unretouched negatives)

Figures 1-4 *Camarozonotriletes parvus* n. sp. (Page 40)
1, holotype, proximal surface, GSC No. 15573; 2, subpolar view, GSC No. 15574; 3, subpolar view, GSC No. 15575; 4, proximal surface, GSC No. 15576.

Figure 5 *Samarisporites praetervisus* (Naumova) Allen, 1965 (Page 42)
Subpolar view, GSC No. 15577.

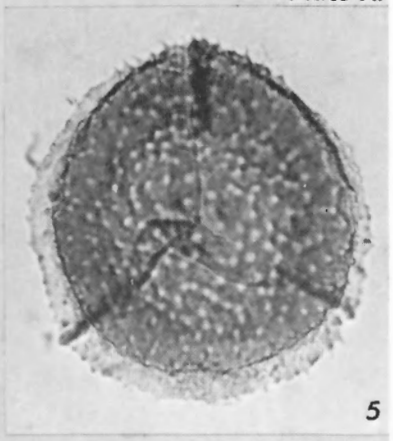
Figures 6-10 *Samarisporites tozeri* n. sp. (Page 41)
6, proximal surface, x330, GSC No. 15578; 7, subpolar view, x330, GSC No. 15579; 8, subpolar view, x330, GSC No. 15580; 9, 10, holotype, proximal and distal surfaces respectively, GSC No. 15581.


1

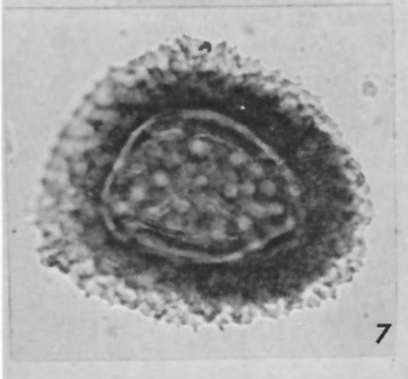

2

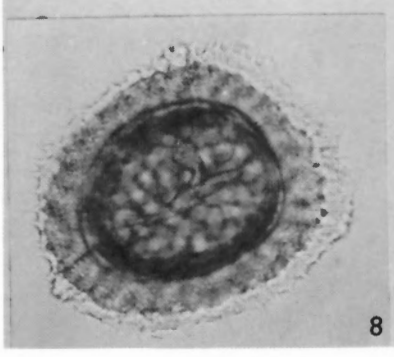

3

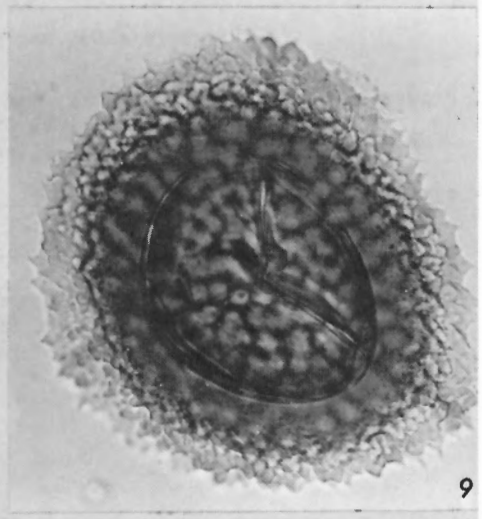

4


5


6


7


8


9

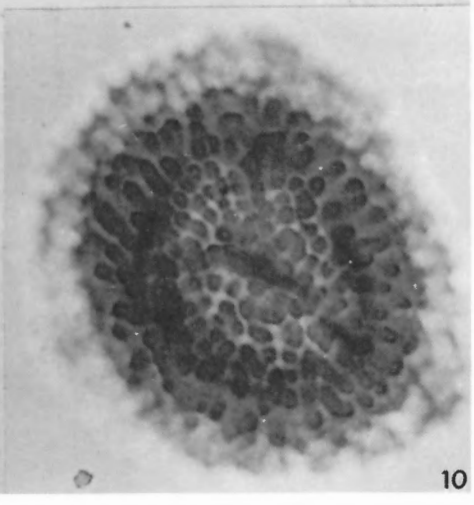

10

PLATE XII

(All figures x500, and from unretouched negatives)

Figures 1, 2, 4 *Samarisporites inaequus* (McGregor) n. comb. (Page 43)
1, subpolar view, GSC No. 15582; 2, proximal surface, GSC No. 15583; 4, proximal surface, GSC No. 15584.

Figures 3, 5, 6 *Samarisporites galeatus* n. sp. (Page 44)
3, holotype, distal surface, GSC No. 15585; 5, subpolar view, GSC No. 15586; 6, subpolar view, GSC No. 15587.

Figures 7-9 *Samarisporites concinnus* n. sp. (Page 45)
7, subpolar view, GSC No. 15588; 8, oblique compression, GSC No. 15589; 9, holotype, proximal surface, GSC No. 15590.

Plate XII

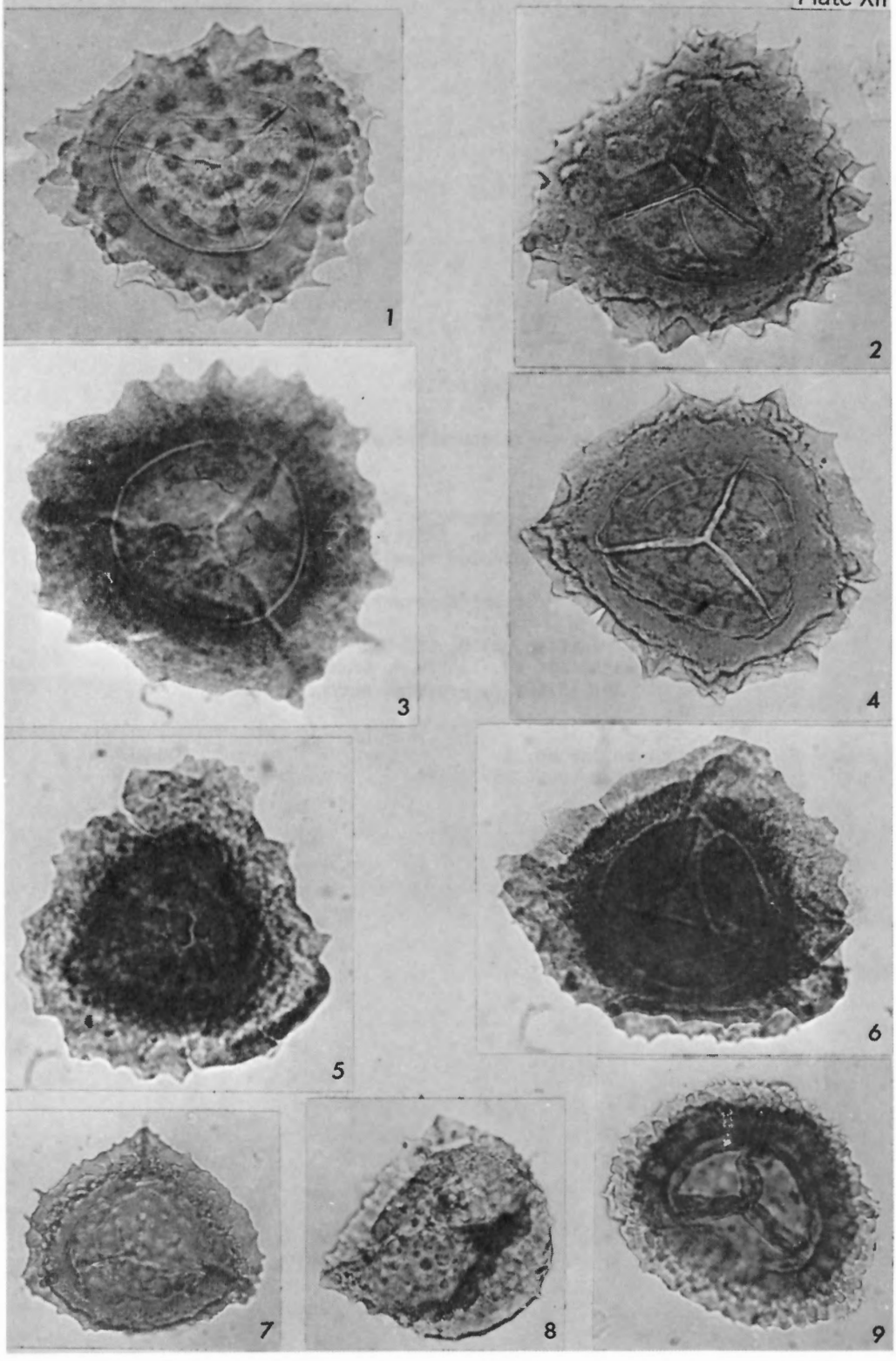


PLATE XIII

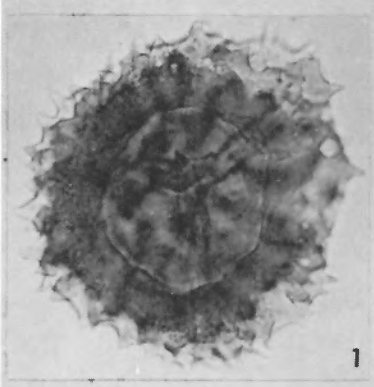
(All figures x500 except where otherwise stated, and from unretouched negatives)

Figures 1-3 *Samarisporites concinnus* n. sp. (Page 45)
1, subpolar view, GSC No. 15591; 2, distal surface, GSC No. 15592; 3, subpolar view, GSC No. 15593.

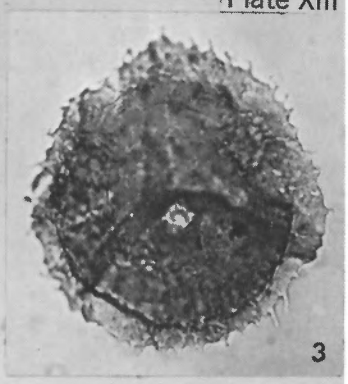
Figures 4-7 *Calyptosporites velatus* (Eisenack) Richardson, 1962 (Page 46)
4, proximal surface, x330, GSC No. 15594; 5, distal surface, x330, GSC No. 15595; 6, proximal surface, x330, GSC No. 15596; 7, proximal surface, x330, GSC No. 15597.

Figure 8 *Calyptosporites* sp. A. (Page 48)
Distal surface, GSC No. 15598.

Plate XIII


1

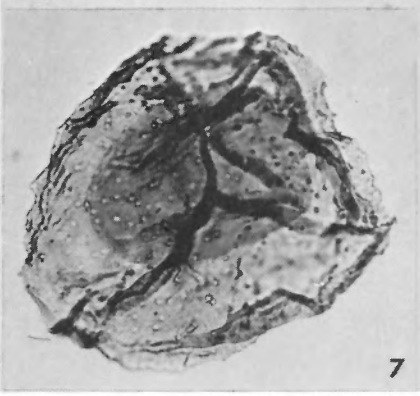

2


3


4


5


6


7

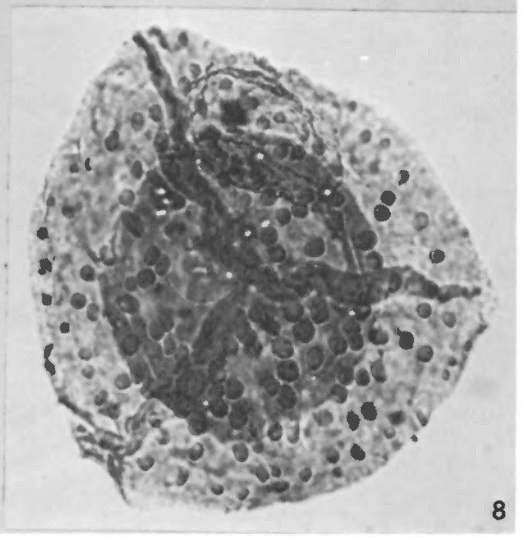
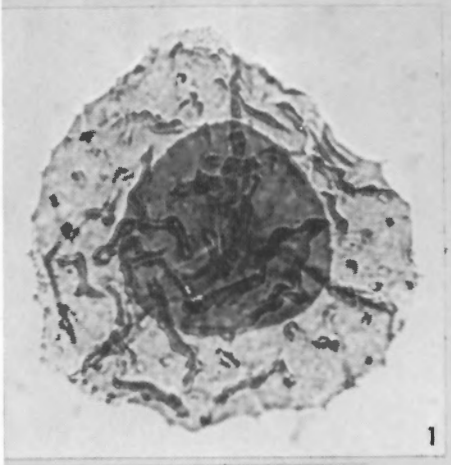

8

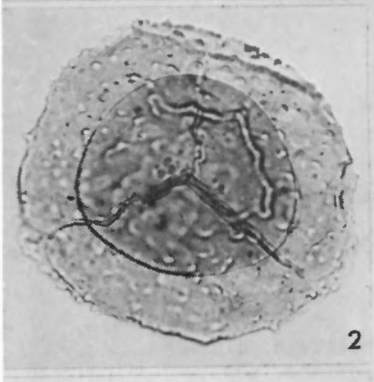
PLATE XIV

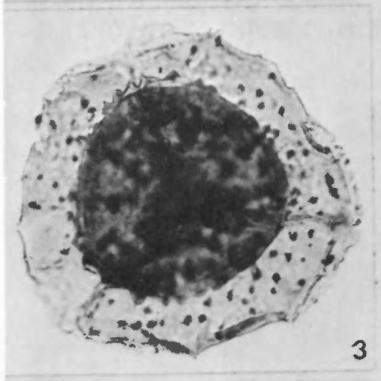
(All figures x330, and from unretouched negatives)

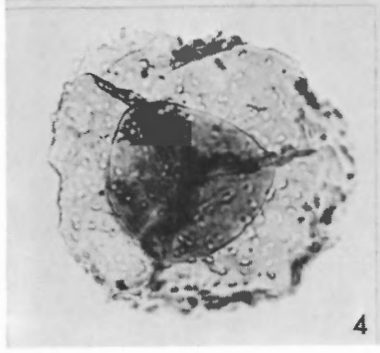
Figures 1-4 *Grandispora mammillata* n. sp. (Page 48)
1, holotype, distal surface, GSC No. 15599; 2, proximal surface, GSC No. 15600; 3, subpolar view, GSC No. 15601; 4, proximal surface, GSC No. 15602.

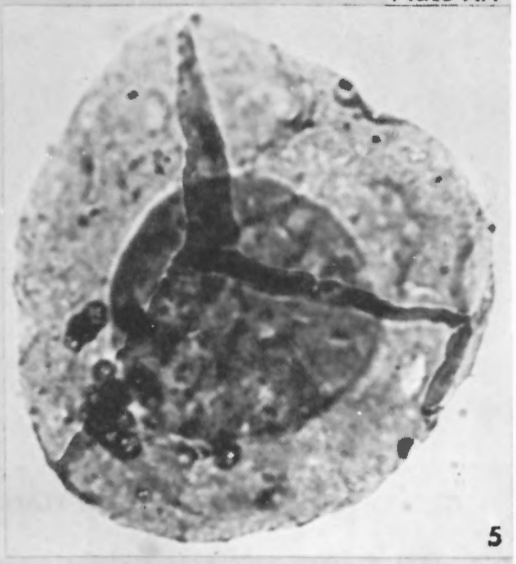
Figures 5, 6 *Auroraspora macromanifestus* (Hacquebard) Richardson, 1960 (Page 55)
5, proximal surface, GSC No. 15603; 6, proximal surface, GSC No. 15604.


1


2


3


4


5

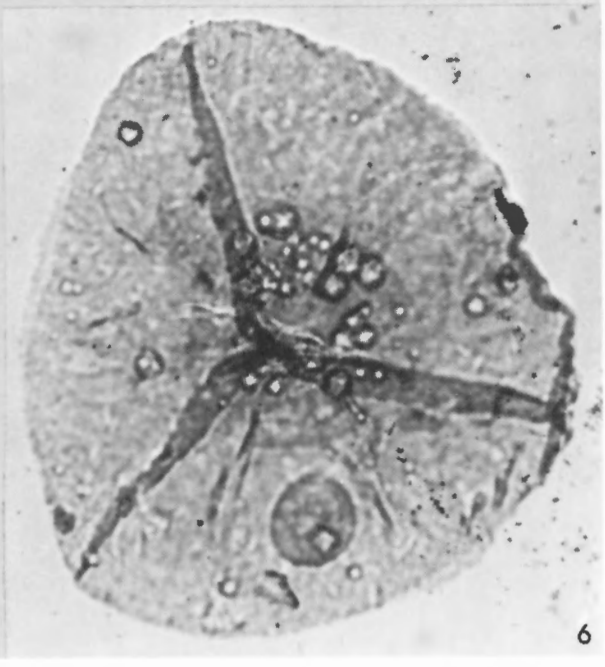

6

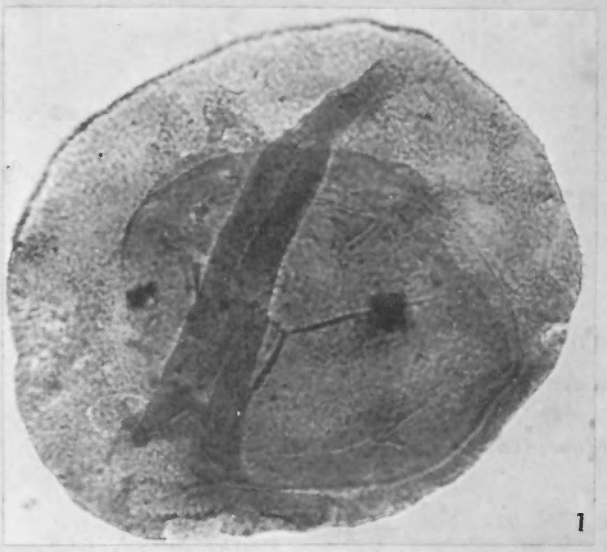
PLATE XV

(All figures x500 except where otherwise stated, and from unretouched negatives)

Figures 1, 2 *Rhabdosporites langi* (Eisenack) Richardson, 1960 (Page 50)
1, proximal surface, x330, GSC No. 15605; 2, proximal surface, x330, GSC No. 15606.

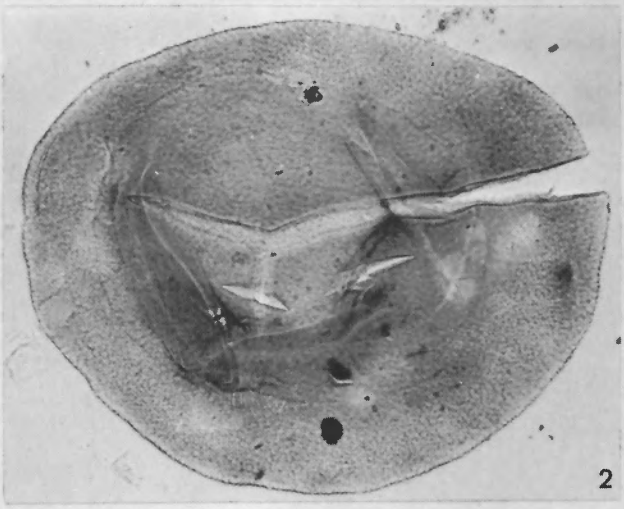
Figures 3-7 *Rhabdosporites micropaxillus* n. sp. (Page 49)
3, subpolar view, GSC No. 15607; 4, holotype, distal surface, GSC No. 15608; 5, proximal surface, x330, GSC No. 15609; 6, subpolar view, GSC No. 15610; 7, proximal surface, GSC No. 15611.

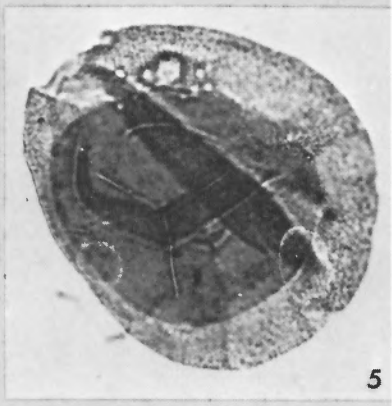
Plate XV


1


3


4


2


5


6

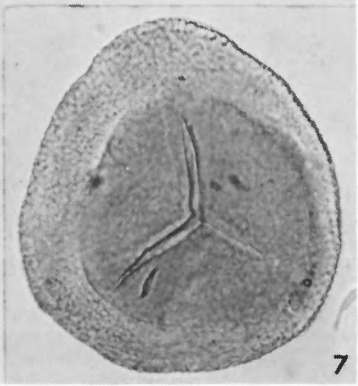

7

PLATE XVI

(All figures x330, and from unretouched negatives)

Figures 1-3 *Contagisporites optivus* (Chibrikova) n. comb. var. *optivus* (Page 52)

1, proximal surface, GSC No. 15612; 2, proximal surface, GSC No. 15613; 3, proximal surface, GSC No. 15614.

Figures 4-6 *Contagisporites optivus* var. *vorobjevensis* (Chibrikova) n. comb. (Page 53)

4, subpolar view, GSC No. 15615; 5, subpolar view, GSC No. 15616; 6, subpolar view, GSC No. 15617.

Plate XVI

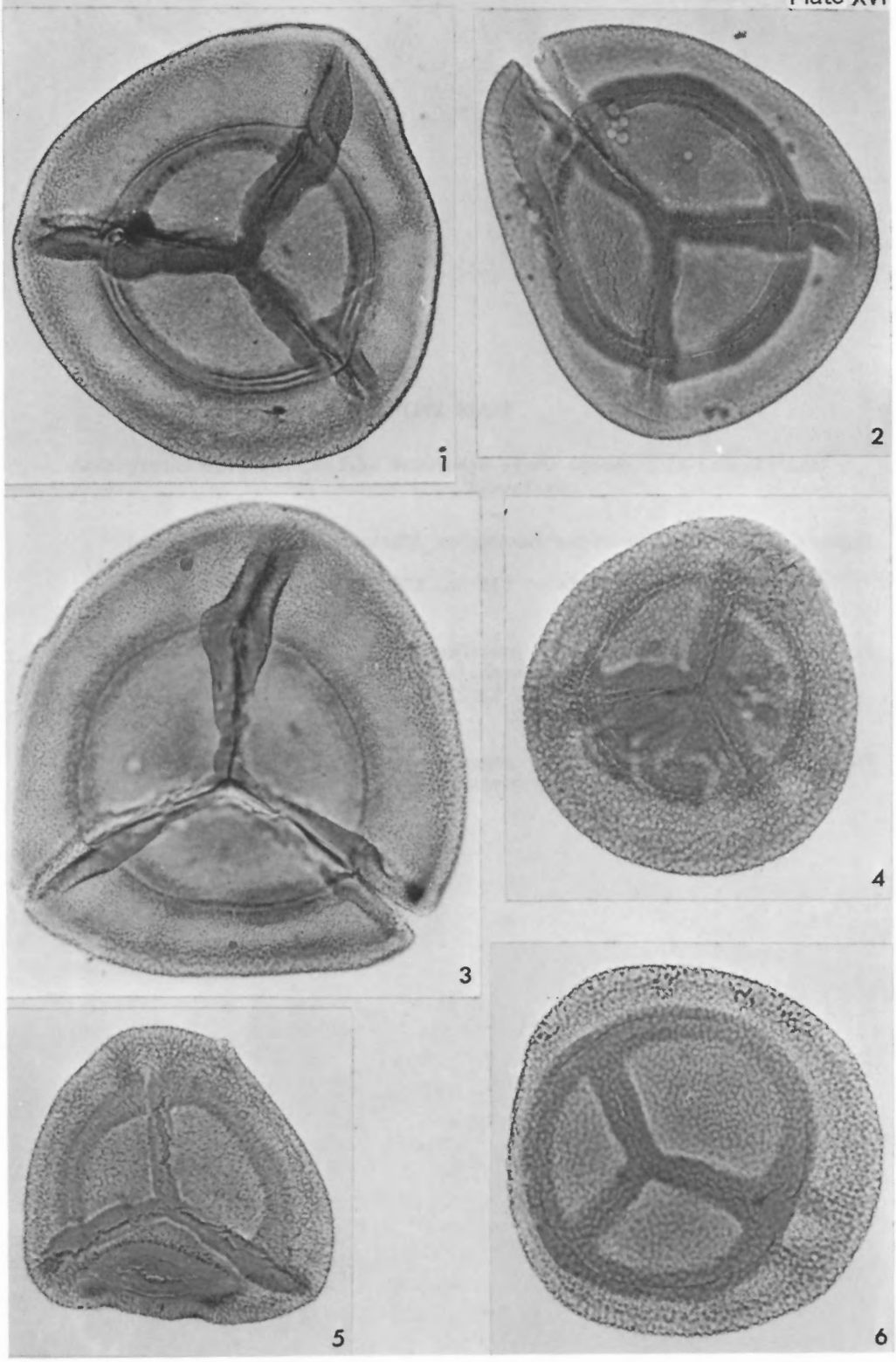


PLATE XVII

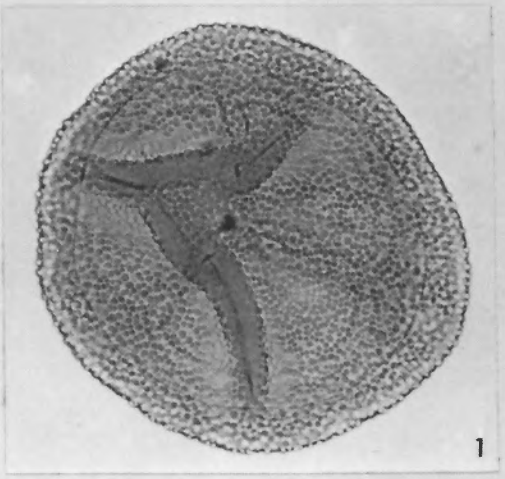
(All figures x500 except where otherwise stated, and from unretouched negatives)

Figures 1, 2 *Contagisporites subnotatus* (Chibrikova) n. comb. emend. (Page 54)
1, distal surface, GSC No. 15618; 2, distal surface, GSC No. 15619.

Figures 3-5 *Spinozonotriletes cassideus* n. sp. (Page 55)
3, lateral compression, x330, GSC No. 15620; 4, subpolar view, x330, GSC No. 15621; 5, holotype, distal surface, x330, GSC No. 15622.

Figure 6 ?*Spinozonotriletes rugosus* n. sp. (Page 57)
Holotype, oblique compression, GSC No. 15623.

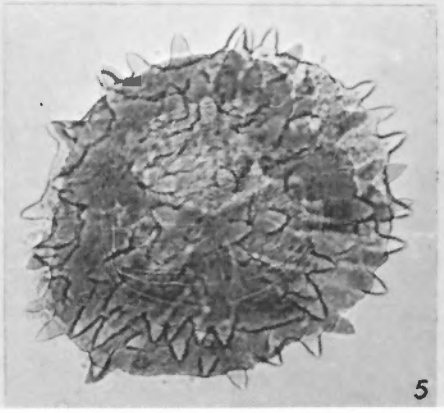
Plate XVII


1


2


3


4


5

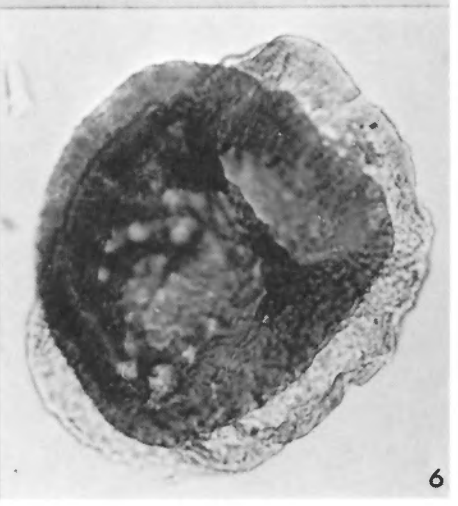

6

PLATE XVIII

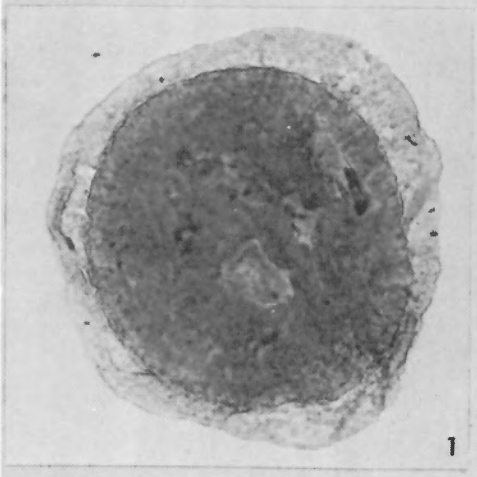
(All figures x500 except where otherwise stated, and from unretouched negatives)

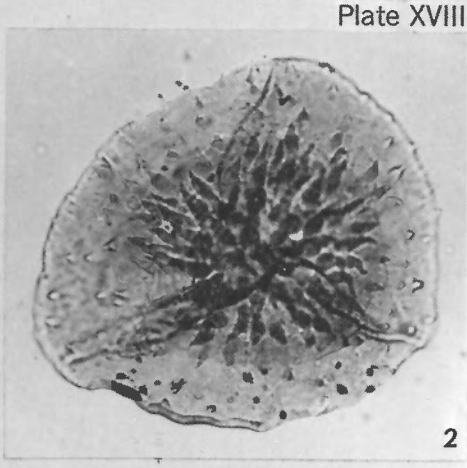
Figure 1 *?Spinozonotriletes rugosus* n. sp. (Page 57)
Subpolar view, GSC No. 15624.

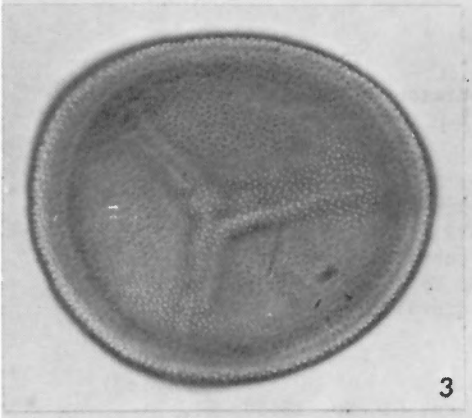
Figure 2 *?Spinozonotriletes* sp. A. (Page 58)
Distal surface, x330, GSC No. 15625.

Figures 3-6 *Geminospora antaxios* (Chibrikova) n. comb. (Page 60)
3, 5, distal and proximal surfaces respectively, GSC No. 15626; 4, proximal surface, GSC No. 15627; 6, distal surface, GSC No. 15628.

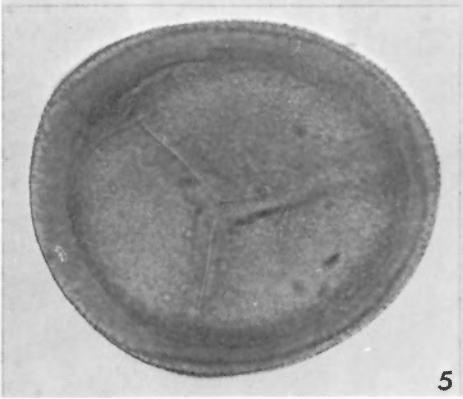
Plate XVIII


1


2


3


4


5

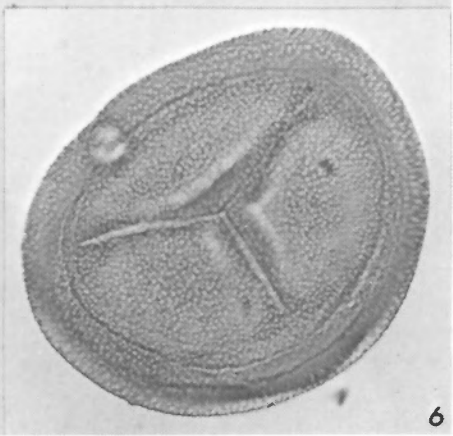

6

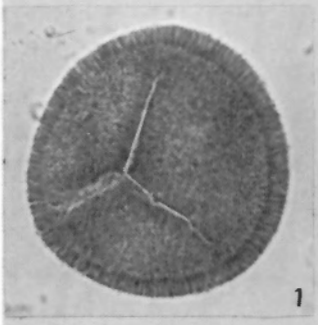
PLATE XIX

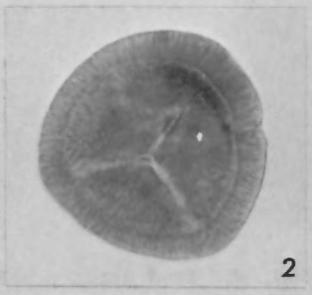
(All figures x500, and from unretouched negatives)

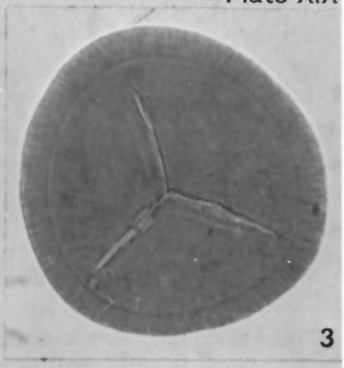
Figures 1-9 *Geminospora punctata* n. sp. (Page 61)
1, proximal surface, GSC No. 15629; 2, subpolar view, GSC No. 15630; 3, proximal surface, GSC No. 15631; 4, distal surface, GSC No. 15632; 5, holotype, proximal surface, GSC No. 15633; 6, subpolar view, GSC No. 15634; 7, subpolar view, GSC No. 15635; 8, proximal surface, GSC No. 15636; 9, distal surface, GSC No. 15637.

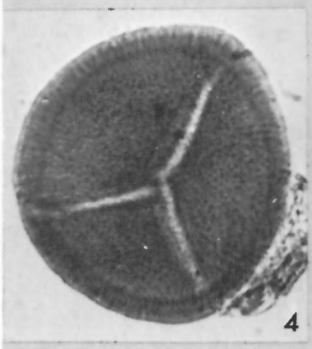
Figures 10-12 *Geminospora verrucosa* n. sp. (Page 63)
10, holotype, proximal surface, GSC No. 15638; 11, lateral compression, GSC No. 15639; 12, subpolar view, GSC No. 15640.

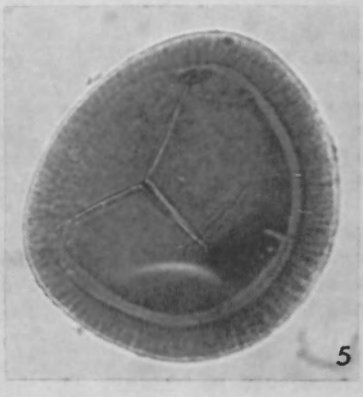
Plate XIX

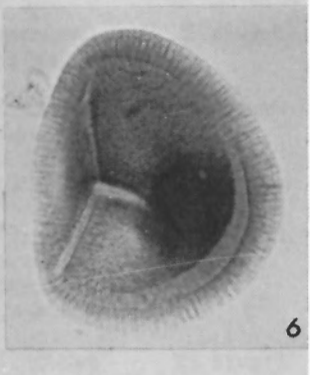

1

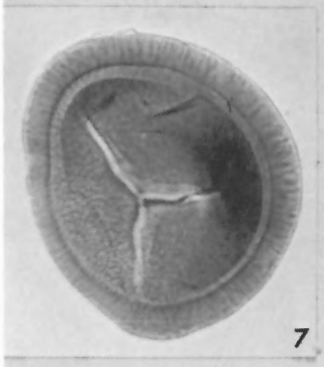

2

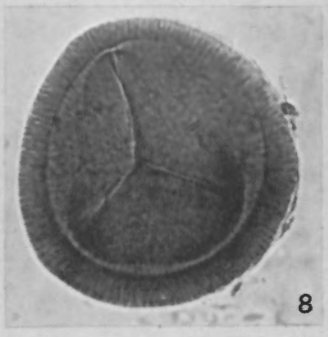

3


4

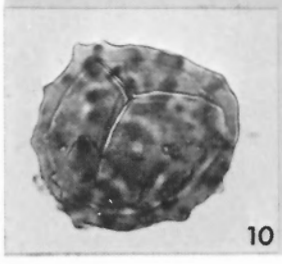

5

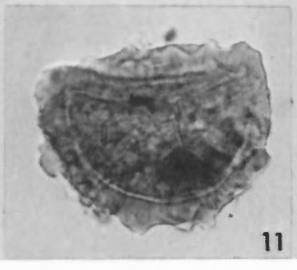

6


7


8


9


10


11

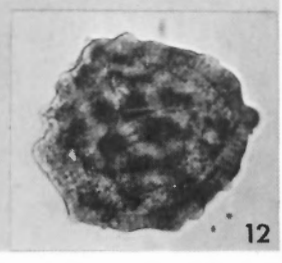

12

PLATE XX

(All figures x500, and from unretouched negatives)

Figures 1, 2	*Geminospora plicata* n. sp. 1, holotype, proximal surface, GSC No. 15641; 2, proximal surface, GSC No. 15642.	(Page 64)
Figure 3	*Geminospora* sp. A. Subpolar view, GSC No. 15643.	(Page 64)
Figures 4-7	*Perotrilites aculeatus* n. sp. 4, subpolar view, GSC No. 15644; 5, holotype, distal surface, GSC No. 15645; 6, distal surface, GSC No. 15646; 7, subpolar view, GSC No. 15647.	(Page 65)
Figures 8-10	*Perotrilites minor* n. sp. 8, subpolar view, GSC No. 15648; 9, holotype, proximal surface, GSC No. 15649; 10, distal surface, GSC No. 15650.	(Page 66)
Figure 11	*Perotrilites* sp. A. Distal surface, GSC No. 15651.	(Page 66)
Figure 12	*Latosporites* sp. B. Subpolar view, GSC No. 15652.	(Page 68)
Figure 13	*Latosporites* sp. A. Proximal surface, GSC No. 15653.	(Page 67)

Plate XX

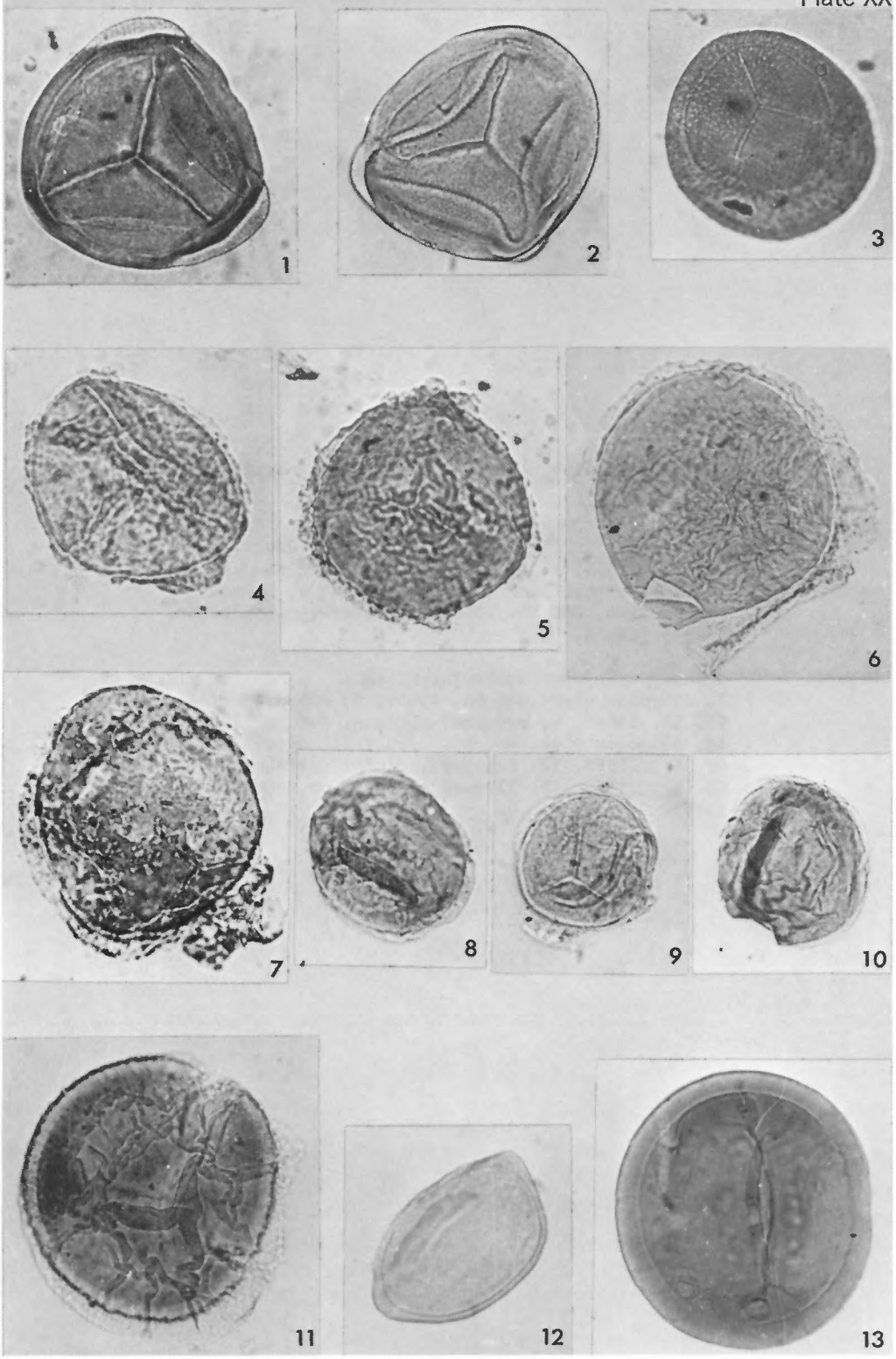


PLATE XXI

(All figures x500, and from unretouched negatives)

Figures 1-6 *Archaeoperisaccus oblongus* n. sp. (Page 68)
1, proximal surface, GSC No. 15654; 2, distal surface, GSC No. 15655; 3, 6, holotype, proximal and distal surfaces respectively, GSC No. 15656; 4, lateral compression, GSC No. 15657; 5, lateral compression, GSC No. 15658.

Figures 7-13 *Archaeoperisaccus scabratus* n. sp. (Page 69)
7, subpolar view, GSC No. 15659; 8, subpolar view, GSC No. 15660; 9, proximal surface, GSC No. 15661; 10, subpolar view, GSC No. 15662; 11, proximal surface, GSC No. 15663; 12, holotype, distal surface, GSC No. 15664; 13, lateral compression, GSC No. 15665.

Plate XXI

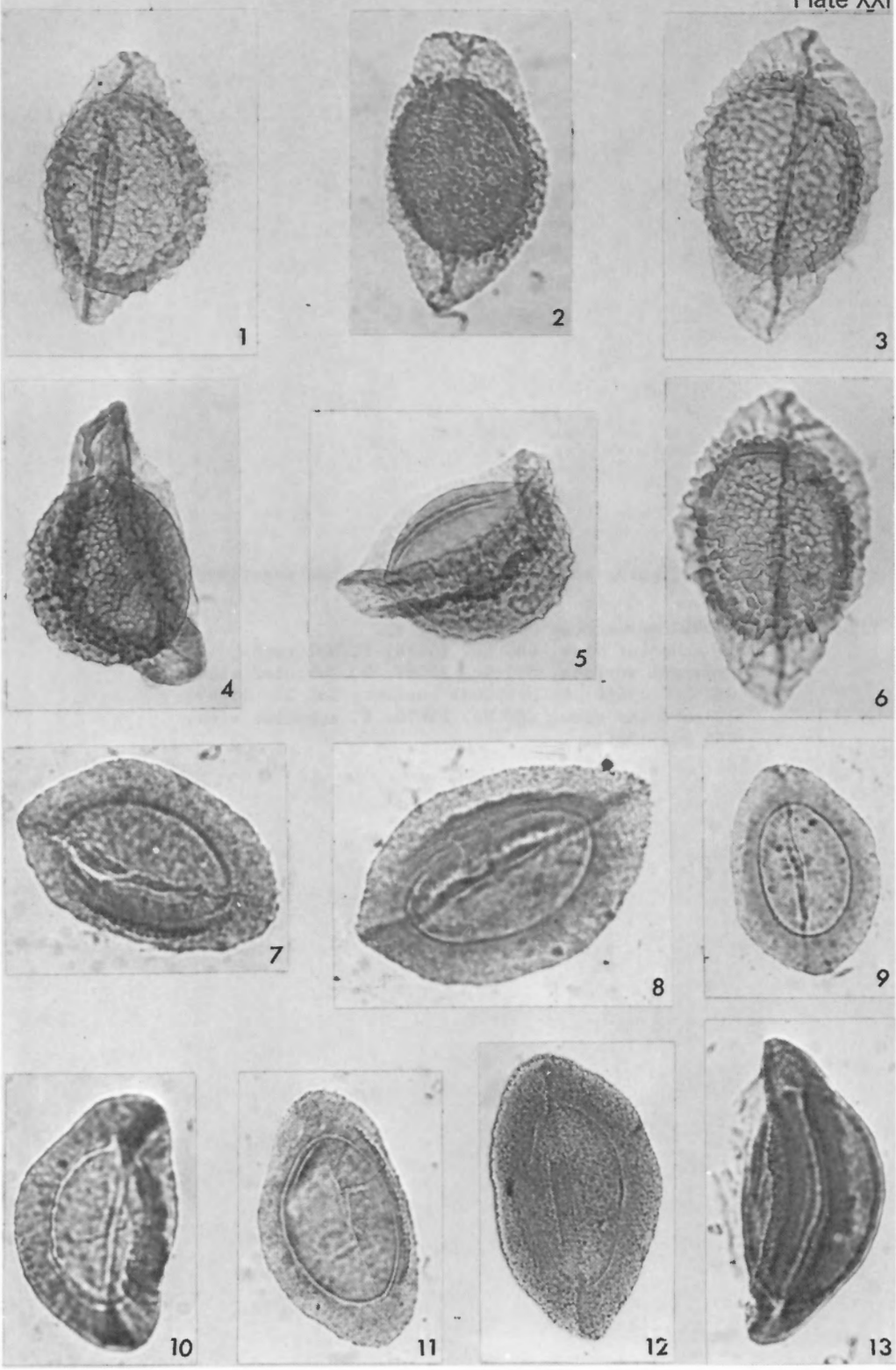


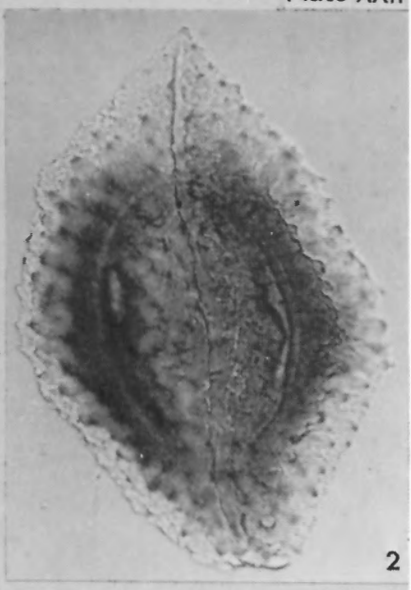
PLATE XXII

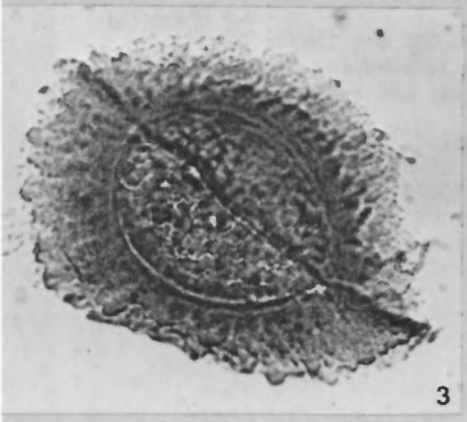
(All figures x500, and from unretouched negatives)

Figures 1-6 *Archaeoperisaccus opiparus* n. sp. (Page 70)
1, subpolar view, GSC No. 15666; 2, holotype, proximal surface, GSC No. 15667; 3, subpolar view, GSC No. 15668; 4, proximal surface, GSC No. 15669; 5, subpolar view, GSC No. 15670; 6, subpolar view, GSC No. 15671.

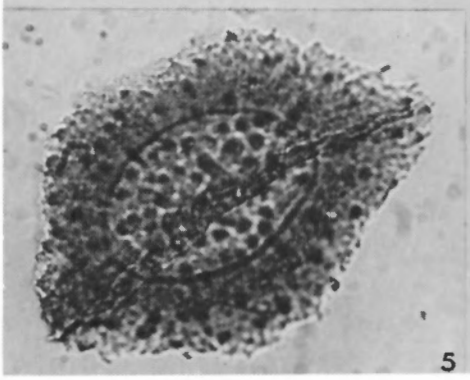
Plate XXII


1


2


3


4


5

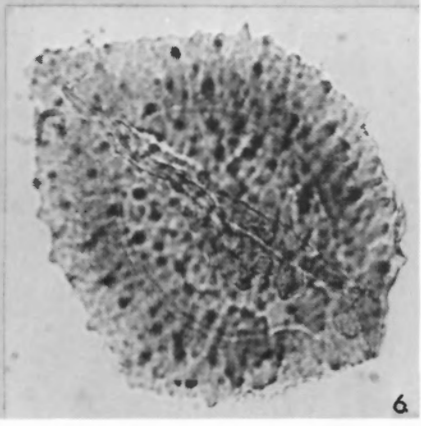

6

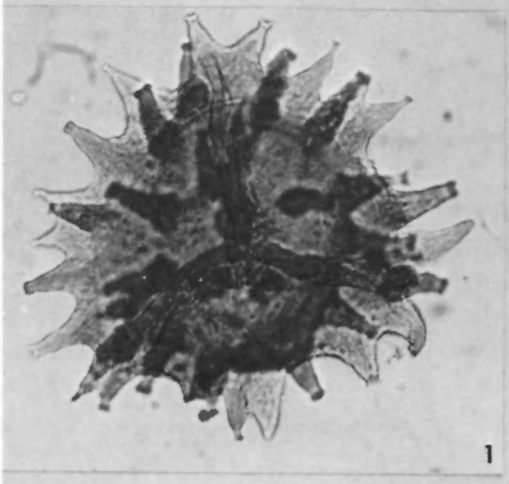
PLATE XXIII

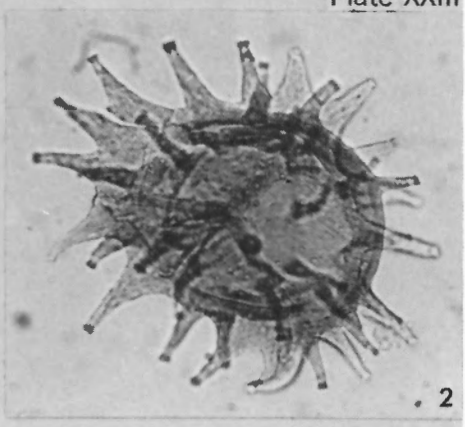
(All figures x500, and from unretouched negatives)

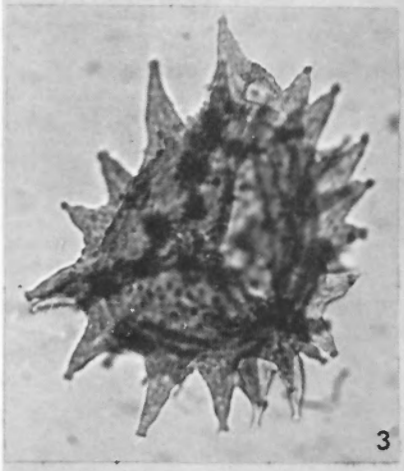
Figures 1-4 *Ancyrospora furcula* n. sp. (Page 71)
1, holotype, proximal surface, GSC No. 15672; 2, subpolar view, GSC No. 15673; 3, subpolar view, GSC No. 15674; 4, subpolar view, GSC No. 15675.

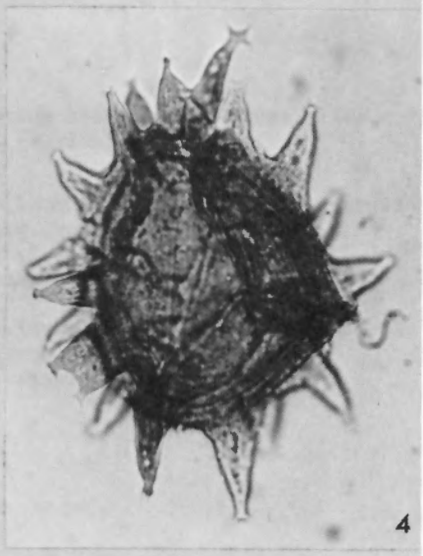
Figures 5, 6 *Ancyrospora melvillensis* n. sp. (Page 72)
5, holotype, distal surface, GSC No. 15676; 6, proximal surface, GSC No. 15677.

Plate XXIII


1


2


3


4


5

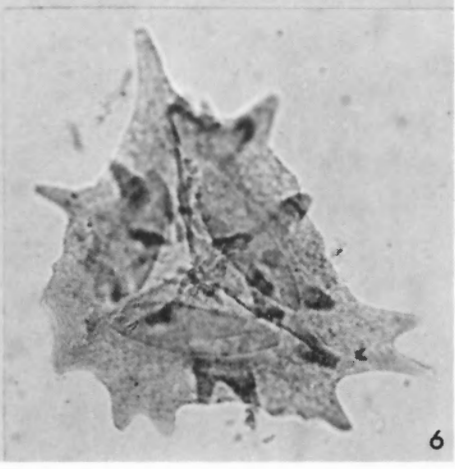

6

PLATE XXIV

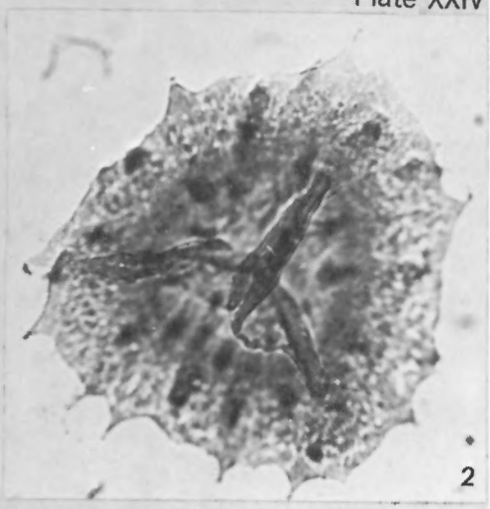
(All figures x500 except where otherwise stated, and from unretouched negatives)

Figures 1-4 *Ancyrospora ampulla* n. sp. (Page 73)
1, 3, holotype, proximal and distal surfaces respectively, GSC No. 15678; 2, proximal surface, GSC No. 15679; 4, proximal surface, GSC No. 15680.

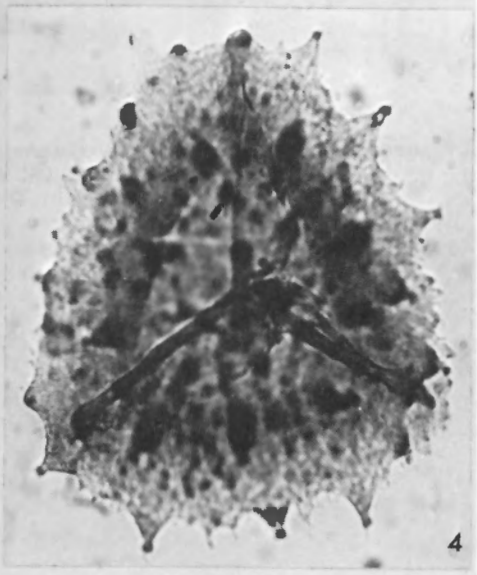
Figures 5, 6 *Ancyrospora involucra* n. sp. (Page 74)
5, holotype, subpolar view, x330, GSC No. 15681; 6, proximal surface, x330, GSC No. 15682.

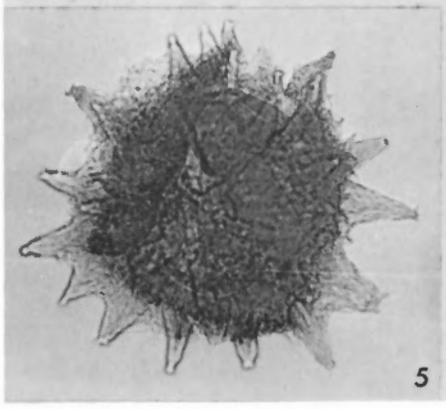
Plate XXIV


1


2


3


4


5

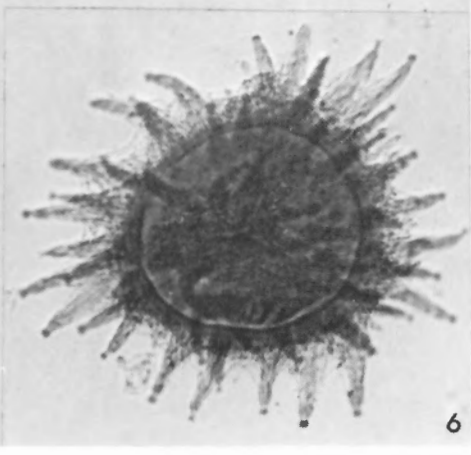

6

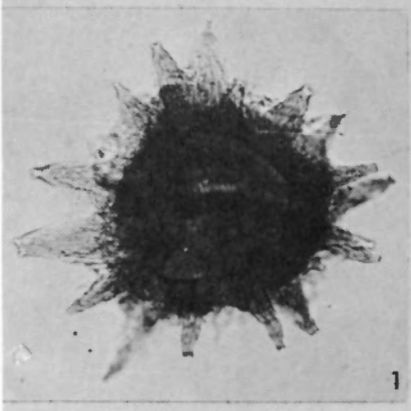
PLATE XXV

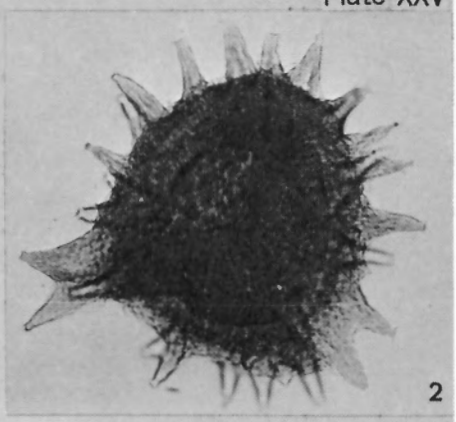
(All figures x330, and from unretouched negatives)

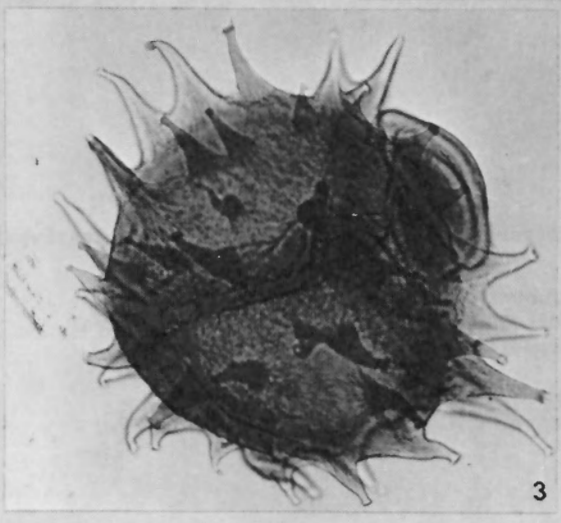
Figures 1, 2 *Ancyrospora involucra* n. sp. (Page 74)
1, subpolar view, GSC No. 15683; 2, subpolar view, GSC No. 15684.

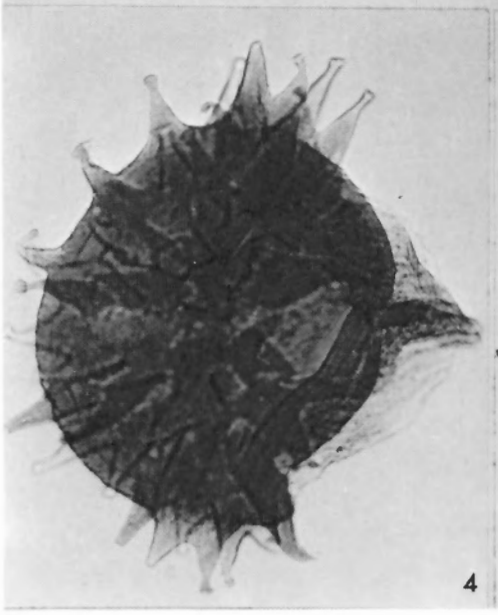
Figures 3-5 *Ancyrospora pulchra* n. sp. (Page 75)
3, distal surface, GSC No. 15685; 4, lateral compression, GSC No. 15686; 5, holotype, subpolar view, GSC No. 15687.

Plate XXV


1


2


3


4

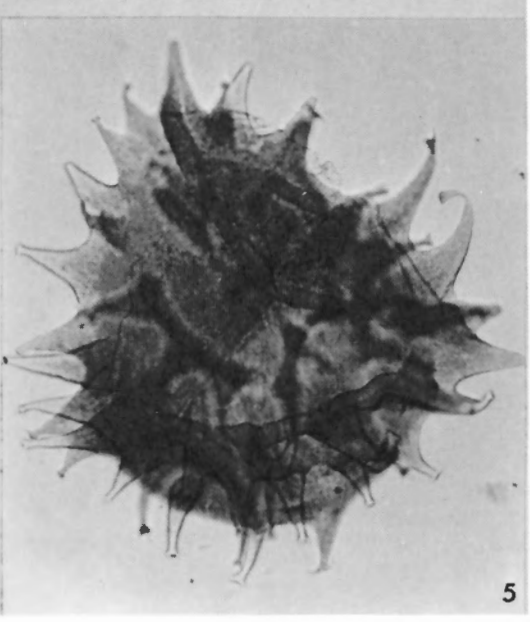
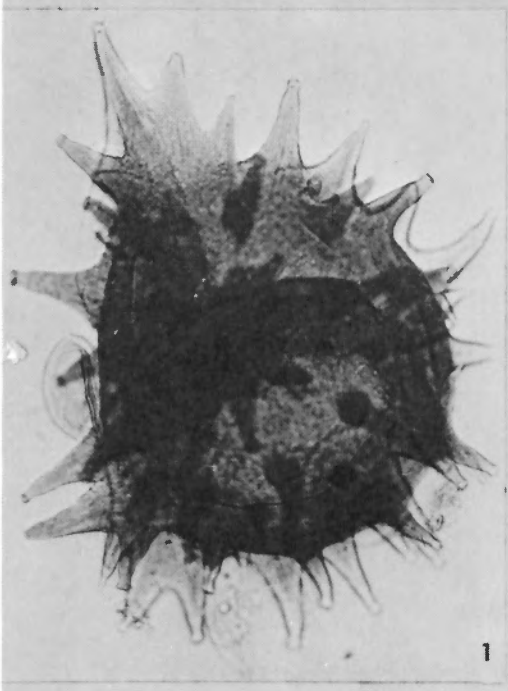

5

PLATE XXVI

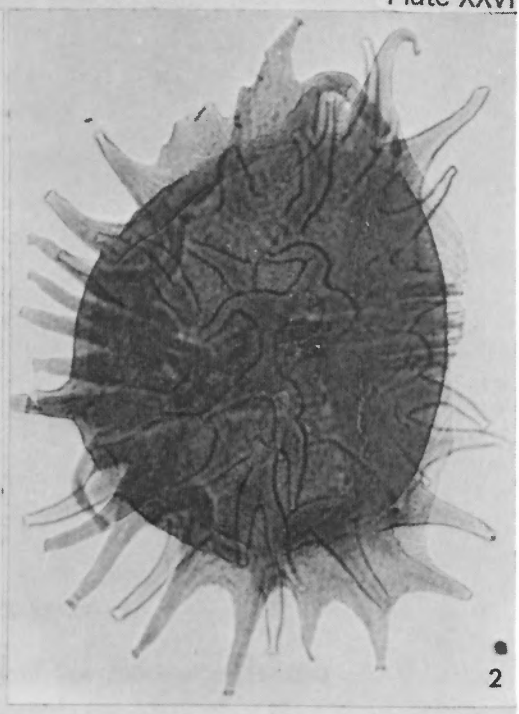
(All figures x330, and from unretouched negatives)

Figures 1, 2 *Ancyrospora pulchra* n. sp. (Page 75)
1, subpolar view, GSC No. 15688; 2, lateral compression, GSC No. 15689.

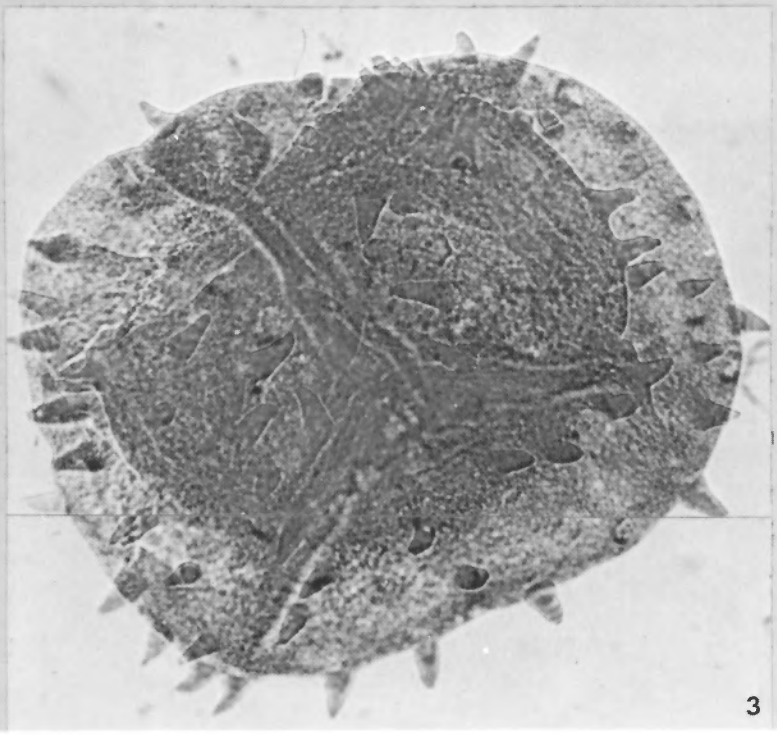
Figure 3 *?Ancyrospora magnifica* n. sp. (Page 77)
Holotype, distal surface, GSC No. 15690.



1



2



3

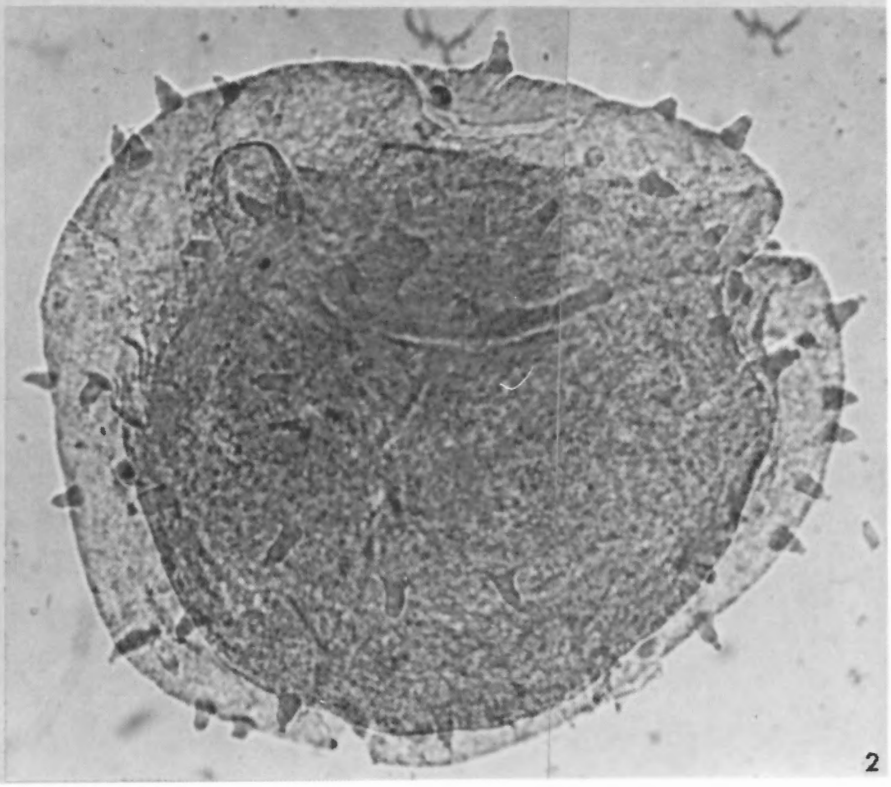
PLATE XXVII

(All figures x330, and from unretouched negatives)

Figures 1, 2 ?*Ancyrospora magnifica* n. sp. (Page 77)
1, lateral compression, GSC No. 15691; 2, distal surface, GSC No. 15692.

Plate XXVII

1



2

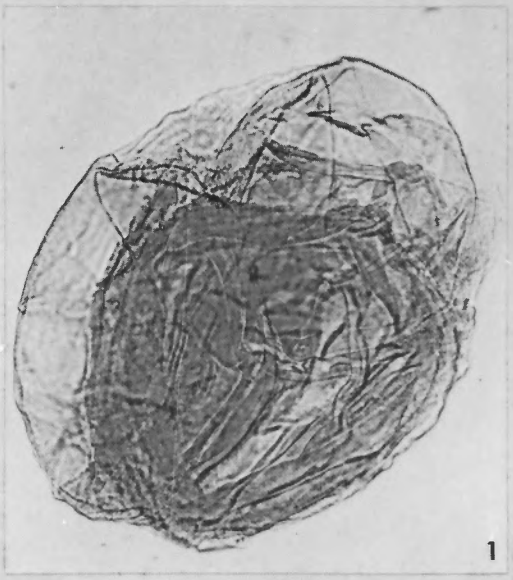
PLATE XXVIII

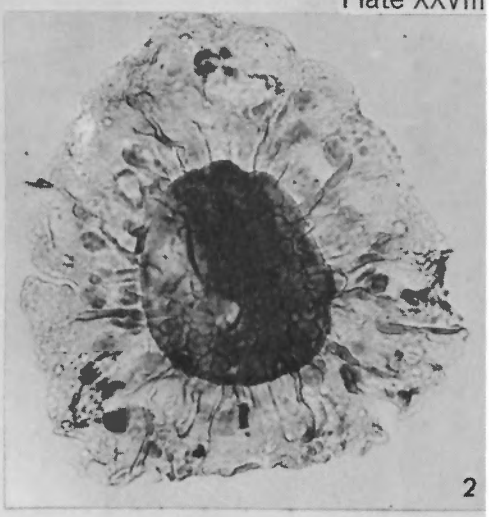
(All figures x330, and from unretouched negatives)

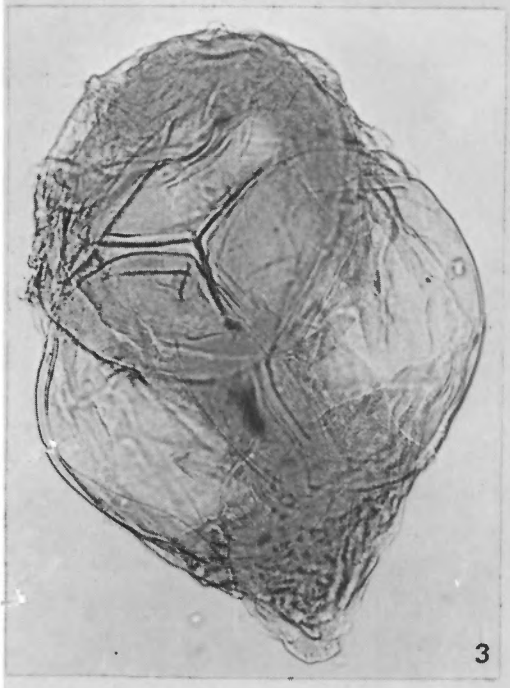
Figures 1, 3, 5 Spore Type A. (Page 78)
1, tetrad of spores, GSC No. 15693; 3, tetrad of spores, GSC No. 15694; 5, individual spore isolated from tetrad, GSC No. 15695.

Figures 2, 4 Spore Type B. (Page 78)
2, distal surface, GSC No. 15696; 4, distal surface, GSC No. 15697.

Plate XXVIII


1


2


3


4


5

ADDENDUM

February 10, 1971

Since the completion of this manuscript, two papers have been written that have significant bearing on the data presented here.

D.C. McGregor and T.T. Uyeno in "Stratigraphic ranges of spores and conodonts of Devonian rocks of Melville and Bathurst Islands, Northwest Territories", Geol. Surv. Can. Paper (in preparation), refer to several new species of spores that are named and described formally in the present paper. They are:

Ancyrospora n. sp. 1 (=*A. melvillensis* Owens n. sp.)
Ancyrospora n. sp. 2 (=*A. furcula* Owens n. sp.)
Apiculatisporis n. sp. (*A. microechinatus* Owens n. sp.)
Archaeoperisaccus n. sp. 1 (=*A. oblongus* Owens n. sp.)
Archaeoperisaccus n. sp. 2 (=*A. opiparus* Owens n. sp.)
Camarozonotriletes n. sp. (=*C. parvus* Owens n. sp.)
Convolutispora n. sp. (=*C. subtilis* Owens n. sp.)
Geminospora n. sp. 1 (=*G. verrucosa* Owens n. sp.)
Geminospora n. sp. 2 (=*G. punctata* Owens n. sp.)
Grandispora n. sp. (=*G. mammillata* Owens n. sp.)
Hystricosporites n. sp. 1 (=*H. gravis* Owens n. sp.)
Hystricosporites n. sp. 2 (=*H. reflexus* Owens n. sp.)
Hystricosporites n. sp. 3 (=*H. furcatus* Owens n. sp.)
New genus n. sp. (=*Verruciretusispora robusta* Owens n. gen., n. sp.)
Rhabdosporites n. sp. (=*R. micropaxillus* Owens n. sp.)
Samarisporites n. sp. (=*S. concinnus* Owens n. sp.)
?Spinozonotriletes n. sp. (=*?S. rugosus* Owens n. sp.)
Verrucosisporites n. sp. (=*V. confertus* Owens n. sp.)

D.C. McGregor, in "Devonian plant fossils of the genera *Kryshtofovichia, Nikitinsporites,* and *Archaeoperisaccus*", Geol. Surv. Can. Bull. 182, 1969, p. 100, has emended the genus *Archaeoperisaccus*. All of the species of *Archaeoperisaccus* described in the present paper are assignable to the genus as emended.